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*LEGISLATION RELATING TO STANDARDS.**

ONE of the first official acts of the National Academy of Sciences, in the capacity of scientific adviser of the government, was the appointment, at the request of the Secretary of the Treasury, in 1863, the year in which the Academy received its charter, of a Committee on Coinage, Weights and Measures, which has continued to be a standing committee of the Academy. The report of this committee in 1866 was one of the effective forces in securing the passage of the most important, and, until recently, the only act of Congress constituting general legislation on the subject of weights and measures. In view of these facts, and on account of the remarkable progress towards unification of standards which has been made during the past few years, affecting in one way or another the whole civilized world, and especially in view of very recent activity and interest in this country, it seems proper to invite the attention of the Academy to a brief resumé of National legislation relating to weights and measures, from the founding of the National Government to the present moment. The task is rendered comparatively easy from the fact, for which metrologists can hardly be too thankful, that such legislation is extremely meager. It is a cause for sincere congratulation that in this respect, at least,

*Presented to the National Academy of Sciences at its April meeting.

the powers conferred upon Congress by the Constitution of the United States have not hitherto been exercised in full. The importance of investing the sole power of regulating standards of weight and measure in the National government was recognized in the Articles of Confederation and expressed in the Constitution of the United States. The importance of a judicious exercise of that power was emphasized by Washington in his first message to Congress. By direction of Congress, the Secretary of State, Thomas Jefferson, made a report on July 15, 1790, in which he proposed an extremely interesting scheme founded on the length of a uniform rod which would make a single vibration per second when swinging from one extremity.

Jefferson fully appreciated the advantage of a decimal system of weights and measures, and the scheme proposed by him was as purely decimal as that of the Metric System, and in passing from the unit of length to that of volume and mass resembled it greatly. It may be truly said that full credit has never been accorded this, the most accomplished of the fathers of the Republic, for his nearly complete anticipation of the results of the labor of the most brilliant men of the most brilliant period of French science. Jefferson's report was referred to a committee in the Senate which, having learned of the movement toward uniformity in France and other European countries, reported that, in view of that movement, they considered it inexpedient to make any changes in the existing systems. Thus a little more than a hundred years ago the policy of 'waiting for the Metric System' was inaugurated and has practically continued to be the policy up to the present time. Occasional further references to the matter were made in reports, messages, bills offered, etc., during the last years of the last century, but no legislation resulted other than the inspection law of 1799, noted below. At least one important consequence followed a reference to the desirability of action in the message of President Madison, sent to Congress on December 3, 1816. The paragraph relating to weights and measures was referred by the Senate to the Secretary of State, who was requested to prepare a report in full upon the subject, including such measures 'as may be proper to be adopted in the United States.' Four years later the Secretary, John Quincy Adams, transmitted to the Senate his famous report, which must always be regarded as a classic. For exhaustiveness, elaboration of detail and thoroughness of treatment no other document in any language relating to this subject is comparable with it. While it has been a storehouse of information and argument for all metrologists of later date, it did not result in any very decided action on the part of Congress. "Let them take the one or the other, according to the degree of their courage," Jefferson had said when, in 1792, he proposed two schemes, the one being a patching up of existing systems and the other a sweeping reform through the adoption of a decimal ratio throughout. While no one has appreciated the merits of the Metric System more completely than did Adams, and no one has ventured to praise it more highly, at the end of his splendid contribution to metrological science he reached the rather impotent conclusion that Congress ought to fix the existing systems with the partial uniformity of which they may be susceptible, excluding all innovations for the present, and that consultation with foreign nations should be begun, looking to the future establishment of universal and permanent uniformity. It is difficult to estimate what the lack of courage on the part of a great and far-seeing statesman has cost the people of the United States. The population of the whole country at that time did not exceed ten millions, and a change in standards of measure would have been comparatively easy.

The first act of Congress relating to the establishment of standards of weight and measure was that of May 19, 1828, in which a certain brass troy-pound weight which had been procured in London for the use of the mint at Philadelphia was declared to be the standard troy pound. This standard is well known to all metrologists. It was made by Capt. Kater in 1827, being a copy of the imperial troy pound taken from the House of Commons for that purpose. It is of brass, approximately pear-shaped, and its adjustment was accomplished by the addition of fine wires placed in a cavity in the upper part of the weight. Owing to this peculiarity of construction, it is impossible to know its density, and it has only historical value as a standard.

The next legislation by Congress was in the form of a resolution adopted in June, 1836, directing the Secretary of the Treasury to cause a complete set of all standards adopted by the Treasury Department for use in the custom houses and for other purposes, to be delivered to the Governor of each State of the Union. This was a useful measure, calculated and intended to give effect to the recommendation of Adams fifteen years earlier. It resulted in a tolerably complete unformity of standards of length and mass throughout the Union.

A quarter of a century now passed without further National legislation on the subject. In the meantime, and especially towards the latter part of this period, the attention of many intelligent people in different parts of the country had been drawn to the great superiority of the Metric System of weights and measures, which had gone into extensive use in Europe, Mexico, Central and South America, and the enormous burden borne by English-speaking people in maintaining the customary standards had begun to make itself evident. As early as 1859, the legislature of New Hampshire urged upon Congress the necessity for reform and the adoption of a decimal system. Maine followed in 1860 and Connecticut in 1861. In his first annual report as Secretary of the Treasury, Mr. Chase, in December, 1861, again brought the subject to the attention of Congress, and, as already stated, at his request the National Academy appointed its Committee for the consideration of the subject in 1863.

Although matters of greater moment occupied the time of Congress and filled the public mind during the five years following that of 1860, much progress was made towards a rational system of metrology, especially through the active interest of a few individuals and societies. For the final culmination of this agitation in the passage of the Metric Law of 1866, we are unquestionably indebted to Mr. John A. Kasson more than to any other one man. In 1861 Mr. Kasson was appointed First Assistant Postmaster-General by President Lincoln. In this office he became aware of the great embarrassment in the administration of international postal laws arising out of a lack of uniformity of units of weight and currency. Seeking relief therefrom, he originated and represented the United States in the International Postal Conference held in Paris in 1863, on the invitation of Mr. Seward, Secretary of State, which was, in fact, the forerunner of the International Postal Union, organized a little more than ten years later. One of the recommendations of the conference of 1863 was that the Metric System of weights be adopted for postal purposes. Mr. Kasson resigned the office which he held in the Postoffice Department in order to take his seat in Congress in December, 1863. Here his opportunities for advancing the interests of metrological reform were greatly enlarged. Having been appointed to serve on the Committee of Ways and Means and finding that that committee had within its jurisdiction the subjects of 'Coinage, Weights and Measures,' he sought the creation of a separate committee, which should be exclusively charged with the consideration of these subjects and obtained from the House an order to that effect. Of this important committee, Mr. Kasson was made Chairman, and, beginning as it did, it has, during the thirty years of its existence as a standing committee of Congress, generally been favorable to metrological progress. During the next two or three years Mr. Kasson made an exhaustive study of the subject and did much to concentrate the growing interest in the Metric System and to guide the activity of various scientific bodies, commercial organizations, etc. In a private letter referring to this very important period in the history of legislation relating to standards, he speaks in highest praise of the invaluable assistance rendered by our Associate, Professor H. A. Newton, of Yale University, to whom was committed the task of preparing the tables of relation and conversion which accompanied the report of the committee and which form a part of the statute. In January, 1866, the Committee of the Academy on Coinage Weights and Measures made its report, and on May 17th Mr. Kasson submitted to Congress the report of the committee of the House of Representatives, unanimously recommending accompanying bills and resolutions, which, with a single exception, afterward were enacted into laws, and on July 28, 1866, the use of the Metric System was legalized by Act of Congress for the whole United States, being then and for many years the only system of weights and measures having the authority of National legislation. In the passage of this bill through the House, Mr. Kasson feared opposition, due, as he says, 'to the love of talk,' and to avoid furnishing a text for debate he tactfully declined to make a speech in favor of the passage of the bills and resolutions, simply offering to answer any questions which might be asked. His policy was successful, and the proposed Act being only permissive and not obligatory in character, the whole matter was disposed of favorably in an hour or two. In the Senate the bill was referred to a special committee, of which Charles Sumner, who took a lively interest in the matter, was chairman. Sumner was generally eager to lead in reforms of this kind, and after mastering the material which was put into his hand he prepared an elaborate and scholarly speech in favor of the measure, which, however, he refrained from delivering, it is believed, on the advice and suggestion of Mr. Kasson. In this speech, which was afterwards printed, in a manner which was somewhat characteristic of the great champion of human liberty and the rights of man, he ignored in a great measure the work of the House Committee on Weights and Measures, if not, indeed, the action of the House, and was lauded by a portion of the public press as the successful first champion of this very important step towards a more advanced civilization. I have gone into these details concerning the Act of 1866 because of the real moment and significance of that Act. Although it produced little if any immediate effect in the way of a beginning in the actual use of the system, the attention of the general public was at once turned to it. Nearly all text-books on arithmetic published since that date have included a treatment of the Metric System, and instruction in its use has been given in thousands of schools throughout the country, thus, in a measure, preparing the way for its final exclusive use. In science quite universally, and in many arts, trades and professions, it has come into general use, to the end that at this moment most intelligent people know something of it. For this there is little doubt that we are largely indebted to the Act of 1866 and the agitation which followed its passage The general introduction of the system in the postoffices of the country was contemplated and provided for in Mr. Kasson's Act, and he had ready for future introduction a resolution providing for its compulsory use in the custom houses, thus greatly facilitating its general adoption in trade. His removal from Congress to the Diplomatic Corps of the United States prevented realization of his designs, but metrologists and the public at large should not fail to recognize the splendid services which he rendered in directing the legislation of thirty years ago.

The statutes are silent in the matter of weights and measures for more than a quarter of a century following the Act of 1866. The general trend of public sentiment during this period and the leaning of government authorities towards the final adoption of the Metric System is unmistakably shown, however, in the annual appropriations for the support of the International Bureau of Weights and Measures, to which we were committed as a nation by the International Convention of 1875.

The next legislation relating to standards was an Act, approved March 3, 1893, establishing a standard gauge for sheet and plate iron and steel. This measure is by no means an advance in practical metrology, its enactment being in response to the urgent demands of those actually engaged in the rolling of sheet metal. The influence of the Office of Weights and Measures prevented it from involving certain unscientific and physically impossible conditions, besides securing the use of metric units as well as the pound, foot and inch. It also secured the addition of a 'limit of error' or tolerance, a very important part of practical legislation in metrology, which has hitherto been almost, if not quite, absolutely neglected in this country.

Although not an Act of National legislation, a step of great importance was taken on April 5, 1893, in the approval by the Secretary of the Treasury of a Bulletin issued by the Superintendent of Weights and Measures announcing the definitive adoption of the International Prototype Metre and Kilogramme as fundamental standards of length and mass and declaring that in the future the customary units, the yard and the pound, would be derived from them, in accordance with the Act of 1866. This put the government of the United States, as far as relates to the operations of all the Departments (with the single exception of the mint, for which the old troy pound remains a standard as explained above), on an international metric basis, all measures in ordinary use being derivatives of the metre and kilogramme.

The next step in metrological legislation was the Act of July 12, 1894, establishing a series of units for electrical measurement. This Act grew out of the recommendation of the International Electrical Congress held in Chicago in 1893. The units which it establishes are all founded on the centimetre, the gramme and the second, and it is distinctly a 'Metric' Act. For the successful management of this important Act, from the time of its introduction in the House, through its reference to the committees in both House and Senate and up to the time of its approval by the President, we are very largely indebted to Hon. Charles W. Stone, member of Congress from Pennsylvania, then a member and now Chairman of the House Committee on Coinage, Weights and Measures, who, by reason of his tastes and training, had an intelligent comprehension of the importance of a measure which was so technical in its character as to be nearly unintelligible to the ordinary legislator. Mr. Stone pressed the bill through its various stages with tact and influence to its final enactment as a law, at a time and under conditions when very little legislation of any kind was possible, and the obligations under which he has placed metrologists is a matter worthy of record.

Up to the present date this Act completes the list of statutes relating to weights and measures, and it will be seen that in a hundred years only four laws fixing standards have been made. In 1828 the standard of the mint was fixed by law; in 1866 the Metric System was legalized; in 1893 a gauge for measuring sheet iron was established, and in 1894 the units for electrical measurement were defined.

This seems entirely inadequate to the needs of a great nation, and such a condition of things could never have continued had not the several States long ago exercised that authority which by the Constitution belongs to Congress, but which Congress has thus far practically ignored. For reasons already given, this condition is not one to cause regret. It leaves our National law makers to-day practically free from the influence of past legislation, which might be a serious obstacle in the way of following that course which a century of experience has now shown conclusively to be the only wise one.

History shows that marked advances of the character here referred to are usually brought about through the active, personal interest and enthusiasm of a very few men, often not more than one or two. It is true that they must be supported and reënforced by outside influence, but in a matter of this kind it will usually happen that not many members of either House or Senate will have the time or the interest to thoroughly inform themselves of the merits of a measure which does not immediately appeal to them. They depend largely on the few who are well informed, who have made a special study of the subject, and who by reason of their personal character and influence are accepted as authority. A general Act, however, changing either now or at some fixed future time the whole system of metrology in daily and constant use is something which is likely to challenge opposition and to secure which it will be necessary to give the widest possible range to discussion and criticism.

Such an act is now under consideration by Congress. On December 26, 1895, Hon. D. M. Hurley, of New York, introduced a bill looking to the compulsory adoption of the Metric System within the next few years. It was considered with much care by the Committee on Coinage, Weights and Measures, to which it was referred, and on March 16th the Chairman of that Committee, Hon. Chas. Stone, made, by the unanimous direction of the Committee, an elaborate, interesting and valuable report, recommending the passage of a substitute for Mr. Hurley's bill, involving essentially the same principles, but differing from it somewhat as to details. Mr. Stone, as Chairman of the Committee, has championed the bill on the floor of the House with the same interest and skill that characterised his previous efforts in behalf of a scientific metrology. He has been efficiently seconded by Mr. Hurley and others, to the end that the friends of the measure have much confidence in its final success in the next session of Congress. No more important measure has been considered by Congress for many years and no opportunity to pass a law which will be for the great and lasting benefit of the whole of the people in so great a degree as this is likely to present itself for many years to come.

T. C. Mendenhall.

Note.—The following are the Acts referred to above, except that of 1894, defining electric units, which has already been published in this journal:

Act of Congress of 1799, directing a semi-yearly comparison of weights and measures used in custom houses:

Number of gauge.	Approximate thickness in fractions of an inch.	Approximate thickness in decimal parts of an inch.	Approximate thickness in millimeters.	Weight per square foot in ounces avoirdupois.	Weight per square foot in pounds avoirdupois.	Weight per square foot in kilograms.	Weight per square meter in kilograms.	Weight per square meter in pounds avoirdupois.
0000000	1-2	.5	12.7	320	20.00	9.072	97.65	215.28
000000	15-32	.46875	11.90625	300	18.75	8.505	91.55	201.82
00000	7-16	.4375	11.1125	280	17.50	7.983	85.44	188.37
0000	13-32	.40625	10.31875	260	16.25	7.371	79.33	174.91
000	3-8	.375	9.525	240	15.	6.804	73.24	161.46
00	11-32	.34375	8.73125	220	13.75	6.237	67.13	148.00
0	5-16	.3125	7.9375	200	12.50	5.67	61.03	134.55
1	9-32	.28125	7.14375	180	11.25	5.103	54.93	121.09
2	17-64	.265625	6.746875	170	10.625	4.819	51.88	114.37
3	1-4	.25	6.35	160	10.	4.536	48.82	107.64
4	15-64	.234375	5.953125	150	9.375	4.252	45.77	100.91
5	7-32	.21875	5.55625	140	8.75	3.969	42.72	94.18
6	13-64	.203125	5.159375	130	8.125	3.685	39.67	87.45
7	3-16	.1875	4.7625	120	7.5	3.402	36.62	80.72
8	11-64	.171875	4.365625	110	6.875	3.118	33.57	74.00
9	5-32	.15625	3.96875	100	6.25	2.835	30.52	67.27
10	9-64	.140625	3.571875	90	5.625	2.552	27.46	60.55
11	1-8	.125	3.175	80	5.	2.268	24.41	53.82
12	7-64	.109375	2.778125	70	4.375	1.984	21.36	47.09
13	3-32	.09375	2.38125	60	3.75	1.701	18.31	40.36
14	5-64	.078125	1.984375	50	3.125	1.417	15.26	33.64
15	9-128	.0703125	1.7859375	45	2.8125	1.276	13.73	30.27
16	1-16	.0625	1.5875	40	2.5	1.134	12.21	26.91
17	9-160	.05625	1.42875	36	2.25	1.021	10.99	24.22
18	1-20	.05	1.27	32	2.	.9072	9.765	21.53
19	7-160	.04375	1.11125	28	1.75	.7938	8.544	18.84
20	3-80	.0375	.9525	24	1.50	.6804	7.324	16.15
21	11-320	.034375	.873125	22	1.375	.6237	6.713	14.80
22	1-32	.03125	.793750	20	1.25	.567	6 103	13.46
23	9-320	.028125	.714375	18	1.125	.5103	5.493	12.11
24	1-40	.025	.635	16	1.	.4536	4.882	10.76
25	7-320	.021875	.555625	14	.875	.3969	4.272	9.42
26	3-160	.01875	.47625	12	.75	.3402	3.662	8.07
27	11-640	.0171875	.4365625	11	.6875	.3119	3.357	7.40
28	1-64	.015625	.396875	10	.625	.2835	3.052	6.73
29	9-640	.0140625	.3571875	9	.5625	.2551	2.746	6.05
30	1-80	.0125	.3175	8	.5	.2268	2.441	5.38
31	7-640	.0109375	.2778125	7	.4375	.1984	2.136	4.71
32	13-1280	.01015625	.25796875	$6\frac{1}{2}$	.40625	.1843	1.983	4.37
33	3-320	.009375	.238125	6	.375	.1701	1.831	4.04
34	11-1280	.00859375	.21828125	$5\frac{1}{2}$	.34375	.1559	1.678	3.70
35	5-640	.0078125	.1984375	5	.3125	.1417	1.526	3.36
36	9-1280	.00703125	.17859375	$4\frac{1}{2}$	.28125	.1276	1.373	3.03
37	17-2560	.006640625	.168671875	$4\frac{1}{4}$	.265625	.1205	1.297	2.87
38	1-160	.00625	.15875	4	.25	.1134	1.221	2.69

By a law of Congress, passed in 1799, 5th Congress, 2d Session, it was ordered that "the surveyor (of each port of the United States) shall, from time to time, and particularly on the first Monday in January and July in each year, examine and try the weights, measures and other instruments used in ascertaining the duties on imports, with standards to be provided by each collector, at the public expense, for that purpose ; and when disagreements and errors are discovered, he shall report the same to the collector, and obey and execute such directions as he may receive for the correction thereof, agreeably to the standards aforesaid."—(Statutes at Large, Vol. 1, page 643.)

Revised Statutes of the United States, May 19, 1828: "Sec. 3548. For the purpose of securing a due conformity in the weight of coins of the United States to the provision of this title, the brass troy pound weight procured by the Minister of the United States at London, in the year eighteen hundred and twenty-seven, for the use of the Mint and now in the custody of the Mint at Philadelphia, shall be the standard troy pound of the Mint of the United States, conformably to which the coinage thereof shall be regulated.''

Resolved, by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Treasury be, and he hereby is, directed to cause a complete set of all the weights and measures adopted as standards, and now either made, or in progress of manufacture, for the use of the several custom-houses, and for other purposes, to be delivered to the Governor of each State in the Union, or such person as he may appoint, for the use of the States respectively, to the end that a uniform standard of weights and measures may be established throughout the United States.

Approved June 14, 1836.

An Act to authorize the use of the Metric System of Weights and Measures, July 28, 1866:

Be it enacted by the Senate and House of Representatives of the United States in Congress assembled, That from and after the passage of this Act it shall be lawful throughout the United States of America to employ the weights and measures of the Metric System, and no contract or dealing, or pleading in any court shall be deemed invalid or liable to objection because the weights or measures expressed or referred to therein are weights and measures of the Metric System.

Sec. 2: And be it further enacted, That the tables in the schedule hereto annexed shall be recognized in the construction of contracts and in all legal proceedings, as establishing, in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures expressed therein in terms of the Metric System; and said tables may be lawfully used for computing, determining and expressing in customary weights and measures the weights of the Metric System,'' 1866.

An Act establishing a standard gauge for sheet and plate iron and steel:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That for the purpose of securing uniformity the following is established as the only standard gauge for sheet and plate iron and steel in the United States of America, namely:

[See table previous page.]

And on and after July first, eighteen hundred and ninety-three, the same and no other shall be used in determining duties and taxes levied by the United States of America on sheet and plate iron and steel. But this act shall not be construed to increase duties upon any articles which may be imported.

Sec. 2. That the Secretary of the Treasury is authorized and required to prepare suitable standards in accordance herewith.

Sec. 3. That in the practical use and application of the standard gauge hereby established a variation of two and one-half per cent., either way may be allowed.

Approved, March 3, 1893.

THE LACOE COLLECTION IN THE NATIONAL MUSEUM.

THE Lacoe Collection of Fossil Plants, the removal of which from Pittston, Pennsylvania, to Washington, has now been accomplished, is by far the largest and most valuable of its kind in America, and compares favorably with the richest paleobotanical collections in European museums.

Mr. R. D. Lacoe, who has so generously presented this magnificent collection to the Museum, is a leading business man of Pittston, who for twenty-five years has found diversion and outdoor occupation in collecting fossils, and whose enthusiasm in connection with his scientific and practical knowledge of mining has enabled him to bring together a most unique and valuable series of the Paleozoic plants of America.

His interest in the subject is a natural outgrowth of his taste for science, and has doubtless been stimulated by his environment, for he lives in the very heart of the northern Anthracite coal region. To this fact is also in large measure due his interest in paleontological research in general.

The collection contains nearly 100,000 specimens and was shipped in 315 cases, and is constantly being increased through the collecting agencies established by Mr. Lacoe in all the principal coal regions in the United States. The series illustrating the morphology of species and their geographical and geological distribution alone comprises over 17,000 specimens. It represents more thoroughly than any other collection the fossil flora of the Anthracite region of Pennsylvania. There are also especially good series from the coal fields of Illinois, Tennessee and Missouri, and from other States, besides important collections from Nova Scotia, New Brunswick and Brazil.

The collection has been arranged in the following categories: (1) types and specimens intended for study, (2) exposed slabs suitable for exhibition, and (3) unstudied and duplicate material. Some idea of its bulk may be formed from the fact that it is estimated that 1,000 museum drawers, in addition to six large exhibition wall cases, will be required to accommodate it.

In addition to gathering specimens in the field and labeling them with his own hands, Mr. Lacoe long since engaged the services of collectors in a number of States and the Canadian Provinces, and with their assistance and the purchase of private collections has, by the expenditure of perhaps $50,000 of his private fortune, succeeded in accumulating this enormous mass of material.

Mr. David White, Assistant Paleontologist of the United States Geological Survey, has devoted many months to the labeling and packing of the collection at Pittston, and since its arrival at the Museum has been almost constantly employed in the work of arranging and cataloguing. Progress has been slow because of the pains taken to authenticate each specimen.

Mr. Lacoe began the formation of the great collection which bears his name, early in the seventies, and upon the organization of the Second Geological Survey of Pennsylvania, in 1878, it had already assumed such proportions that Prof. Leo Lesquereux, the foremost of American paleobotanists, was detailed by the Director of the Survey to study the collection on behalf of the State. The results of his studies, together with descriptions of the larger number of species in the collection, were incorporated by him in his famous work on the 'Coal Flora of the Carboniferous Formation in Pennsylvania and throughout the United States,' published as Report P of the Second Geological Survey of Pennsylvania. It is safe to say that nearly one-third of the specimens illustrated in the atlas accompanying the first and second volumes, and the greater part —in fact, nearly all—of those in the third, are in the Lacoe collection.

Owing to the hurried publication of the third and final volume, in compliance with the time-limit for the work specified in the Legislative act, there were many new forms in the collection upon which Lesquereux had not completed his studies. To this number many more have since been added, and a number of drawings have been prepared. Most of these unpublished forms are accompanied by manuscripts in various stages of completion, and in some instances by notes and sketches. The manuscripts have been placed by Mr. Lacoe in the hands of Mr. White, who will assist in revising, verifying and completing Lesquereux's posthumous work for publication. The manuscripts contain descriptions of approximately 125 species or varieties, of which perhaps 80 are new.

The Collection, as far as described, embraces about 750 published *types*, and includes perhaps nearly half of the originals of the American Carboniferous flora. The few others which are still in existence are for the most part in the custody of the university and State geological museums.

A number of these new forms were described by Lesquereux in the Proceedings of the American Philosophical Society, the Catalogue of the Pottsville Scientific Association, and the Reports of the Geological Surveys of Arkansas, Illinois and Indiana, by Prof. D. P. Penhallow in the Proceedings of the National Museum, and by Sir William Dawson in the Canadian Record of Science and in his work on the Fossil Plants of the Devonian and Upper Silurian formations of Canada.

When he gave the plants from the Paleozoic formations, Mr. Lacoe also sent to the Museum examples of the Cretaceous and Tertiary flora of Colorado, studied and partially published by Lesquereux, and an interesting lot of specimens of Triassic and Paleozoic fishes and crustacea, studied by Cope, Hall, Whitfield and others; also a collection of 800 Dakota Group plants, about 125 of which are described by Lesquereux in Monograph XVII. of the United States Geological Survey, on the "Flora of the Dakota Group."

A portion of the Collection will be placed on exhibition, as soon as it can be labeled and installed.

Mr. Lacoe formally offered the collection to the Museum in December, 1891, in a letter to Prof. Lester F. Ward, an old friend and correspondent, expressing his belief that this disposition of it would best insure the fulfillment of his purpose in its formation, which was primarily to bring together in one place as complete a collection as possible of the older fossil flora, for use in scientific research, the conditions imposed being merely that the Collection should be kept entire, with such additions as may hereafter be made to it by exchange of duplicates or subsequent contributions by the donor; that it be known as 'The Lacoe Collection,' and that it be accessible to scientists and students without distinction, provision being made for the proper preservation of the specimens from loss or injury.

The acquisition of this wealth of material makes the National Museum an important reference center for all future comprehensive work in this field. The Lacoe Collection is a noble monument to the public spirit and generous enthusiasm of its founder.

G. Brown Goode.

NOTE ON THE DEVONIAN PALÆOSPONDYLUS.

In my review of Dr. Dean's 'Fishes, living and fossil,' I have ventured to suggest an ordinal name for the remarkable *Palæospondylus Gunni*, discovered by Dr. Traquair in the Caithness Flagstones. I now give reasons for so doing.

The "*Palæospondylus Gunni* is a very small organism, usually under one inch in length, though exceptionally large specimens occasionally measure one inch and a-half * * *. It has a head and vertebral column, but no trace of jaws or limbs; and, strange to say, all the specimens are seen only from the ventral aspect, as is shown by the relation of the neural arches to the vertebral centra.

"The head is in most cases much eroded * * *. It is divided by a notch * * * into two parts * * *. The *anterior part* shows a groove the edges of which are elevated, while the surface on each side shows two depressions like fenestræ, though perhaps they are not completely perforated, and also a groove partially dividing off, posteriorly and externally, a small lobe. In front there is a ring-like opening * * * surrounded by small pointed cirri, four ventrally, at least five dorsally, and two long lateral ones which seem to arise inside the margin of the ring instead of from its rim like the others. The *posterior part* of the cranium is flattened, but the median groove is still observable. Connected with the posterior or occipital aspect of the skull are two small narrow plates which lie closely alongside the first half dozen vertebræ."

"The bodies of the vertebræ are hollow or ring-like, and those immediately in front are separated from each other by perceptible intervals; their surfaces are marked with a few little longitudinal grooves, of which one is median. They are provided with neural arches, which are at first short and quadrate, but towards the caudal extremity lengthen out into slender neural spines, which form the dorsal expansion of a caudal fin, while shorter hæmal ones are also developed on the ventral aspect."

Such are the essential features of *Palæospondylus* as recorded by Dr. Traquair in 'The Annals of Scottish Natural History' (III., p. 94–98, pl. 3, 1894). He maintained that "there seems no escape from the conclusion that the little creature must be classed as a Marsipobranch" and that, "if *Palæospondylus* is not a Marsipobranch, it is quite impossible to refer it to any other existing group of vertebrates."

Dr. Dean in a recent note 'on the supposed kinship of the Palæospondylus' (SCIENCE, N. S., III., p. 214) claims to have discovered 'a series of transversely directed rays, arising from the region of the post-occipital plates of Traquair' which, in his opinion, 'warrant the belief that this lamprey-like form was possessed of paired fins, a character decidedly adverse to the now widely accepted view of Marsipobranchian affinities.'

In the case of the little animal in question, we have to deal with matters of observation first and then of interpretation. The latter, however, largely preponderate for even what is represented as being seen must be the result of interpretation of traces or filling-up of outlines; of course, then, taxonomic deductions must stand or fall in the ratio of the correctness or failure of the interpretation as well as observation.

Assuming the correctness of Dr. Traquair's description and figures, we certainly have a remarkable combination of characters. On the one hand, if the 'median opening or rim' is indeed nasal, the animal certainly cannot be referred to the class of Selachians or of Teleostomes. On the other hand, the cranium and the segmented vertebral column indicate a more advanced stage of development of the vertebrate line than that from the living Marsipobranchs must have originated. We may, therefore, with propriety isolate it as the representative not only of a peculiar family (*Palæospondylidæ*), but of an order or even subclass (Cycliæ) of vertebrates which may provisionally (and only provisionally) be retained in the class of Marsipobranchs.

The group may be defined as Monorrhines with a continuous (?) cranium, a median nasal (?) ring, and a segmented vertebral column.

The name Cycliæ has been constructed on the model of the classical names *Acanthias*, *Anthias*, *Xiphias*, etc., and is derived from κύκλος circle, and the termination -ιας, *i. e.*, cyclias in the plural number. The word is descriptive and will fit, whatever interpretation may be put on the ring-like structure.

The differences between the Hyperoartia and Hyperotreta are very great, and Prof. Lankester did not go much too far when he elevated those groups to class rank. Among the numerous distinctive characters are the great differences in the auditory organs. Perhaps the organs of *Palæospondylus* might be worked out in some specimen and throw light on the subject of affinities. At present even the region of the auditory organs is not exactly known and we are now at a loss to orient the several parts of the cranium. In fact, the question of the relations of *Palæospondylus* is a very open one.

THEO. GILL.

[Just after this note had been sent to SCIENCE, and when the review of Dr. Dean's 'Fishes' was in page form, I had the pleasure of receiving from Dr. Dean an extract from the 'Transactions of the New York Academy Sciences, Vol. XV., pp. 101–104, plate V.,' entitled 'Is Palæospondylus a Cyclostome?' Dr. Dean concludes that "the position of the fossil * * * is certainly undefinable," but suggests that "perhaps one might most reasonably place it with the Ostracoderms among the curiously specialized off-shoots of the early chordates."]

THE CULTURE GIVEN BY SCIENCE.

To be a man of broadest culture is a high ideal. Fortunately, the idea and the associations conveyed by this word 'culture' are still of the finest, the noblest. But when scanned in the new light of the present, has not the flower of culture, like everything else of the best, gained a living heart of science, taken on the pure, high, unfading colors of science, the benign empress of our modern world? And with this change has not culture developed a firmer moral fiber from the inexorable, inevitable insistence of science on a moral courage in her votaries which would sacrifice all unflinchingly in the pure cult of truth?

Before the age of science the man of the then culture was, as his fellows, in fear of being known to have been wrong.

Said Lowell: "There are three short and simple words, the hardest of all to pronounce in any language (and I suspect they were no easier before the confusion of tongues), but which no man or nation that cannot utter can claim to have arrived at manhood. These words are, *I was wrong.*"

Even Goethe, the very highest type of culture not based on a core of science, even Goethe, with his calm and coldness as of the immortals, with his magnificent appetite and digestion, even Goethe mouths and sulks and rants like a stupidly obstinate boy when even his friends declare that in the explanation of colors he is wrong and the man of science, Newton, is right. He snarls and spits to the very last, and, like his countryman, Hegel, makes himself disgusting by blaspheming Newton.

Says J. H. Stirling, Hegel's devoted apologist: "One thing, however, he will not think excusable even in a Hegel: this letter's unsparing bitterness of tone to him—Newton—whom as a productive thinker mankind have so much reason sincerely to thank and supremely to honor."

Says Helmholtz: "To give some idea of the passionate way in which Goethe, usually so temperate and even courtier-like, attacks Newton, I quote from a few pages of the controversial part of his work the following expressions, which he applies to the propositions of this consummate thinker in physical and astronomical science—'incredibly impudent;' 'mere twaddle;' 'ludicrous explanation;' 'but I see nothing will do but lying, and plenty of it.'"

Nothing could more exactly illustrate the change of heart which culture has undergone. Could any one imagine Justus von Liebig berating Pasteur for overthrowing utterly Liebig's theory of fermentation?

The friends of Darwin bemoaned the inestimably valuable time which he habitually gave to considering the weakest objections of the feeblest objectors, and even to setting forth and clothing all objections with his own strength.

The culture given by science is strikingly characterized by equipoise of mind, impartiality of view, freedom from obscurations due to selfishness, a taking of self objectively.

This comes in part from the fact that high scientific instruction or attainment cannot be divorced from scientific investigation.

Thus, in Germany, the leader of modern culture, "a university professor is both a teacher and a scientific investigator, and the latter is considered the more important." "Again, when a professor is mentioned the question is asked: What has he written? What are his scientific achievements?"

The culture given by science relegates to the moribund institutions of tradition the old hypothesis that truth is given and fixed, and needs only to be transmitted unchanged. We have seen in our own generation changes accepted and made part of regular university instruction which are so deep-reaching as to under-cut the knowledge thought fixed for twenty centuries. Witness the non-Euclidean geometry and evolution. The watchword of modern scientific culture is independence of thought and investigation, "Whatsoever is, may be wrong!" Its most cherished palladium is freedom to think, freedom of research, freedom in teaching.

To break a bond restricting liberty to search and say the truth may be more important than killing a definite positive error. The culture given by science can tolerate no distinct dogmatic brand.

A pertinent illustration is found in the attitude of the highest culture now toward language and language teaching. It is found that language, like the expression of numbers by symbols, has attained a higher state by taking aid from space concepts, by making definitely fixed use of position as significant.

The inflectional languages, such as Latin and Greek, correspond to their writing of numbers. There is a hint at some use of position. Witness IV. and VI., or the difference of emphasis given by position in the Latin sentence. But this is like confining the use of steam to the blowing of whistles. Compare 10 and .01, or a few English sentences with their Latin translations. Like the Hindoo discovery of the zero and consequent modern arithmetic is the organic use of position in language as typified by English.

Again, the number system of every child is at first *one*, *two*, *many*. The third number, the indefinite, takes different forms, 'some,' 'a few,' 'a lot,' etc. But the mental step from knowing *two* up to knowing *three*, recognizing a class or aggregate as just exactly possessing the distinctive quality *three*, as being triple or a triplet, is a slow and long and difficult step. In the high-bred, smart American child this step represents roughly a whole year's development, which cannot be much hastened.

Now, just this child stage, with the enormously undue importance which it attaches to the number two, is represented by the whole Greek language and grammar. This speech has a whole system of grammatical forms, called duals, whose creation rests wholly on the baby mistake, the child misconception of *two*. To babies and to Greek grammar *two* is still a god in a trinity.

A modern writer speaks slightingly of 'the aping and prolonged caw called grammar, the cackling of the human hen over the egg of language,' but may not the laborious puerilities which have so long passed current as Latin and Greek grammar be of interest to the scientist in comparative child study? "A single scientific idea may germinate into a hundred arts."

GEORGE BRUCE HALSTED.

AUSTIN, TEXAS.

CONVENTION OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

THE American Society of Mechanical Engineers held its annual spring convention at St. Louis recently, discussed a number of valuable papers, visited many points of interest and enjoyed informal meetings for social purposes. The papers were less numerous than usual and included fewer very striking or novel communications than ordinarily.* The convention was fairly well attended and very greatly enjoyed by all who took part.

The Secretary of the Society, Prof. Hutton, presented a discussion of the catalogue system proposed for engineering libraries. Dewey's 'Decimal Classification' was considered a model difficult to excel for general purposes. For an engineering collection, however, further classification is required, and the writer of the paper proposed a special scheme including twenty-two heads, each covering a division of engineering science or art. To these were appended about

* The papers will appear in the Transactions of the A. S. M. E., Vol. XVII., 1896.

a dozen other heads to cover accessions in the fields of general literature, more or less of which is found in every technical collection. The schedule is very complete and was thought a most satisfactory one.

Mr. Murray offered a paper on 'Structural Steel Fly Wheels.' The rapid increase in the employment of 'high-speed' engines, especially in electric light and power stations, where great irregularity of load is usual, has made the 'running away' of engines a comparatively frequent occurrence, and accidents of great importance are not unusual, involving loss of life and great destruction of property. The weakness of the older type of fly wheel, due partly to the fact that it is constructed of cast iron, partly to its inefficient connection of parts, makes it liable to go to pieces at a comparatively low speed, and gives but small margin above the ordinary working speed. Where, as is probably not very uncommon, an engine, when suddenly deprived of load, jumps up to double speed before the governor can act, or at a time, as is also not unusual, when the governor is not acting, the old cast-iron wheel is very sure to go to pieces and to produce the effect of an exploding giant bomb-shell. Various constructions of wrought-iron and steel wheels have been introduced, and Mr. Murray described a steel wheel made of open-hearth structural steel of about 60,000 pounds tenacity, and built up of a series of discs forming the hub, of a pair of dished disks constituting the main portion of the wheel in place of the ordinary arms, and a rim composed of heavy steel boiler plate; all rivetted together in such manner as to give a factor-of-safety, as computed by the writer of the paper, of twenty-six. All details are given and the construction fully described.

Prof. Goss exhibited the effect of long connections upon the action of steam in the steam-engine indicator and on the diagram, as experimentally determined by him. He found that even short pipe connections were likely to invalidate conclusions drawn from the diagram regarding the character of the expansion and compression line or the quality of the steam. For usual lengths of connection the area of the diagram will be greater than that of a true diagram, though that area may vary in either direction from the proper dimensions. To secure reliable results the indicator must be attached to the steam cylinder by very short and perfectly straight pipes.

Mr. Whitham described the recent 'mechanical stokers.' Of late years the supply of fuel to the furnace of the steam-boiler and the management of the fire has been effected by the employment of these machines, which, very various in form, all have the common function above described. Their advantages, when successful, are their adaptability to the cheap fuels; their reduction, in large 'plants,' of the cost of labor, by about forty per cent.; their economy of use of fuel, and the constancy or uniformity of conditions of combustion which lies behind the last-named advantage. They are, however, costly, both in manufacture and in repairs, are dependent upon the action of a steam-engine and a steam-blast, and are necessarily dependent, also, upon special skill on the part of the attendants. Anything going wrong, the whole establishment may come to a standstill.

Several forms of stoker are described and their performance, as ascertained by trials, tabulated. A number are found to be efficient for special cases, each in its own province. The engines use a fraction of one per cent. of the steam made; the fans demand three to five per cent., and the steam blasts from five to eleven per cent. in the cases described. The 'stoker' is less adaptable to a fluctuating demand for steam than is hand-firing; but it is constant in maintenance of a fire in good order, and saves handsomely when operated under favorable conditions on a large scale.

Prof. Carpenter described a new form of steam 'calorimeter' employed at Sibley College, Cornell University, in the determination of the 'quality' of steam. It consists simply of a small chamber, jacketed with steam, a water-glass gauge and a specially graduated pressure gauge. Discharge takes place through a 'standard orifice," and the gauge indicates the flow in the unit of time. The separated moisture is collected in the reservoir, and its weight is compared with that of the indicated volume of dry steam discharged, to give a measure of the original quality of the vapor. The instrument had been in use about a year, in the form described, and found very accurate and satisfactory after prolonged comparison with the familiar forms of apparatus employed for the same purpose.

Mr. Alberger presented an account of a 'self-cooling condenser' for use where condensing water for the steam engine is difficult to obtain or costly. These systems of cooling the water of condensation for repeated use in a circulation comprehending the condenser and a cooling tower or other device for the removal of the heat taken up from the steam, are coming rapidly into use in many localities. That described consists of a tower in which is installed a large mass of tiling, over which the water circulates and in the midst of which large volumes of air are circulated by the action of a fan blast. A steam-pump circulates the water from condenser to the top of the tower and back in a continually moving stream flooding the tiling; drawing water from a well or tank at the foot of the tower, and passing it through the condenser and then through the masses of tile in the cooling tower, the water finally falling into the well after its temperature has again been reduced to the minimum. The fan requires less than two per cent. of the power of the main engine; it may not exceed one per cent. The heat is carried away mainly by evaporation into the rising current of air from the fan. The cost is stated at about that of one pound of water per horse power per hour as used in the engines, including all expenses of steam-making.

Mr. Kent discussed the definition of steam-boiler 'efficiency,' as that term is now applied in connection with the boiler-trials made under the now usual forms of standard tests. The paper indicated the nature and extent of the difficulties arising in the endeavor to obtain the unit of measurement, and in its application to the numerical rating of boiler efficiencies; showing that the uncertainties introduced through the inaccuracy of existing methods of measuring the total heating power of a fuel, and in thus obtaining a basis of comparison, might be so great as to preclude any possible uniformity or accuracy of measurement of the true efficiency of the boiler. Two illustrative cases were presented in the paper. The heating power of a coal was reported by two different systems of calorimetric measurement, as respectively, 13, 302 and 14, 620 from different calorimeters, and, in the other case, 13,799 and 16,212 B. T. U. per pound. The boiler thus received credits for efficiency, ranging from 56.66 to 66.37 in the one case, and from 73.12 to 85.83 in the other, accordingly as one or another calorimeter was employed to do the work of measuring the 'actual' heating power of the fuel.

Prof. Thurston presented a paper on 'Superheated Steam; Facts, Data and Principles Relating to the Problem of its Use.' The nature of superheated steam, its thermal and thermodynamic properties and its value in the steam-engine were studied. Its only use to-day is that of reducing internal wastes by 'cylinder condensation,' through the process of supplying sufficient heat to the cylinder wall to check that initial loss. It has no thermodynamic value, in a proper sense, as it does not increase the range of adiabatic expansion. The economical value of superheating and of 'reheating' between the cylinders of the multiple-cylinder engine was discussed, and illustrations were given from the reported results of engine trials, showing that superheating is more effective than other expedients for the prevention of internal waste. By reference to experiments reported in large numbers on the value of heat transferred to the steam by steam-jackets for the same purpose, the conclusion was drawn that for each unit of heat expended in the prevention of this waste several could usually be saved in the engine. For simple engines this ratio of saving to expense amounted to an average of six and seven; for compound engines, to between three and four, the gain being the less as the engine is the more economical originally. Experience in Europe, far more than in the United States, affords fact and datum for the conclusions reached. The Schmidt superheating engine, reported upon by Schroeter, of Munich, gives the horse power on but 10.2 pounds of steam per hour; the pressure being about 125 pounds and the engine one of moderate size. The little twenty-horse-power engine of Sibley College, operated with 300 to 500 pounds of steam, as elsewhere described, is here stated to give the horse-power, the steam being saturated at the high-pressure cylinder and reheated between cylinders with 'less than ten pounds, 11,000 B. T. U., per horse power per hour.' The conclusion is reached that "This is, to-day, the greatest of all the problems presented to the designing and constructing engineer, with the possible exception of that of finding a system of effectually rendering the interior of the working cylinder non-conducting in such manner as to entirely prevent the occurrence of initial condensation; thus conforming the 'ideal case' to the real, and making the steam engine a purely thermodynamic machine."

A number of papers were read describing details of practical engineering work and a set of 'topical questions' was propounded; both papers and questions eliciting much interesting discussion bearing upon practical, rather than scientific, points in engineering.

CURRENT NOTES ON ANTHROPOLOGY.

THE SCIENCE OF LANGUAGE.

Within the compass of about 300 duodecimo pages, Prof. Giacomo de Gregorio, of the University of Palermo, has compressed an admirable survey of the elements of the science of language, a task by no means easy. ('Glottologia.' Ulric Hoepli, Milan, 1896.)

He divides the subject into three parts, glottology, language in general, and particular languages. In the first he discusses the place of the study of language among the sciences, and rapidly sketches its historic development, naming the most prominent students and their works. The second part enters fully into the phonetics and the physiology of articulate sounds, and in a second chapter reviews the theories of linguistic radicals and the origin of speech. The third part presents an able chapter on the various proposed classifications of languages, and a summary of the principal linguistic stocks of the globe. An excellent bibliography of linguistic writings precedes the text.

The author is much more than a compiler. He is an independent and acute critic, and threads his way with clear vision through the dust and fog of conflicting hypotheses and averments. He is not a supporter of any 'school,' but claims for linguistic science the high and right place that it deserves among the natural sciences relating to man, and his method is that of those sciences.

ETHNOLOGY AND HISTORY.

WHEN the science of ethnology shall be properly understood, the application of its methods to the sociologic development of the human race will lead to an entirely novel plan of writing history, and to a different appreciation both of its motives and its aims. That which has long been sought for under the attractive name of 'The Philosophy of History' will be found to be nothing more than a series of ethnologic deductions; and 'The Mission of the Historian' in its largest sense will be nothing more than the application of the natural science of man to the welfare of man; nothing more but that will be the greatest achievement which the human species will have witnessed, far transcending any mere material gains or discoveries which it has made or can make.

At the last annual meeting of the New Jersey Historical Society I delivered by request an address upon this subject, which has since been published. A limited number of copies remain by me, which I shall be glad to send to such readers of SCIENCE as may apply for them. (Address, Media, Penna.)

PRIMITIVE COSMIC CONCEPTIONS.

SLOWLY but surely the theory that similarities of mythical concepts betokened ancient intercommunication is giving way to the true explanation that such similarities are owing to the unity of the human mind and the sameness of its processes.

No one has taught this profound truth more positively than Prof. Bastian, the eminent director of the Ethnographic Museum of Berlin. Very lately he has published a most instructive work of about 200 pages entitled, 'The Thought Creation of the Surrounding World out of Cosmogonic Conceptions.' (Dümmler, Berlin.) It treats of the various so-called 'elements' which make up the myths of religions, the beliefs and notions of his surroundings, real and imagined, which every man forms unconsciously to himself, and which deeply influence his life and works. Such are his views about the divine, the soul, death, spirits, creation, magic, etc. These and a hundred others develop similarly in similar stages of culture, and the parallel schemes drawn from culture-horizons far asunder which the author lays before the reader are striking and convincing.

It would be very desirable if Dr. Bastian's remarkable studies on this and allied subjects could be brought in a compact shape before the English reading public.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

NOTES UPON AGRICULTURE AND HORTICULTURE.

DISEASES OF CITROUS FRUITS IN FLORIDA.

THE orange industry is a large one in the warmer portions of our country and the citrous fruits have several diseases which cause annual losses of not less than a half million dollars. In order to obtain good control of these diseases and check their ravages the government has had a station of research in Florida for the past three years, and Bulletin 8 of the division of Vegetable Physiology and Pathology just issued is a report of progress by Messrs. Swingle and Webber at the Subtropical Laboratory. The bulletin commends itself at sight, being attractive in plates, three of which are colored, and the text is carefully prepared. Six diseases are considered, namely: (1) Blight, (2) Die-back or Exanthema, (3) Scab or Verrucosis, (4) Sooty Mould, (5) Foot-rot and (6) Melanose.

The blight, probably contagious, the cause of which is yet unknown, seems to be incurable; therefore affected trees should be burned. Die-back is due to malnutrition and improper drainage and culture. Brown eruptions appear upon the twigs which afterwards die, and the fruits split and drop before maturing. It is an advantage to withhold organic nitrogenous manures. The scab attacks lemons and sour oranges and disfigures the foliage and fruit by producing warts. It can be prevented by spraying with fungicides. Sooty mould is a fungus following the attacks of insects and fumigations to kill the insect prevents it. Foot-rot is the most destructive malady and is recognized by gum exudation at the base of the tree. The cause is probably some minute organism and prevention is found by cutting away the diseased parts and washing with fungicides. Melanose is a new disease of all citrous fruits, not yet very destructive, the cause of which is unknown, but Bordeaux mixture is a satisfactory remedy.

COMBATTING CARNATION RUST.

The growing of carnations is a large industry in this country, but is beset with many vicissitudes not among the least of which is the carnation rust. This trouble has been under investigation at some of the experiment stations, and before us lies bulletin No. 100, of the New York Experiment Station, with the title as given above. Mr. Stewart, the author, has tested the germination of the spores of the rust fungus in various substances, and finds, for example, that a 1-100 solution of copper sulphate is much too weak to prevent germination. When common salt is used 1–45 is the strongest solution in which the spores can grow. The spores, on the other hand, are remarkably susceptible to the action of potassium sulphide, a 1–3,000 solution entirely preventing germination. A similar series of results was obtained by soaking cuttings in the above solutions, those in potassium sulphide being unharmed. Attempts to cure rusty plants by spraying with fungicides failed, but good results were obtained in preventing its appearance upon healthy plants. Rust, it has been shown, will spread among mature plants. It is important that carnation plants be held up from the ground by inverted V's of wire netting. For unknown reasons, some varieties are much more susceptible than others to the rust.

POTATO DISEASES UPON LONG ISLAND.

In addition to his carnation investigations Mr. Stewart has made a study of potato diseases, the results of which appear in Bulletin No. 101, of the New York Station. In addition to the good results following from spraying with the Bordeaux mixture for the blights, notes are given upon an internal browning of potatoes, the cause of which is not determined. The brown spots are entirely surrounded by healthy tissue, and cultures made from the discolored portions produced no growth. Under the microscope the brown spots give no clue as to the cause of the trouble, and it would seem to be physiological and not mycological in its origin. Field experiments indicate that the browning is not transmitted from seed to product, but the discolored tubers are not the best to use for planting. There are several stem blights of potatoes, but Mr. Stewart finds another which seems to strangle the plant and working internally will be a difficult one to check. A new fusarium (*F. acummatum* E. & E.) is reported.

Byron D. Halsted.

Rutgers College.

SCIENTIFIC NOTES AND NEWS.

ASTRONOMY.

A meeting was held at Paris last month which will be of the greatest importance to the progress of astronomical science. Each of the four nations whose governments publish elaborate astronomical ephemerides were represented at this meeting. The object of the conference was the discussion of the best system of astronomical constants, with a view to the introduction of uniformity in the various astronomical ephemerides.

The French ephemeris was represented by MM. Faye and Loewy; the British by Dr. Downing and Dr. Gill; the German by Prof. Bauschinger, and the American by Prof. Newcomb and Dr. Backlund, director of the Russian National observatory. Dr. Bakhuyzen and M. Trépied acted as Secretaries.

The delegates succeeded in deciding upon definitive constants of nutation, aberration and the solar parallax. The values adopted for these constants are those deduced by Dr. Gill from heliometer observation of the minor planets Victoria, Sappho and Iris.

The determination of the constant of precession and the formation of a catalogue of standard stars was left to Prof. Newcomb.

There can be no doubt that the introduction of uniformity in the four great national astronomical ephemerides will bring about a great improvement in the reduction of astronomical observations in general, and will do away with a great deal of confusion which now exists.

H. J.

THE GREENWICH OBSERVATORY.

WE learn from the London *Times* that the Astronomer Royal, Mr. H. M. Christie, has presented his annual report to the Board of Visitors. The most important event of the year has been the completion of the north wing and central octagon tower of the new Physical Observatory and the reërection upon this tower of the Lassell dome. When finished it will consist of a central octagon tower surmounted by a dome, from which will radiate four wings running due north, south, east and west, built of red brick faced with terra cotta. The completion of the east and west wings has now been sanctioned, and provision has been made in the estimates for commencing the work during the present year. Within the dome upon this handsome new building will eventually be placed the 26-inch photographic telescope presented to the Royal Observatory by Sir Henry Thompson, and now nearly finished and ready for inspection at Sir Howard Grubb's works in Dublin. As a guiding telescope the old Merz 12¾-inch telescope, which used to be called the Great Equatorial, and that not many years ago, will be remounted, and in place of a counterpoise on the other side of the declination axis will be mounted a Cassegrain reflecting telescope of 30-inch aperture, also the gift of Sir Henry Thompson, for which Dr. Common has undertaken to figure the mirrors and to supervise the construction. Another handsome new building also built of red brick and terra cotta, with its dome, was completed early in January, and houses the altazimuth, or universal transit circle, which will very shortly be ready for use. The lighting of this dome, as well as that of the old Lassell dome, by a series of port hole windows clearly points to the Argus-eyed character of the instruments within.

The report contains important details regarding the management and scientific work of the observatory. In concluding his report the Astronomer Royal says: "The reorganization of the staff of the Observatory which has been referred to in the two last reports, and which has now been approved, will provide the much needed increase in the permanent staff of trained observers and in the supervising power by the appointment of an additional chief assistant. The benefit of this increase of permanent staff will, it is hoped, be felt in the future, but during the past year the work of the Observatory has had to be carried on by a reduced staff, there being three vacancies in the staff of five second-class assistants which could not be filled up, as under the scheme now sanctioned six established computers are to be appointed in lieu of three second-class assistants. Under these difficult circumstances (aggravated by the inconvenience arising from the building operations in progress) it is highly creditable to the assistants and computers that the record of work for the past year compares so well with that of any previous year, and I take this opportunity of acknowledging the zeal and energy with which the whole staff has worked to maintain the credit of the Observatory."

GENERAL.

PROF. W. L. ELKIN, of Yale University, has been elected by the Yale Corporation director of the observatory.

THE division of ornithology and mammalogy of the department of agriculture will after the first of July be entitled the Biological Survey, at the head of which Dr. C. Hart Merriam will remain. An important part of the work of the Survey will be the determination of zoological and botanical zones, which have already proved so important economically and scientifically.

The United States Fish Commission steamer Albatross, with the Bering Sea Commission, created to make an exhaustive study of the life and condition of the fur seals in Bering Sea, sailed from Seattle, Wash., for the north, on June 24th.

According to the plans of the Geological Survey for the field work of the present season, five parties will work throughout the summer in the New England States and eastern New York, five in the Appalachian region, two in the coastal plain from the mouth of the Hudson to the Gulf of Mexico, five in the interior or Mississippi region, four in the Rocky Mountain region, and eight in the Pacific region.

The new library of Pratt Institute, Brooklyn, was dedicated on the afternoon of May 26th with addresses by Mrs. Margaret Deland, Truman J. Backus and Melvil Dewey. Charles M. Pratt, President of the Trustees, made an interesting statement of the work of the library. The cost of the building was $190,000. It is finely appointed in every respect and admirably adapted to its purpose. The new iron stack has been pronounced by many the most attractive and satisfactory of any yet built.

We regret to record the death of Sir Joseph Prestwich, professor of geology at Oxford University. He was born near London on March 12, 1812, and was educated at University College, London. He was President of the Geological Society, 1870–72; Vice-President of the Royal Society, 1870–71; President of the International Geological Congress, 1888; Corresponding Member of the Paris Academy of Sciences; D. C. L., of Oxford University, etc. He was eminent for his researches in geology and related subjects such as the 'Antiquity of Man,' 'Sub-marine Temperatures,' 'The Water Supply of Cities,' etc.

We have not hitherto noticed the death of M. Jules Simon, as he did not himself make contributions to science. His philosophical publications are, however, of value, and he accomplished much for the advancement of science in France. In view of the conditions of political life in America, France may be congratulated that it could have for Premier and for one of its most prominent statesman a man such as Jules Simon.

According to the annual custom, the second of the receptions of the Royal Society, which was held at Burlington House on June 11th, was a ladies' *Conversatzione.* The exhibits were in large measure the same as at the preceding conversatzione, which we have already noticed, and there will further be a public exhibition of a number of these, lasting about two weeks, at the Science Museum at South Kensington.

According to the announcement of the publishers, a new scheme for arctic exploration will be described in *Appletons' Popular Science Monthly* for July, by Robert Stein, of the United States Geological Survey. The chief features of the plan, which has been commended by many experienced explorers, are that the work shall be continuous and that it shall have a base of supplies reached every year by the whalers. Mr. Stein accompanies his statement with an interesting map of the arctic regions, showing what has been done by recent expeditions and how much remains unexplored. It is proposed to initiate the new undertaking in 1897.

Dr. Paul M. Jones, instructor in natural history and geology in Vanderbilt University, is spending the summer on the southern coast of Florida, studying the marine life of that coast and of the Bahama Islands, and collecting specimens for the biological museum and laboratory of the University.

Advices received at London from Berbera, East Africa, under date of May 25th, show that Prof. Daniel Elliot, who left London in March last for Somaliland, has returned to Berbera from the Eolas Mountains. He intends to start at once for the interior with a large caravan. All his party are well. He has thus far met with much success in his search for specimens of the fauna of the country for the Field Museum at Chicago. Some of the animals obtained by him and prepared by the taxidermist of the party are very rare.

THE periodical comet discovered by Mr. W. R. Brooks on July 6, 1889, whose orbit has been computed by Dr. S. E. Chandler, Prof. Chas. Lane Poor and others, has been detected by M. Javal, one of the assistants of the Observatory of Nice.

THE Josselin Botanical Society of Maine will hold its second annual meeting at Farmington on July 7th to 10th, 1896. The first two days will be devoted to the reading of papers and discussions and the last two to field expeditions in the surrounding country. Further details regarding the meeting may be obtained from the Secretary, Mr. M. L. Fernald, Cambridge, Mass.

IN an article contributed to the *Naturwissenschaftliche Rundschau* Dr. L. Fomm, of Munich, states that he has secured interference effects with the X-rays and has found their length to be about 0.000014 mm.

DR. CHARLES MARGOT has recently investigated (*Arch. des Sciences phys. et nat.*) the curious colors of the alloys of aluminium. White metals usually give white alloys, but 78 parts of gold and 22 parts of aluminium give an alloy of a brilliant purple color, and 72 parts of platinum and 28 parts of aluminium give a bright yellow alloy. The author holds that these alloys are true chemical combinations. They might prove useful for coins, except that the structure is crystalline and the alloy turns to powder when struck by a blow.

M. A. RIVOIRE has recently described before the Paris Academy an instrument that automatically transcribes a composition played on the piano. The record is said to be as legible as the ordinary musical notation, and it might be an advantage to a composer to directly record his compositions. It would also show the exact rate at which a composer or performer plays a given piece, our ordinary musical notation being deficient in this respect.

AN English magistrate has recently decided that it is illegal to sell green peas colored with copper sulphate. It is said that about twenty million tins containing these peas are consumed annually in Great Britain. They are also sold extensively in America, and the makers should be required at least to state the amount of copper sulphate that they contain.

AN expedition for the purpose of boring to a considerable depth into the atoll of Funafuti in the Ellice group (lat. 9° S., long. 179° W.) left Sydney on May 1st, on board H. M. S. Penguin, a surveying vessel, under command of Captain Field, R. N. Prof. W. J. Sollas, of Trinity College, Dublin, and the Geological Survey of Ireland, is in chief charge as geologist, and with him are Mr. Stanley Gardner, of Cambridge, and Mr. Hedley, of the Australian Museum, who will be doing biological work and collecting. The department of mines of the New South Wales government is lending diamond drill plant and giving some monetary aid as well, while Prof. Anderson Stuart, Mr. Slee and Prof. David have given much time and thought to the expedition. The main funds are provided by the British Government Grant Committee and by the Royal Society, while the Admiralty are providing a ship to carry men and apparatus from Sydney to the island and back to Fiji, where the expedition will disperse. Although the work is surrounded by many difficulties, and possibly by unforeseen ones which may prevent the carrying out of the complete program, it is hoped that a section through a considerable part of an atoll at sea level may be obtained sufficient to show the constituent rocks, the foundation on which they rest, and possibly the exact method according to which the atoll has been built up. It is hoped that the work may be completed before October.

A REUTER despatch to the London *Times* states that the steam yacht Windward left St. Katharine Docks yesterday afternoon for Franz Josef Land. The Windward, which is now under the command of Captain James Brown, an Arctic explorer of over 36 years' experience, is taking out as ice master Mr. John Crowther, who has already made the return journey to Franz Josef Land on three occasions. All told, her crew consists of 22 officers and men. Since her return from Franz Josef Land the Windward has been strengthened throughout, has been practically reëngined, and, in order that additional warmth may be secured, has been lined with three thicknesses of felt. She is taking out a very large supply of provisions, a number of sledges, and two additional members to the Franz Josef Land party. The Windward does not go out on this occasion for the purpose of bringing Mr. Jackson home. She will call at Vardö, when, after embarking sheep, coal and live reindeer, she will sail direct for Franz Josef Land. Four or five days after leaving Vardö she will get into the ice belt, which will probably be of 300 miles width. It is hoped she will get through this in about a fortnight, and it is anticipated that she will communicate with the explorers at Cape Flora, Franz Josef Land, on or about July 20th. As soon as the Windward has discharged her cargo she will leave Franz Josef Land with news of the doings of the explorers, and as she is bound, owing to the ice conditions, to sail before August 20th, she may be expected in England by the end of September. About this time next year, if all has gone well, she will leave London again to bring the explorers home.

Prof. Wm. H. Brewer contributes to the Yale Scientific Monthly an account of the observations he has made during the past 45 years on earth tremors at Niagara Falls The heaviest vibrations were on either side and near the Horseshoe Fall. They disappeared in places in the soft shales below the limestone, although they were evident in the harder beds of limestone and sandstones interstrated with the shales. Passing down the river along the brink of the gorge, the vibrations rapidly decreased in intensity, becoming too faint to be preceived between the two suspension bridges, increasing again on nearing the rapids. It is a popular belief of persons living near the Falls that crystals are more common in the rocks there than elsewhere in the same formation. But macroscopic examination of limestones taken near the Falls and those gathered a few miles away did not show that the crystallization or the texture of the rocks had been affected by the jar of the cataract. As Prof. Brewer remarks, it would be interesting to make the investigation microscopically, and to study the jar of the cataract with proper instruments.

UNIVERSITY AND EDUCATIONAL NEWS.

The *Oxford University Gazette* for June 9th contains the eighth annual report of the delegates of the University museum (1895). It will be remembered that two important changes were made during that year, Mr. Francis Gotch having succeeded Dr. J. S. Burdon-Sanderson as professor of physiology, and Mr. Henry A. Miers having succeeded Prof. H. M. Storey Maskelyne as professor of mineralogy. The principal improvement in the museum building during the year was the alteration and fitting up of two rooms in the department of medicine for a pathological laboratory, the cost of the scientific installation of which has been defrayed out of a sum of £500 presented by a benefactor who does not wish his name to be made public. Prof. Sanderson, the Regius professor of medicine, on his resignation of the physiological chair presented to the laboratory instruments to the value of £105, made under his direction during his tenure of the chair, and paid for by him in excess of the departmental income. The fine portrait of Prof. Burdon-Sanderson, painted in 1893 by the Hon. John Collier, has been presented to the department by Mrs. Burdon-Sanderson.

The June examination under charge of the University of the State of New York was the largest in the history of the department. About 400,000 question papers were required, all of which were printed in the department by its own employees. The preliminary examinations for professional and technical students, and those for license to practice were so large that the accommodations heretofore in use proved insufficient. Besides the 69th régiment armory in New York City it became neccessary to use two large assembly rooms in the New York University building in Washington Square.

In response to an appeal by the Chancellor at the annual banquet of the alumni of Vanderbilt University, twenty-six of those present made subscriptions of one hundred dollars each to endow a chair in the University. An endeavor will be made to increase the amount to $50,000 within the next year. The annual address before the University body was delivered by Postmaster-General William L. Wilson.

WILLIAM T. MAGRUDER, M. E., adjunct professor of mechanical engineering in Vanderbilt University has resigned and has been elected professor of mechanical engineering in the Ohio State University.

SCIENTIFIC LITERATURE.

The Jack Rabbits of the United States. By T. S. PALMER, M. D., Assistant Chief of Division. Bulletin No. 8, U. S. Department of Agriculture, Division of Ornithology and Mammalogy, Washington. Government Printing Office. 1896. 8vo., pp. 84, 6 pll. and frontispiece and 2 text figures.

No jack rabbits are found in the United States east of about the 95th meridian; west of this line they are of almost universal distribution, sometimes several species occurring over the same area. They extend northward over the plains of the Saskatchewan, and southward into Mexico far beyond our southern border. The extent of their abundance and the amount of injury they are capable of doing to growing crops is little known to the general public, outside of the jack rabbit area. In Bulletin No. 8, of the Division of Ornithology and Mammalogy of the U. S. Department of Agriculture, a vast amount of information is given on both these points, both statistically and pictorially, Dr. Palmer having treated his subject with great thoroughness, and in a way at once interesting to the naturalist and the general reader. The matter is non-technical and relates to the habits and distribution of the five or six species (no attempt is made to discriminate the subspecies) found in the United States, including their abundance and rapidity of increase; their injury to crops and the means of protection against them, and the methods of destruction employed to reduce their numbers. There is also a chapter on 'Rabbit Drives and Hunts,' and another on the value of jack rabbits as game.

In respect to the abundance of these animals over certain areas, Dr. Palmer gives some striking statistics. For instance, he states that in Modoc county, California, 'nearly 25,000 jack rabbits were said to have been killed in three months on a tract of land only six by eight miles in extent.' "A still more remarkable case has been recorded in the San Joaquin Valley. Some of the early drives near Bakersfield took place on a ranch less than one square mile in extent. In the first drive, on the afternoon of January 2, 1888, 1,126 rabbits were killed; as soon as the animals were dispatched, the same field was passed over again and 796 more killed. A week later, on January 10th, there were two drives on the same ground, the first resulting in the destruction of 2,000 rabbits, the second in more than 3,000; in the latter an adjoining field was also driven over. It was estimated that altogether about 8,000 rabbits were killed on this ranch in nine days. The 'Kern County Echo' of March (8 ?) 1888, stated that a total of about 40,000 rabbits had been killed in the drives about Bakersfield from January 1, 1888, up to that date, and referred to an estimate that two-thirds of the rabbits killed in the drives were females and the average number of young of each of these was 3½. On this basis it was computed that had these 40,000 rabbits lived two months they would have increased to 135,000. When it is considered how much injury a single rabbit can do, the damage which such an army of rabbits is capable of inflicting would hardly be less than that caused by a grasshopper plague." In another place Dr. Palmer states that "it has been estimated that five jack rabbits consume as much as one sheep."

As means of protection rabbit-proof wire fences are sometimes resorted to, and poisons are occasionally used to reduce the number of rabbits; many are also shot, but the chief dependence is wholesale destruction by drives. These are described at length, and illustrated by cuts and some striking reproductions of photographs of some of the remarkably effective drives made about Fresno, in California, where in one instance 20,000 rabbits were killed in a single drive. In the larger drives hundreds of men and boys participate, some on foot but many on horses. It is said that in one drive near Fresno, resulting in the death of 15,000 rabbits, 2,000 horsemen took part. A list of 155 rabbit drives in California is given, with a map showing their location. These drives resulted in the destruction of nearly 400,000 rabbits during a period of about eight years. Lists of drives made in Oregon, Utah, Idaho and Colorado are also given.

The jack rabbits have at present little commercial value; their skins are used to some extent for furs, and many of the animals are sent to the markets of the larger cities and sold as food. It is estimated that some 600,000 are annually consumed in the United States, the greater part being sent to the larger Eastern cities. It is believed that "commercial utilization is the most promising and least expensive method of keeping these pests in check in localities where they are unusually abundant; but returns from this source will only partially offset the losses sustained on account of injuries to crops."

"In America," says Dr. Palmer, "the rabbit question never has, and probably never will assume the proportions it has assumed in Australia. The jack rabbits of the United States are all indigenous species and ordinarily are held in check by natural enemies and by disease. Although local conditions may sometimes favor their temporary increase, yet natural agencies aided by the persistent and constantly increasing war of extermination are gradually, but none the less surely, diminishing their numbers."

Incidentally some account is given of the rabbit pest in Australia, New Zealand and Tasmania, due to the introduction of the common rabbit of Europe (*Lepis cuniculus*), about thirty years ago, for purposes of sport. As is well known, they multiplied so rapidly as to become soon a very serious pest. Dr. Palmer cites statistics showing that about $5,500,000 had been expended prior to 1888 for their destruction, and in building several thousand miles of rabbit-proof fences for the protection of crops.

J. A. A.

Catalogue of Fossil Fishes of the British Museum. Vol. III. By Arthur Smith Woodward, F. C. S., F. Z. S.

Since the publication of the first volume of this series the student of vertebrate morphology, not less than the specialist, has felt that he was to be indebted to Mr. Arthur Smith Woodward for an admirable text-book on the entire subject of Fishes. Critics have universally commended the catalogue, from its general plan down to the details of its text figures and plates, a work which only could have been written by one who has had the long experience, the broad judgment, to say nothing of the industry, of its author.

The volume which has recently appeared deals with those groups of fishes popularly known as Mesozoic Ganoids, and reviews this subject in such a way that the fourth volume of the series, beginning with the 'Teleosts,' may complete the catalogue. It is understood that a supplememtary volume will thereafter be published to supply omissions and to bring the entire subject up to date. Those only who know the confusion which has existed in our knowledge of extinct Ganoids—confusion due to a large and scattered literature, faulty nomenclature, imperfect and partial study—can appreciate the degree of order which has been infused into the entire subject by the present work. Indeed, one may well believe that this volume could not be possible had its author not felt it necessary to visit every noteworthy collection, at home and abroad, for the purpose of making comparison of his material.

The present volume begins with a review of the structural relations of the following groups: the Palæoniscoids of the Trias, *Catopterus* and *Dictyopyge*; the Protospondyli, *Semionotids*, *Macrosemiids*, *Pycnodonts*, *Eugnathids*, *Amiids*, *Pachycormids*; the Aetheospondyli, *Aspidorhynchids*, *Lepidosteids*; the Isospondyli, *Pholidophorids*, *Leptolepids*. Then follows the catalogue proper, a careful review of the systematic side of the subject, with complete reference lists and descriptions, illustrated by numerous text figures. Among these are a number of new and admirable restorations, including those of *Dapedius*, *Cleithrolepis*, *Eugnathus*, *Caturus*, *Hypsocormus*, *Aspidorhynchus* and *Leptolepis*. There are also eighteen plates illustrating those specimens in the Museum which prove of especial interest. A careful review of the book brings out clearly that the treatment of the subject is a purely morphological one, and that the most recent studies on the modes of evolution have been brought into good use. General conclusions have, in the majority of cases, been drawn from the study of progressive series, as, for example, where the author shows that "the most advanced stage of the endoskeleton (of *Neor-*

hombolepis and *Otomitla*) is attained in the latest members of the race with the least modified exoskeleton or when he notes that at the time the jaw elements become more simplified among the Teleostomes, a 'new vigor' is apparently infused into their race, marked by the outcrop of a varied series of families. By this means parallelisms have been largely evaded, but of these many interesting examples are cited, as the structures arising in the *Semionotids* and *Macrosemiids*, which are clearly interpretable as the result of similar physiological needs. And it was only after the closest scrutiny that the author was inclined to follow the lead of Prof. Cope in selecting fin structures as the most constant elements in comparison. The old tenets of classification, the characters of scales and even of vertebral axis, were found to be of decidedly minor importance, in the case of scales, as in *Eugnathus* and *Caturus* of not more than generic value. Throughout the volume phylogenetic views are seldom expressed definitely, for even the splendid series of forms which the author has been able to study has not convinced him, in the majority of cases, of more than probable kinships; thus we learn that the "origin of the Chondrostei is still entirely obscure," or that "it seems most reasonable in the present state of knowledge to place the Oligopleuridæ with the (Pholidophoridæ) near the base of the Isospondylic Series," or, again, that, "if speculation were permitted in seeking the direct ancestors of the Pycnodonts, it might be most profitable to turn toward the earliest Mesozoic fishes of the *Colobodus* type."

Mr. Smith Woodward regards his volume as acceptable 'merely as a convenient basis for further research, full of imperfections which each specialist will readily discover for himself.' But when one is familiar with the researches of its author, and knows, moreover, that the present volume embodies four years' diligent work, we may naturally expect that its sins, either of omission or commission, will not prove formidable. If criticism must be found one might be inclined to regret that the number of text figures, especially restorations, were not larger, although be it understood that from the obvious nature of the catalogue this number is already a goodly one. BASHFORD DEAN.

The Cyprinodonts. By S. GARMAN. Memoirs of the Museum of Comparative Zoölogy at Harvard College. Vol. XIX., No. 1, pp. 179, pls. XII. 1895.

The present monograph on the 'top minnows' has been based upon Mr. Garman's studies of the remarkable—possibly the most complete—collection of these forms, that of the Agassiz Museum at Harvard; and it is certainly one of the most valuable of recent contributions to the study of Fishes. It is important to the systematist, because there is scarcely a group of recent Teleostomes which has stood in greater need of critical revision, for the Cyprinodonts are not merely a large and scattered group, profusely and often very imperfectly described, but one whose species present a most confusing range in coloration, dentition and sexual characters.

One cannot help feeling that in the systematic portion of the work Mr. Garman's studies of the variation among members of each species have enabled him to interpret 'specific' differences with modern broadness, and that the order which has been drawn out of the tangle of synonymy (where a single form had, for example, been placed by various authors in as many as a half dozen 'genera') is one which will prove of permanent value. The monograph is one which, like that on the Discoboli, does fitting justice to its author's careful work; it might well be taken as a model of thoughtful preparation. The plates are admirable examples of the work of the artist and of the lithographer, and especially interesting are Pls. IX.–XII., which were drawn by Sonrel for the elder Agassiz.

The wide range in structural characters which the Cyprinodonts have evolved has been brought out clearly in the introductory portion of the monograph, but perhaps not as fully as many morphologists would desire. But the arrangement of the material with a view of sketching broadly the evolutional problems suggested by this group is certainly satisfactory. And there can be no doubt that many well-trained morphologists will here learn, for the first time, that sexual dimorphism—where the males or females of the same species will be either sinistral or dextral—may occur among vertebrates. And on the evidence of cyprinodonts it must be admitted that several of the characters which have been almost universally regarded as stable landmarks in morphological studies should be given comparatively little definite importance. For in this group, ranking only as a *family*, oviparous and ovoviviparous forms have been evolved, together with a broad range in intromittent organs and in embryonic nutriment. So that, for example, we must admit that structures like the 'claspers' of sharks are of but little moment in separating the phylum of the elasmobranchs from that of the Dipnoan or of the Teleostome. In the morphological portion of his work Mr. Garman has directed especial attention to varietal changes, notably in the case of Fundulus heteroclitus, and to structural variation as shown principally in teeth, digestive tract, urinogenital system and vertebral column. Under the latter head he attributes the decrease in the number of vertebræ of fishes in general, in and toward the torrid zone, to the 'lessening of the comparative activity of the species,' due to an enlarged food supply and to a decreased need of nutriment, the decreased number is not, therefore, attributable to the direct action of temperature, as several writers appear to have inferred. BASHFORD DEAN.

A NEW DETERMINATION OF THE RELATIVE DENSITIES OF OXYGEN AND HYDROGEN AND OF THE RATIO OF THEIR ATOMIC WEIGHTS.

To one familiar with the work of Prof. Morley on this subject it would seem that any one who wishes to add anything to our knowledge of the matter must be an experimenter of unusual ability, and must be willing to expend a very large amount of labor on his determinations. That Julius Thomsen, who has recently published the results of his experiments in this field,* is an experimenter of unusual ability every one will admit. That the results obtained can carry with them any considerable weight in comparison with those of Prof. Morley is very doubtful. It is, however, of very considerable interest to find that, by the use of comparatively simple apparatus and by methods differing in almost every detail, he has obtained results which are in fairly close agreement with those of Prof. Morley's elaborate researches.

* Zeit. für Anorg. Chem. 11, 14; and 12, 1.

The method employed for the determination of the ratio of the atomic weights consisted in the determination, first, of the ratio between the weight of a certain amount of aluminium and of the weight of hydrogen evolved by its solution in a strong solution of caustic potash, and, second, of the weight of oxygen required to burn the hydrogen evolved by the solution of a known weight of aluminium.

The density of hydrogen was determined by measuring over water saturated with hydrogen, the gas evolved by the solution of a known weight of aluminium. The density of oxygen was determined in a similar manner, the gas being evolved by the decomposition of potassium chlorate. The volume of gas measured was approximately one and one-half liters, while Prof. Morley measured a volume of hydrogen amounting to *forty-two* liters. The results obtained were:

Ratio of Atomic Weights	1:15.8690±0.0022
Density of hydrogen at 0°, 760 mm. and 45° Lat.	0:089947±0.000012
Density of oxygen "	1.42906
Prof. Morley's values were:	
Ratio of Atomic Weights	1:15.879 ±0.00032
Density of hydrogen at 0°, 760 mm. and 45° Lat.	0.089873 ±0.0000027
Density of oxygen "	1.42900 ±0.000034

In discussing the result of his determination of the ratio of the atomic weights, Prof. Thomsen remarks that, as he has avoided the weighing and measuring of large volumes of gases, it is probable that his result is nearer the truth than that obtained by others, and that the uncertainty does not extend beyond the fourth decimal. He seems to have overlooked the fact that, in his syntheses of water, Prof. Morley weighed his hydrogen absorbed in paladium, and also weighed the water formed by its combination, and that, while he weighed the oxygen in gaseous form, the sum of the weights of oxygen and hydrogen agreed almost exactly with the weight of the water.

It is noticeable that Prof. Thomsen's density of hydrogen is higher than that of Prof. Morley, while his ratio for the atomic weights is lower. This seems to indicate that the hydrogen obtained by Prof. Thomsen was contaminated with a trifling amount of some impurity. From the experiments of Prof. Morley it seems probable that hydrogen evolved by the solution of aluminium in potassium hydroxide containing a small amount of the carbonate would contain carbon. As no account is given in the paper of any attempt to exclude the presence of potassium carbonate, or if any experiments to prove the absence of compounds of carbon or of other impurities in the hydrogen used, it is, at least, possible that the difference in the results of the two workers is due to this cause.

To one familiar with the character of such work it is rather a matter of suprise that the difference is not greater.

W. A. NOYES.

A Dictionary of Chemical Solubilities, Inorganic. By ARTHUR MESSINGER COMEY, PH. D. 8mo. Pp. 515. London and New York, Macmillan & Co., 1896.

The attempt is made in this book to give reliable data concerning the solubility of all inorganic substances that had been analyzed before March, 1894.

"The solubility of the substance in water is first given, the data being arranged chronologically in the longer articles. Then follow the specific gravities of the aqueous solutions, and also any data obtainable regarding their boiling points; other physical data concerning solutions are not included. Following this is the solubility of the substance in other solvents —first, the inorganic acids; then alkali and salt solutions, and finally organic substances."

The theories of solution are not discussed, the term 'soluble' being used to indicate that "a solution of some sort has been formed."

The plan of the book is admirable and, so far as our examination has extended, there are no serious omissions. The arrangement of the compounds and the nomenclature adopted are satisfactory and, probably, as good as any that could be employed.

A synchronistic table of periodicals is added in an appendix as well as some formulas and tables for the conversion of various hydrometer scales into specific gravity.

The work is a worthy successor to the earlier volume of Prof. Storer, and the author deserves the thanks of his colleagues for the time and labor he has put upon it.

L. B. HALL.

SCIENTIFIC JOURNALS.

AMERICAN CHEMICAL JOURNAL, JUNE.

On the Specific Gravities of Mixtures of Normal Liquids: By C. E. LINEBARGER. The methods used to determine the molecular masses of liquids, which consist either in converting the liquid into the state of vapor and determining its specific gravity in this condition, or in determining the change in freezing- or boiling-point of a solvent upon the addition of the liquid, do not throw much light on the molecular complexity of the substance in the liquid state. From work in other lines it is probable that in some cases the molecular aggregate is the same in the liquid as in the gaseous condition; but in other cases the complexity increases as the substance passes from the gaseous to the liquid condition. The present paper is a study of the changes in specific gravity which take place when liquids which suffer no change in passage from one state of aggregation to another are mixed. In cases where association or dissociation takes place the number of factors which enter into play is so great that no general conclusions can be drawn. In the determinations pycnometers of a special form were used, and in most cases great precautions were taken to secure pure substances. If two liquids of different chemical composition are mixed, the volume of the resulting liquid will not be equal to the sum of the volumes before they were mixed, but will be greater or less. This is explained by the fact that dilution diminishes the molecular attraction and the internal pressure. The number of molecules in the unit of surface decreases and the volume increases. In this paper the observed and calculated results for a large number of mixtures are given; but the data at command at present is not sufficient to enable one to draw any general conclusions.

Dianthranol—A Dyhydroxyl Derivative of Dianthracene: By W. R. ORNDORFF and C. L. BLISS. When anthranol in benzene solution is exposed to the sunlight crystals, having the same percentage composition as the anthranol, but differing in other ways, separate out. The substance can also be obtained by boiling the anthranol for a long time in xylene, and by shaking a solution of anthranol in caustic potash, in contact with the air. The determinations of the molecular weight show that it has twice that of anthranol. A crystallographic study of the crystals shows also that this substance is different from anthranol. Some derivatives were also made and studied. The formation of a diacetyl derivative shows the presence of two hydroxyl groups, and the authors consider that it is made up of two molecules of anthranol, in which the two hydroxyl groups are intact. They think that the union takes place by the breaking of the para bond between the two γ-carbon atoms and the joining of the groups.

Bromine Derivatives of Metaphenylene Diamine: By C. LONG JACKSON and S. CALVERT. In the course of an investigation of the behavior of tribromdinitrobenzol, the authors tried the action of tin and hydrochloric acid in hopes of either replacing some or all of the bromine. The number of cases on record, in which the bromine has been replaced by hydrogen when treated with this reducing agent, is small. As the result of work contemporary with this, Schlieper concludes that the bromine which stands in the ortho position to two negative groups is replaced in this manner; but the authors of this paper find this not to be strictly true, for they succeeded in replacing all three bromine atoms in tribromdinitrobenzol, a result not in accord with the above mentioned theory. They conclude that the ortho position, while not absolutely necessary, is yet very favorable for the replacement. The cause of the easy replacement is probably due to the fact that there are other radicals attached to the benzene ring, but their nature does not affect the result. They made several bromine derivations of phenylene diamine and also salts of these products.

On the Halogen Derivatives of the Solphonamides: By J. H. KASTLE, B. C. KEISER and E. BRADLEY. The authors find that chlorine and bromine derivatives of the sulphonamides can be prepared; but up to the present they have not been able to obtain similar ones containing iodine. These substances are somewhat similar to the acid chlorides and are also unstable, exploding when heated rapidly. Their composition can be explained in two ways, as they can be regarded either as addition—or substitution—products of the sulphonamides. The authors consider the evidence to be in favor of the latter, for not only do they show an analogy to nitrogen trichloride in their instability, but they are good oxidizing agents and are easily decomposed by acids. The easy evolution of chlorine is explained more readily by the substitution theory. If it is an addition product we should expect the chlorine to come off in combination with hydrogen, which it does not do. Just as nitrogen trichloride reacts with hydrochloric acid to form ammonium chloride and chlorine, so these products react to form the amide and the halogen.

The Reduction of Copper Sulphide: By DELIA STICKNEY. The author finds that copper sulphide can be readily reduced by allowing it to come in contact with the Bunsen flame. If the substance is heated in a crucible the reduction is always incomplete. The addition of some sulphur to cupric and cuprous oxides facilitates the reduction to metallic copper.

This number contains a review of the work done in the field of carbohydrates during the last year, and a physical-chemical study of the Gas Battery.

Brief reviews of the following books are also given in this number of the *Journal.* Elektro Metallurgie, Dr. W. Borschers; Lehrbuch der Elektrochemie, Dr. M. Le Blanc; Laboratory Experiments in General Chemistry, Chas. R. Sanger; A Short Course of Experiments in General Chemistry with Notes on Qualitative Analysis, Chas. R. Sanger; The Scientific Foundations of Analytical Chemistry, treated in an Elementary Manner, W. Ostwald; A text-book of Gas Manufacture for Students, J. Hornby; The Elements of Chemistry, P. C. Freer; Repertoire des Réactifs Spéciaux, Généralement Désignés sous leurs Noms d'Anteurs, Jean et Mercier.

J. ELLIOTT GILPIN.

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

*PHYSIOLOGY IN THE SCHOOLS.**

That some knowledge of physiology and hygiene should form a part of the education of every human being will, I think, be granted by every one who believes that wisdom is safer than ignorance, that ignorance is not innocence, and that health and manly and womanly vigor are better than nerveless helplessness, and lastly that a knowledge of what the Creator pronounced 'very good' is worthy the contemplation and thought of man. It is not necessary, however, to enter into an extended defense or advocacy of physiology and hygiene in the schools; they are there already by the sanction of the people and their representatives in the State Legislature, and hence the real question upon which thought and discussion should be directed is: How can this study be made to yield the best results of which it is capable? The question is apparently easily answered by saying: Put good text-books in the pupils' hands, and supply capable teachers and ample time and facilities. While such an answer may seem sufficient, it is in the present state of educational progress only hollow sound. What is really needed is a discussion of what makes a good text-book, how earnest men and women may become capable teachers, and how facilities, often inadequate, and time mostly too limited, may be best utilized.

*A paper presented at the Thirty-fourth University Convocation of the State of New York, June 24, 1896.

As to the text-books—and there are many of them of various grades of excellence—none seem to me to come up to the standard which should be striven after. The defects are due either to an author's imperfect knowledge of modern physiology or to unfamiliarity with the actual needs of the school room. I believe no truly great text-book for school, college or university can be created out of hand. It must be an evolution, a growth in its natural environment, the school room or laboratory where the pupils can help the teacher by their questions and difficulties. The atmosphere must be one of freedom for learner and teacher. Books written by so-called 'experts,' under the *supervision* of the scientific department of a temperance organization, may, it is admitted, make the subject 'very exciting and entertaining;' that is not what is here advocated, however, but a book by a teacher who, on the one hand, is truly an expert in the grade of schools where the book is to be used, and on the other, the possessor of a knowledge of physiology at first hand; that is, he must have a knowledge that is recognized as expert by the physiologists of the world, then he must write under the *supervision of* his own conscience, not that of an organization.

It is a truism which cannot be repeated too often or too emphatically that one cannot teach what he himself does not know. Therefore, for the teacher of physiology the first requisite is knowledge. Knowledge from books and of books and monographs, but greater than all book learning is knowledge at first hand from nature herself. Such knowledge has the precious quality of being alive, of being the leaven to vitalize the whole lump of knowledge obtained from books, and it makes teaching an inspiration to both teacher and pupil. Such information can only be acquired by the expenditure of considerable time and money. A six weeks' course will hardly accomplish it, although I hasten to add that a term at a university summer school or at a sea-side laboratory where the instruction is given by original investigators will give an uplift and inspiration to an earnest teacher that will be of inestimable value.

But, given the suitable text-book and the capable teacher, *what* shall be taught and *how* shall it be taught? The question of instruction upon the effects of alcohol and other narcotics need take but a sentence, for the subject has been most ably treated by President Jordan and discussed by our Superintendent of Public Instruction, Charles R. Skinner, and others. If I rightly understand them, my view corresponds with theirs and with those of my honored teacher, Prof. Burt G. Wilder, who is to discuss this paper. It is, in a word, to tell the truth, to present fairly both sides of the question, so that when the pupils use their own eyes and put the statements to the test of experience, as most of them surely will, they may feel, as well as know theoretically, that the statements made are true, and the teacher's earnest counsel is reasonable and not merely lurid sentiment.

Another problem will confront the teacher, prepared as indicated above; that is the experimentation upon living animals for the purpose of instruction in the schools. If he has the knowledge requisite he will know that, excepting a few facts, all which is known of physiology and hygiene has been acquired by experimenting upon living animals or living human beings. If one stops for a moment to reflect, physiology deals with the functions or activities of living organisms; it has to do with the living, not with the dead. For example, how shall one know whether a plant is good for food, whether it is medical or poisonous? Of two white crystalline substances, like chlorid of sodium (common salt) and chlorid of mercury (corrosive sublimate), how is one to know that one is almost indispensable for health and well being in both man and animals, while the other is deadly to both and also to plants? Certainly the desired information cannot be gained by the chemist's test tube or by application to a dead animal. How are the splendid results of the modern physiological psychology being attained? Not by dissecting the dead, but by experimentation upon the living.

Shall our schools then become the 'chambers of horrors' described by the anti-vivisectionists? Heaven forbid! The fundamental facts of physiology, those most intelligible and useful for the pupils in the schools, can be demonstrated for them and by them without the infliction of pain or even discomfort; and most of them can best be performed by the pupil upon himself. Let us take a few examples: Every child knows that there is feeling, as he calls it, in the skin; he also knows the sensation of cold. But he, and indeed most grown people, do not know that the tactile sense does not reside in every part of the skin, and so of the temperature sense. If some object like the rounded end of a lead pencil or a bit of steel be drawn carefully over the skin, say upon the back of the hand, it will be felt simply as an object over the tactile areas, while over the temperature areas there will be a sensation of cold. Then how easy it is to give the real physiology of muscle by having each pupil perform some definite movements of the arms. If the muscles are felt during these movements, especially if some force is exerted, as in lifting a weight, the changes in the form and consistency of the muscles can be easily determined. It will also probably be a revelation to the pupil to find that in raising the arm, for example, the muscles around the shoulder and at the elbow, which by themselves would tend to lower the arm or draw it outward or inward, also contract. After such an experiment it will not be difficult for the pupil to understand that, for the steady and definite movements of parts where the joints give considerable freedom, it is necessary that there should also be a moderate contraction of antagonistic or opposing muscles which by themselves would cause movements in other directions; that is, he will gain, by such a simple experiment, the ground idea of coordination.

Perhaps none of the experiments that can be performed are of more practical utility than some simple ones in digestion. It is now very easy to obtain from the pharmacies the ferment of the stomach or of the pancreas. With these ferments and a glass vessel the pupils can see for themselves the solvent action on various forms of food. They can see that finely divided food is more quickly dissolved than large masses, and hence one of the principal advantages of thorough mastication. So if the ferment of the saliva or pancreas were mixed with raw starch and with cooked starch it could be seen, with a distinctness never to be forgotten, that fire is a powerful ally of the human digestive organs. These experiments are also instructive because the processes are practically identical with those going on in the living body, and thus illustrate the side of physiology that may be demonstrated without experimenting on a living organism.

The circulation of the blood is a fact of such fundamental importance and so interesting in itself that every student ought to have the privilege of viewing it under a microscope. This can be very easily shown in the web of a frog's foot or in the external gills of a water salamander like the Necturus. If a little ether is put in the water containing the animal it will soon become anæsthetized without interfering with the circulation. The ether will render the perfectly painless observation successful without even arousing the apprehensions of the animal, which soon revives when placed again in fresh water, and appears as happy as if nothing had occurred. The experiment will also illustrate in a striking manner the effect of anæsthetics on all living beings. A very far-reaching lesson may be given by having each pupil perform some of the simpler experiments showing the illusions of the senses; these are so graphic that the dullest cannot fail to appreciate the fact that the only safe way is to look on all sides, to verify appearances by applying as many tests as possible—in short, to appreciate the *scientific method* which is so tersely expressed in the words of Scripture, "Prove all things; hold fast that which is good."

So far nothing has been said about anatomy. What place shall it have in a course upon Physiology? Undoubtedly it is a very great help in the study of function to have a good knowledge of the structures performing the various functions; but it seems to me that in many books, and in some courses in physiology, anatomy is so preponderant that the physiology is too much lost sight of—that is, the mechanism is exalted above its achievements. Only the grossest functions of the organs, like the supportive action of the bones, can be deduced from the anatomy alone; yet it is certainly the fact that, after the physiology has been once determined by experiments upon living beings, one can often see how admirably the structure of an organ is correlated with the performance of its function. For example, the small intestine with its millions of villi projecting like so many rootlets into the digested food seems from its very structure destined for absorption.

On the other hand, if one studied never so profoundly the structure of the salivary glands and the pancreas he would never know that they produce digestive liquids without experiment, and much less would he know that the one is so limited in its power (saliva) and the other so unlimited and powerful as a digester. So I think the microscopic structure or histology is liable to be made too much of in elementary books and teaching. But, for a few points, the microscope is truly a revealer; *e. g.*, the mystery of the current by which the air passages are swept clean of dust and other particles is simplified by microscopic observation which shows the tireless multitude of cilia with their ceaseless waving. The fact is not to be forgotton, however, that even in this case only the minute agents and their method of work have been found. *Why* they work is as great a mystery as ever. So also in the study of the circulation of the blood under the microscope one can see how closely every living element is surrounded by the blood capillaries, and how ceaselessly the blood corpuscles and the plasma move along, to be followed by a never-ending fresh supply.

The purpose of this paper has not been unduly to criticise, but to throw out what I hope will prove to be a few helpful suggestions. That the efforts of the teachers of this State are earnest and devoted is thoroughly believed. That the pupils they instruct are not all acquainted with sufficient anatomy and the fundamental principles of physiology is also known by the examinations for entrance in the University in which I have the honor to teach. From carefully compiled statistics obtained during the last few years it is found, however, that the pupils who have studied physiology something in the way indicated above have been far more successful than those who have merely studied the books.*

* Facts concerning entrance examinations in physiology at Cornell University: The great majority of students enter in physiology with the other studies, from Regents' diplomas or from graduation at accredited schools.

From the reports of the President and Dean it was seen that about one in sixteen so entering could not remain in the University on account of defective scholarship, while of those taking entrance examinations

If in closing I may briefly epitomize, it seems to me, that the best results may be obtained in physiologic instruction in the schools as follows:

1. Text-books written by able teachers who know the subject at first hand should be provided.

2. The fact should be emphasized that physiology is very real, and that every one may demonstrate upon himself many of the most striking and fundamental phenomena; for example, how quickly will the pupil see that it is not necessary to go to the teacher or to the book to find out the number of heart-beats and respirations per minute, and that both are greatly accelerated by exercise or excitement.

3. Anatomy should not overshadow physiology, but nice structural adaptations whereby specific functions are performed may be pointed out and worked upon with great advantage; for example, the valves in the heart, the veins and lymphatics, the forms of the joints, etc. Such knowledge is interesting and would aid all. Perhaps also it might arouse some slumbering genius whose future efforts would reveal adaptations now hidden.

4. The teacher should inspire his pupils with respect for the human body and its powers, and with due sympathy for all living things. Lastly, he should impress upon them with solemn earnestness the fact that their physical and moral health is largely in their own hands, and that the physical and moral laws of their being are inexorable.

SIMON HENRY GAGE.
CORNELL UNIVERSITY.

at the University one in eight was dropped, showing that the more poorly prepared were those who came for examinations including physiology. Physiology papers of 195 of the latter class have been looked over with reference to determining the quality and kind of preparation made, as taken from answers to questions.

The average standing of the 195 was..................53%
The average standing of those having dissection and drawing..................59%
The average standing of those having nothing but books..................47%
The average standing of those self-prepared.........59%
The average standing of those having previous college training..................66%

DISCUSSION OF PROF. GAGE'S PAPER ON PHYSIOLOGY IN THE SCHOOLS.

IT is fitting that the address on physiologic instruction should be given by a Cornell professor. For, in 1868, at the suggestion of the first president of that institution (the Hon. Andrew D. White) the entire Freshman class attended a course on physiology and hygiene during the first term; the examination questions were such as were asked in medical schools at that time, and diagrams were required of both macroscopic and microscopic structures. The choice of the speaker was equally happy; for the year of his graduation, 1877, was memorable in the annals of Cornell, in that then first physiology became a requirement for admission. Furthermore, Prof. Gage is a master in the elucidation of the fine anatomy of animal tissues which aids so materially the comprehension of function, and his address last summer as President of the American Microscopical Society, 'A Plea for Physiologic Histology,'* well merits mention in this connection.

If I commence with an emphatic corroboration of his complaint as to the inadequacy of existing text-books, it is because no other want has been more constantly and keenly felt by me during the twenty-eight years in which I have delivered 40 courses of lectures upon physiology (one-fourth of them in medical schools), and have addressed upon the subject more than 4,000 individuals.

From the nature of the case a text-book can never be *complete*. But the other four of what I call the five C's may surely be

*SCIENCE, August 23, 1895.

attained, viz., it should be *correct* so far as it goes and so far as existing knowledge permits; it should be *concise, consistent* and, above all things, CLEAR.

For use in systematic instruction the textual form of a scientific manual should be neither that of a treatise to be perused nor that of a lecture to be spoken. The paragraphs should be short, categoric and visibly, as well as logically, coordinated and subordinated.

It is probable indeed that one of the grounds for the success of mathematics and linguistics as disciplinary studies is the relative perfection of their pedagogic methods, and especially the way in which the general rules and exceptions thereto are set forth.

As to the *writer of a text-book*, if the book fulfills the requirements perhaps its source is of little moment. But even if this be not conceded I fear the limitation indicated by Prof. Gage is practically unattainable. With the absolute convictions natural to comparative youth, he is perhaps so sure that "a little knowledge is a dangerous thing" as to forget that, if that pithy saying be strictly true, no one of us can regard himself as altogether safe. Indeed, it is now many years since any one person could obtain *all* physiologic information at first hand. I trust, therefore, that Prof. Gage may assent to this less stringent statement: The writer of a text-book should have made some real contribution to physiologic method, fact or idea.

Like the teacher, the writer of a text-book needs to guard against the temptation to subordinate the needs and capacities of the learner to the supposed necessity for exhibiting his own erudition. The wisest of teachers is he who knows just what to omit.

In general method there is too often a direct inversion of the natural order. Children should be led to sing before they talk; they should be taught to draw before they write; and they should be encouraged to *observe* before they are compelled to think. In observing and reflecting they should be neither pushed nor pulled, but guided.

As applied to physiologic instruction, instead of '*verba et prœterea nihil*,' or even many words illustrated by a few random demonstrations, there should be numerous and well devised experiments upon which the pupils should reflect and comment. In short, in the place of what may be called *inducation* there should be sought a true *education*. Contrary to the Scripture phrase, the kingdom of science cometh *with observation*.

BURT G. WILDER.

CORNELL UNIVERSITY.

GEOLOGICAL ATLAS OF THE UNITED STATES.

FOLIO 16, KNOXVILLE, TENNESSEE–NORTH CAROLINA, 1895.

THIS folio, by Arthur Keith, consists of six pages of text, a topographic sheet, a sheet showing the areal geology, another showing the economic geology, a third giving structure sections, and a fourth giving columnar sections. The folio describes that portion of the Appalachian province which lies between parallels 35° 30′ and 36° and meridians 83° 30′ and 84°. This district contains about 968 square miles, divided between Knox, Sevier, Bland and Jefferson counties, in Tennessee, and Swain county, in North Carolina.

The text begins with a general description of the province, and shows the relation of this part to the whole. The local features of the drainage by the Holston, Tennessee and Little Tennessee Rivers and their tributaries, such as the Little Pigeon and Little Rivers, follow next in description. The various forms of the surface are pointed out, such as East Tennessee Valley, Smoky Mountains and Chilhowee Mountain, and their relations to the underlying rocks are emphasized.

Under the heading 'Stratigraphy' the

geologic history of the Appalachian province is presented in outline, and the local rock groups are fully described in regard to composition, thickness, location, variety and mode of deposition. The formations range in age from Algonkian (?) to Silurian, the greater portion being Algonkian (?). The Silurian rocks appear in the East Tennessee Valley, the Cambrian in Chilhowee Mountain and in various narrow belts in the valley, and the Algonkian southeast of Chilhowee Mountain. The Algonkian rocks are chiefly slates, sandstones, conglomerates and graywackes; the Cambrian rocks consist of sandstones and shales in the Chilhowee belt and of sandstones, shales and limestones in the valley; the Silurian rocks comprise sandstones, limestones and shales. The details of the series of strata are shown in the columnar section. The process of decay in each kind of rock is discussed, and the manner in which the residual soils and forms of surface depend on the nature of the underlying rock.

In the discussion of 'Structure,' after a general statement of the broader structural features of the province, two methods are shown in which the rocks have been deformed. Of these the extreme Appalachian folding is the chief, and less in importance are the broad vertical uplifts. Three degrees of deformation appear in the Paleozoic rocks—folding, faulting and metamorphism—each being best developed in certain kinds of strata. The region northwest of Chilhowee Mountain is broadly anticlinal, while the Smoky Mountain district is synclinal, and two lines of minor uplift appear in each of these districts. Faults are found chiefly on the west side of these minor uplifts, especially in the Cambrian sandstones, and metamorphism increases southeast from Chilhowee Mountain. In the East Tennessee Valley the rocks are folded to an extreme degree and the strata are frequently perpendicular or overturned. In the sheet of sections the details of the folds and faults appear.

Economic products of this region comprise gold and iron ore, ornamental stone, such as marble, such building stone as sandstone, limestone and slate, and other materials, like lime, cement and brick clay. The localities of each of these materials are noted, and quarries are located on the economic sheet, and the nature and availability of the deposits are discussed. The resources of the region which inhere in timber and water power are also described.

FOLIO 19, STEVENSON, ALABAMA-GEORGIA-TENNESSEE, 1895.

This folio, by Charles Willard Hayes, is bounded by parallels 34° 30′ and 35° and meridians 85° 30′ and 86°. It contains 980 square miles, embracing portions of Franklin and Marion counties in Tennessee; Dade, Walker and Chattooga in Georgia; and Jackson, Dekalb and Cherokee in Alabama. The folio contains four pages of text, including a generalized columnar section and four coal sections; one sheet showing topography, another showing areal geology, a third economic geology and a fourth giving five structure sections inserted in the map.

The Stevenson quarter degree is occupied chiefly by the Cumberland plateau and its outliers, Sand and Lookout Mountains. It includes also a portion of Brown's Valley, which is the southward continuation of Sequatchie Valley and is located upon the westernmost of the sharp anticlines which characterize the folded belt of the Appalachians. Extending diagonally across the center of the area is a broad, level plateau, forming Sand Mountain. It is bounded by straight and steep escarpments. To the east are Lookout and Wills valleys, also located upon sharp anticlines. Finally, the southeastern portion of the area is occupied by Lookout Mountain, also a broad, level plateau. Thus there is seen to be a close relation in this region between structure and topography. The valleys are located upon the anticlines and the plateaus coincide with the synclines. This relation depends upon the relation of hard and soft rocks in this region. Of the strata exposed, the upper formations are hard sandstones and the lower generally limestones. After the anticlinal folds had been produced by lateral pressure the region was for a long time subjected to subaëreal erosion. The whole surface was reduced to a nearly uniform plain, now represented by the summits of the plateaus, but then near sea level. Thus the hard sandstone was removed from the tops of the arches, and when the region was elevated the softer limestones there exposed were easily reduced to the lower level, while the surface within the synclines was protected from erosion by the hard sandstones.

The oldest formation of the region is the Knox dolomite, which is brought to light along the axes of the anticlines. Above this is the Chickamauga limestone, from 1,100 to 1,400 feet in thickness, and the Rockwood, which is here a calcareous shale. The Devonian is represented by black, carbonaceous shale from 20 to 40 feet in thickness, and the Carboniferous by Fort Payne chert and Bangor limestone, representatives of the Mississippian series, and the Lookout and Walden sandstones, forming the coal measures. In all about 5,000 feet of strata are exposed, and the formations generally thicken toward the southeast.

The structure of the region is quite simple, and has already been indicated. In addition to the anticlines which were mentioned, there is a fault along the western side of the Sequatchie anticline which brings the Knox dolomite in contact with the Bangor limestone for several miles.

The principal mineral resources of the region are coal and iron ore, while limestone, building and roadstone and brick and tile clay are subordinate but important. The coal-bearing formations are the Lookout and Walden. They occupy the surface of the plateaus, forming 544 square miles, the larger portion of which probably contains workable coal. The only important development of the coal is in Dade county, Georgia, where five beds occur below the conglomerate, at least four of which are workable locally. The chief iron ore of the region is red hematite or fossil ore of the Rockwood formation. This ore is very similar in appearance to that occurring at the same horizon in such widely separated localities as Wisconsin, New York and central Alabama. It has been extensively worked in the vicinity of Rising Fawn, near the Georgia-Alabama line. It is not always of workable thickness, but the economic map shows the areas within which it may be found.

FOLIO 20, CLEVELAND, TENNESSEE, 1895.

This folio, by Charles Willard Hayes, embraces 4 pages of text, a sheet showing topography, another areal geology, and a third economic geology, also a sheet containing five structure sections, and, finally, a sheet giving two generalized stratigraphic sections.

The Cleveland quarter-degree is bounded by the parallels 35° and 35° 30′ and the meridians 84° 30′ and 85°. It contains 975 square miles, including portions of Meigs, McMinn, James, Bradley and Polk counties. The country represented on the Cleveland sheet lies largely in the Appalachian valley. Its northern corner reaches within two miles of the Cumberland escarpment, which forms the western limit of the valley district, while its southeastern corner reaches beyond the limit of the valley, and includes a small portion of the Unaka Mountains, which form the western chain of the Appalachians. When the valley district is seen from an altitude of 1,000 feet or over, it appears as a broad undulating plain, nearly all the ridges and hills rising to a uniform level a little less than 1,000 feet in altitude. Above this level a few ridges rise some hundreds of feet; below it the Tennessee and Hiwassee Rivers flow in valleys 250 feet in depth. In other words, this portion of the Appalachian Valley may be regarded as a plain on which the higher ridges remain in relief and in which the stream channels have been sunk. A similar plain, having an altitude of about 1,700 feet, stretches along the western base of the Unaka chain. This is much more deeply dissected by narrow stream channels than the lower plain in the valley. These are portions of the two principal peneplains of the southern Appalachian province, formed respectively in Tertiary and Cretaceous time. The greater part of the area is drained by tributaries of the Hiwassee River, which crosses it in a direct course and joins the Tennessee River near the western border. A small part is drained by the Conasauga River, whose waters flow south to the Coosa and thence directly to the Gulf. The divide between the drainage systems is broad and indistinct, and a little below the lower of the two peneplains of the region. From a study of this and adjacent areas it appears probable that during the formation of that peneplain the drainage was very different from that at the present time. Previous to the uplift which caused the streams to cut their present channels in the peneplain, the Tennessee River did not turn westward, as it now does, but continued southward in the valley, across the present divide, directly to the Gulf.

The rocks of the Cleveland quarter-degree fall into three groups: The Ocoee series, the Chilhowee series, and the fossiliferous Paleozoic formations of the Appalachian Valley. Probably the oldest rocks in the region occur in its southeastern corner, forming Big Frog Mountain and the plateau along its western base. No fossils have yet been found in these rocks, and they are separated by a great fault from rocks of known age, so that their position in the stratigraphic column has not been fixed with certainty. However, since they bear all the marks of extreme age, and, so far as known, contain no organic remains, they will be considered Algonkian until satisfactory evidence to the contrary is found. They consist chiefly of graywacke slates, containing many beds of coarse conglomerate and some siliceous limestones.

The Chilhowee series consists of quartzites, sandstones, conglomerates and shales, which form Beans and Starrs Mountains at the southeastern border of the valley. The area of these rocks is separated by faults both from the Ocoee on the east and the fossiliferous valley formations on the west. No fossils have yet been found by which their age can be determined, but they correspond so closely with a series of formations in the Chilhowee Mountains, in which Cambrian fossils have been found, that there can be little doubt that they occupy the same stratigraphic position.

The fossiliferous Paleozoic rocks of the valley embrace three Cambrian formations, made up largely of argillaceous and sandy material. The Knox dolomite, which is from 3,800 to 4,100 feet in thickness, is in part Cambrian and in part Silurian. Above this is the Chickamauga limestone, 1,000 feet in thickness in the western part of the area, and 300 or 400 feet thick in the eastern part, where the upper portion of the limestone is replaced by shales and sandstones, forming the Athens, Tellico and Sevier formations. Finally, above these, is the Rockwood formation, which also shows considerable increase in thickness and in the proportion of coarse material toward the southeast. The Devonian is represented by 15 to 30 feet of black shale, and the Carboniferous by about 350 feet of very siliceous limestone.

The peculiar structures which characterize the intensely folded belt of the Appalachian Valley are highly developed in this region. The sections show five well-marked synclines west of the Ocoee rocks, with a large number which are less distinct. They are all nearly parallel, crossing the tract in a northeast-southwest direction with slightly curved axes. These synclines usually have gentle dips on their western sides and steep or overturned dips on their eastern. In most cases adjacent synclines are separated by thrust faults. Thus the strata are broken into a large number of narrow blocks which overlap each other, the fault plains all dipping southeastward.

The principal mineral resources of the region consist of iron ore, lead ore, limestone, building and road stone, and brick and tile clay. A small amount of hematite or red fossil ore occurs associated with the shales of the Rockwood formation. Also considerable bodies of limonite occur, chiefly along the great thrust faults which separate the Chilhowee series from the valley rocks. The lead ore is found in limestones at the base of the Knox dolomite, and is mined to some extent a few miles south of Cleveland.

FOLIO 21, PIKEVILLE, TENNESSEE, 1895.

This folio, by Charles Willard Hayes, consists of 3½ pages of text, a topographic sheet (scale 1:125,000), a sheet of areal geology, one of economic geology, another of structure sections, and a final sheet giving a generalized columnar section of the district and vertical sections showing the position and thickness of coal beds.

The quarter-degree covered by this folio has an area of 980 square miles. Its southeastern corner is just within the great Appalachian Valley, and its northwestern corner occupies a portion of the highland rim of Middle Tennessee. It therefore extends entirely across the Cumberland Plateau, whose level surface has here an elevation of about 1,700 to 2,000 feet above tide. The plateau is intersected by Sequatchie Valley, a narrow depression between wall-like escarpments which are parallel with the eastern escarpment of the plateau. This remarkable valley is located upon the westernmost of the sharp anticlinal folds which characterize the great Appalachian Valley belt. The western escarpment of the Cumberland Plateau is extremely irregular, being deeply notched by the streams flowing from its surface.

The two most important peneplains of the southern Appalachians are well developed in this region; the higher and older appears in the surface of the plateaus, and the younger, about 1,000 feet below, forms the hilltops of the Sequatchie Valley and the surface of the highland rim.

The larger part of the surface of the Pikeville quarter-degree is occupied by Carboniferous rocks, the coal measures (Walden and Lookout sandstones) forming the surface of the plateaus, while the Bangor limestone and Fort Payne chert occupy the lower slopes of the escarpments and highland rim to the west. The underlying Devonian and Silurian formations are brought to light by the steep folds of the Sequatchie and Tennessee Valleys. The Devonian is represented by fifteen feet of carbonaceous shale which appears to be entirely conformable with the formations above and below.

Three Silurian formations are represented on the map. The Rockwood, at the top, is composed of sandstone and sandy shale in the Tennessee Valley, but becomes more calcareous toward the west, so that in the Sequatchie Valley it is a shaly limestone, and on the next quarter-degree is indistinguishable from the massive Chickamauga limestone below.

Compared with the Appalachian Valley belt to the east, the structure of this region is simple. Its most striking features are the Sequatchie anticline and fault. On either side the strata are nearly horizontal, forming a broad, shallow syncline on the east, and passing westward with a few low undulations into the great expanse of horizontal strata of the Mississippi Basin.

The most important economic interest in the region is coal. Workable beds occur both in the Lookout and in the Walden formations. The lower beds, those in the Lookout, are variable in position and thickness, so that, while they afford much excellent fuel in places, they are not generally suitable for working upon a large scale. Their character at Bon Air, where they are extensively developed, is exceptional. The most important coal seam in the region, by reason of its greater thickness and uniformity, is the Sewanee, which occurs in the Walden sandstone a short distance above the Lookout conglomerates. Its area, within the limits of the Pikeville quarter-degree, is about 500 square miles, of which the greater portion is workable.

FOLIO 22, MCMINNVILLE, TENNESSEE, 1895.

This folio, by Charles Willard Hayes, consists of 3 pages of text, a topographic sheet (scale 1:125,000), a sheet of areal geology, another showing the economic geology and another giving structure sections. Following the text is a generalized columnar section for the district, accompanied by vertical sections showing the position and thickness of coal beds.

The quarter-degree covered by the McMinnville folio has an area of 980 square miles. It joins the Pikeville and Sewanee quarter-degrees on the east and south. The greater part of its surface is within the highland rim. Its northwestern corner includes a small portion of the central basin of Middle Tennessee, and its southeastern corner is occupied by the Cumberland Plateau. From northwest to southeast, then, the surface rises by steps from the central basin, with an altitude of 700 feet, to the highland rim, at 1,000 feet, and again to the Cumberland Plateau at 1,800 feet. Each step or terrace is part of a more or less perfectly preserved peneplain produced by long-continued erosion, when the land stood relatively lower than now. The plateau, which is the highest and consequently the oldest of these plains, formerly extended far to the westward, but has been worn away by the action of streams during and since the formation of the next lower plain. In the same manner the streams are wearing down the second to the level of the third plain, and the escarpment which separates the two is slowly working backward toward the southeast, following the retreat of the higher plateau escarpment.

The McMinnville quarter-degree lies entirely beyond the westernmost of the sharp folds which characterize the Appalachian Valley belt. Its strata are nearly horizontal, having a very gentle and uniform dip toward the southeast of about 30 feet to the mile. The strata exposed measure only 1,700 feet in thickness, which is but a small fraction of the thickness exposed in regions containing folds. Of these 1,700 feet of strata, about 1,500 are Carboniferous, consisting of coal-measure sandstones and shales, forming the upper portion of the plateau, and limestones forming the lower portions of the plateau escarpments and the surface of the highland rim. Beneath the Carboniferous formations are from 10 to 30 feet of black shale, which appears to represent the whole of the Devonian deposition in this region. The streams in the northwestern corner of the quarter-degree have cut down through the Carboniferous and Devonian, and as much as 200 feet into the underlying Silurian limestone. The upper division of the Silurian on the eastwardly adjacent Pikeville quarter-degree, the Rockwood shale, becomes so calcareous toward the west that it cannot be distinguished from the underlying Chickamauga limestone. The McMinnville quarter-degree is essentially an agricultural region, the Carboniferous limestones forming a belt of exceptionally fertile soil along the inner portion of the highland rim. It includes a small area of coal-bearing rocks in its southeastern corner, where the subconglomerate beds, probably corresponding to those at Bon Air, have been opened and worked for local consumption.

WORK OF THE UNITED STATES GEOLOGICAL SURVEY FOR FISCAL YEAR, 1896–97.

The Director of the U. S. Geological Survey recently formulated the plan of operations for the bureau under his charge for the fiscal year ending June 30, 1897, and it received the approval of the Secretary of the Interior. As soon as the plans were approved the surveying parties were made up and ordered to the field.

The plan covers all the work of the year, administrative and scientific, and begins with a financial statement. The total appropriation for topographic surveys for 1896–97 is $184,200, an increase of $25,000 over the appropriation for the year just closed. For geologic surveys and researches there is $118,700, which includes an item of $5,000, specifically appropriated for an investigation of the gold resources of Alaska, and for paleontologic work there is $14,000. For chemical researches the appropriation is the same as that for last year, $10,000. For hydrographic work there is an appropriatiou of $50,000, as against $20-000 for 1895–96. For the preparation of illustrations and of the report on mineral resources, the engraving of maps, etc., there is an aggregate appropriation of about $100,000.

In accordance with the plan 30 parties have taken the field or will soon take the field for geologic work, 5 in the New England region, including New York; 5 in the Appalachian region; 2 in the Atlantic Coastal Plain region; 5 in the Interior or Mississippi region; 4 in the Rocky Mountain region, and 8 in the Pacific region. The mining districts of the Appalachian and Rocky Mountain regions will receive special attention, though areal mapping and other work will go on in all directions, as heretofore.

The paleontologists will engage in the determination of faunas and floras, especially those of the coal regions of the Appalachians and Rocky Mountains, and a study will be made of the Cretaceous fauna of Colorado, Utah and Wyoming, with reference to areal and vertical distribution, for the purpose of aiding the geologists in the solution of problems in areal geology. For this work several of the paleontologists take the field.

The appropriation for hydrographic work has been subdivided, so that $25,000 will be devoted to the gauging of streams and the determination of the water supply of all parts of the country, a second sum of $10,-000 to the investigation of the subject of artesian wells and underground currents in arid and semi-arid regions, and the remainder to the preparation of reports upon the methods of utilizing the water resources. Work will be done in nearly every trans-Mississippi State and Territory, as well as in New England, Pennsylvania and most of the Southern States.

Topographic work this year will be under the immediate charge of the Director, and will thus be placed on the same footing in that respect with the geologic work. A highly important change will be in the method of making the topographic surveys, a change which will, it is expected, materially enhance the value and extend the field of usefulness of the topographic maps. It was provided in the Sundry Civil Act, under authority of which the work will proceed, that levels be established above sea level in every area under survey and that these levels be marked on the ground by iron or stone posts or bench marks. Thus accurate levels will be run everywhere in the course of the surveys and monuments established at short intervals. The work done in this way will progress somewhat less rapidly than it has progressed under the old method. The $25,000 which has been added to the appropriation is expected to meet the cost of doing the work in this way.

There are 30 or 35 triangulation and topographic parties in the field, or about 75 men, all told.

In New York the topographic surveys will be continued on the cooperative basis, the State government having appropriated $15,000, the Federal Survey to allot a similar sum to the work. There will also be cooperation in Maryland.

The joint topographic and land subdivision survey of the Indian Territory, which has been going on without interruption in the field since May, 1895, will be continued to completion. W. F. MORSELL.

THE NEW YORK STATE VETERINARY COLLEGE.

BY the Legislative acts of 1894, 1895 and 1896 for the establishment and maintenance of a State Veterinary College, New York has taken a notable step in advance. The animal industry of the State is so important and extensive, and the relations of animal diseases so intimately interwoven with human health and well-being that every undertaking whereby the financial and sanitary interests of the State will have the benefit of the knowledge and continued investigations of a body of experts must command the approval of every one. It is believed, too, that the establishment of the College upon the campus of a great university with the full advantages of its libraries and laboratories and surrounded by the university atmosphere will be of inestimable advantage to it. On the other hand, it will aid the university to have in its midst a group of investigators and students dealing with the great practical problems involved in the live stock interests of the State and the relations of this industry to public health. In a word, it is believed that the atmosphere of a university will inspire and liberalize the College, and the efforts of the College for the information and betterment of the condition of society will have a like beneficial effect on the university, by bringing clearly before it practical problems and the real efficiency of our present knowledge in dealing with great sanitary and financial interests.

The standard for the veterinarians of New York State is very high, and the State school ought naturally to prepare men well for their profession; it has therefore the duties of a professional school. On the other hand, its purpose being to study and if possible eradicate or show the means of avoiding animal diseases and epidemics, it must also be a center of investigation. For this double purpose of teaching and investigation, it has six special buildings in addition to those of the University; and it is believed that under the wise guidance of its Director, Dr. James Law, who has served the State and the Nation so well and efficiently in the past, that its opening in the coming autumn will mark another milestone of progress in the State. The following have been already appointed upon the staff of the College:

1. For director of the State Veterinary College and professor of veterinary medicine, principles and practice, zymotic diseases and State medicine: James Law, F. R. S. V. S. of Great Britain; professor of veterinary science in Cornell University;

formerly professor of materia medica and anatomy in the Edinburgh new Veterinary College and the Albert Veterinary College; chairman of the United States treasury cattle commission; State veterinarian of New York; consulting veterinarian to the New York State Agricultural Society; chief director of the United States Bureau of Animal Industry for the suppression of lung plague in the Mississippi valley and in New York; member of the tuberculosis commission of the State of New York; chairman of the regents' board of veterinary examiners for New York and author of a 'General and Descriptive Anatomy of the Domestic Animals,' the 'The Farmers' Veterinary Adviser' and numerous monographs on veterinary subjects.

2. For professor of veterinary surgery, obstetrics, zootechny and jurisprudence: (Appointment not yet made.)

3. For professor of veterinary and comparative pathology and bacteriology: Veranus Alva Moore, B.S., M.D.; chief of the pathological division of the United States bureau of Animal Industry, Washington, D. C., professor in the National Veterinary College and of histology in the medical department of the Columbian University, Washington, D. C.; author of numerous bulletins on the pathology and bacteriology of animal diseases, published by the Bureau of Animal Industry.

4. For assistant professor of veterinary and comparative physiology, materia medica and pharmacy: Pierre Augustine Fish, B.S., D.Sc., D.V.S.; assistant in the pathological division of the United States Bureau of Animal Industry, Washington, D. C.; formerly instructor in physiology and vertebrate zoology in Cornell University, and in zoloogy in the Marine Biological Laboratory at Wood's Holl; author of several papers on the structure and function of the nervous system and on pharmacological subjects.

5. For assistant professor of veterinary anatomy and anatomical methods: Grant Sherman Hopkins, B. S., D. Sc., instructor in comparative anatomy and embryology in Cornell University, author of monographs on topics in comparative anatomy and histology and on methods of anatomical and physiological demonstration.

6. For professor of microscopical technology, histology and embryology: Simon Henry Gage, B.S., professor of anatomy, histology and embryology in Cornell Unisity; former chairman of the section of biology of the American Association for the Advancement of Science, and president of the American Microscopical Society; author of notes upon Histological Methods, the Microscope and Microscopical Methods; joint author of Anatomical Technology; contributor to Wood's Reference Hand-Book of the Medical Sciences, to Foster's Medical Dictionary and to various scientific periodicals and transactions.

7. For instructor in microscopy, histology and embryology: Benjamin Freeman Kingsbury, A. B., Ph. D., formerly graduate scholar and fellow in Cornell University; author of monographs on histology and upon the structure and morphology of the nervous system and organs of sense.

8. For assistant in veterinary bacteriology: Raymond Clinton Reed, Ph.D.

CURRENT NOTES ON PHYSIOGRAPHY.

RIVERS OF CENTRAL IOWA.

The annual report of the Iowa Geological Survey for 1895 contains an essay by J. L. Tilton, of Indianola, on Warren county, in the south-central part of the State, in which particular attention is given to the origin of the river courses. The small ravines are post-glacial, consequent on the slope of the surface. The larger streams follow preglacial valleys, though they have not yet cut down to the bottom of the drift that clogged their former courses. It is believed that in Cretaceous times the chief drainage was down the faint dip of the strata to the southwest, with longitudinal subsequent branches along the strike of the weaker shales; but post-Cretaceous elevation being greatest to the northwest, the southeast-flowing subsequent streams gradually gained possession of the drainage and became the chief rivers of the region; the Des Moines being an example of this kind. Diverted consequent streams enter these masters from the northeast; headward-growing obsequent streams enter from the southwest, perhaps marking the reversed paths of former beheaded consequents; the streams of Warren county being chiefly of the latter class. Faint escarpments facing northeast are formed along the outcrops of the harder strata. The larger streams have broad flood-plained trenches below even uplands of adolescent dissection; but to cite these trenches as examples of the 'immensity of erosion' leaves no fitting term for the much greater erosion by which the generally even surface of the uplands was fashioned.

GEOMORPHOLOGY OF NORWAY.

PROF. EDUARD RICHTER gives further account of his work last summer (See SCIENCE, June 26), in his '*Geomorphologische Beobachtungen aus Norwegen*,' contributed to the Vienna Academy (Sitzungsber., Feb., 1896), from which a very clear picture of *fjeld* and *fjord* may be gained. Much importance is attached to the increased rate of weathering in the belt above the limit of vegetation and below the snow line. The plateau-like uplands are ascribed chiefly to this process, and not to peneplanation during a lower stand of the land, as advocated by some authors. The mountains of Jotunheim are regarded as unconsumed remnants of a once much greater mass, now far advanced in reduction to the upland level. Well formed cirques (*Botner*) characterize the later stages of this reduction, and many examples are mentioned in various stages of development. These forms are explained as the result of retreat by weathering back from a reëntrant on which a protective covering of névé or ice lies; and thus explained, they are regarded as trustworthy witnesses of former glacial action in various mountains of middle Europe. As a special feature of the Norwegian fiords, Richter emphasizes not only their U-shaped cross section, but also the discordance of their floor level with that of many side valleys; the steep side-wall of the deeper fiord cutting square across the floor of the shallower side valley. This is ingeniously explained as a modification of a preglacial valley system by a glaciation of just such severity as would fill some valleys with long ice streams, while certain confluent valleys of less and lower catchment area would be occupied by relatively inactive ice or only by névé. The latter valleys would then be little modified, while the former would be rapidly deepened and changed from V to U form.

This essay is of particular interest in giving a clear analysis of the relation of form to process, and in attributing much influence to the climatic control of denudation, both as determined by altitude above sea level and as affected by glacial or interglacial conditions; but the sufficiency of the process suggested for the production of the uplands needs further demonstration.

LITTLEDALE IN THIBET.

LITTLEDALE'S adventurous effort to reach Lhasa is described in an entertaining narrative with incidental mention of notable physiographic features. A number of volcanoes were seen in Thibet south of Cherchen (mid-southern border of the desert of Gobi). Thereabouts, the drainage from the mountains enters salt lakes in flat intermontane depressions of great altitude. Further southeast, rivers escape to the sea in deep valleys and entirely change the aspect of the country. The lakes all stand lower than their ancient shore lines; many small basins of to-day having formerly united in large confluent water bodies. This narrative, like many of its class, indicates great courage and endurance on the part of the explorers, but abounds with personal incidents rather than with geographical matter. (London Geogr. Journal, May.)

DANGER FROM THUNDERSTORMS IN ARABIA.

An excursion of twelve years ago in Oman, southeast Arabia, lately described by S. B. Miles, gives once again an impressive picture of the immediate independence of desert tribes on the wadies or water courses, which determine the place of all the villages and of nearly all the roads. A canyon, six miles long and 1,000 to 1,500 deep, between neighboring valleys, was luckily passed through a day before a heavy thunder storm; less fortunate travellers are not unfrequently overwhelmed in it by the sudden rise of the stream, from which there is no escape. "The huge walls of rock give the appearance as if the mountain range had been suddenly split in twain from the base to the summit by some convulsion of nature." If a real, convulsively split canyon is some day found, what an agreeable change it will be to read: "The huge walls of the fissure formed by this convulsion of nature look just like the walls of ordinary gorges that have been slowly cut down by streams." (London Geogr. Journ., May.)

HILL ON CENTRAL AMERICA AND ANTILLES.

The May number of the National Geographic Magazine has an article by R. T. Hill on the geographic relation of the three Americas, North, Central and South, contending that the North American cordilleras terminate with the line of Mexican volcanoes west of Vera Cruz, that the Andes terminate south of the Isthmus of Panama, and that Central America is to be associated with the transverse deformations of the Antilles; the latter lying on lines of east-west corrugations "which have persisted without continental connection or union with each other since their origin." Thus interpreted, these islands belong to a class that should be welcomed by the physiographer as desiderata, long ago deduced as possibilities, and prepared for in his scheme of classification, but of rare occurrence on this small earth during the brief epoch in which we know it.

W. M. Davis.

Harvard University.

CURRENT NOTES ON METEOROLOGY.

INTERNATIONAL CONGRESS OF HYDROLOGY AND CLIMATOLOGY.

The Fourth Session of the International Congress of Hydrology, Climatology and Geology will be held at Clermont-Ferrand from September 28 to October 4 of this year. Scientific societies in all parts of the world are invited to take part in this Congress. The French railroad companies have reduced their fares 50% for those who attend the meeting, and the *Compagnie Génerale Transatlantique* has given a reduction of 30% to those who travel by its steamers. Among the meteorologists who have charge of the meeting are Angot, Teisserenc de Bort and Plumandon. The list of questions to be considered in the section on climatology is the following: Meteorological observations, their part in the study of climates; What is meant by mountain climate?; Investigation on the proper means of determining the degree of clearness of the sky, of its color, and of these influences in hygiene; The prevalence of winds in certain regions, and their influence on sanitary conditions. Membership in the Congress costs 20 francs, and subscriptions may be sent to M. Doin, 8 Rue de l'Odeon, Paris.

ATLAS OF THE PACIFIC OCEAN.

A PUBLICATION of more than usual interest and importance is the large Atlas of the Pacific Ocean, recently issued by the *Deutsche Seewarte*, at Hamburg, under the direction of Dr. Neumayer. The previous volumes in the same series are an Atlas and a Handbook of Sailing Directions for the Atlantic and for the Indian Oceans. Although primarily intended for the use of ship captains, these publications should be studied by all meteorologists. The data on which the charts are based are the most complete and most authentic obtainable. The charts include among others the following: depths; ocean currents from January to March and from July to September; water surface temperatures for February, May, August and September; isotherms and isobars for the same months; winds for winter and summer; wind districts; relative frequency of winds for January, April, July and October; rainfall by districts; magnetic variation; sailing routes. For the minute study of the general meteorological conditions of the Pacific Oceans there is nothing that can approach these new German charts. The *Sailing Directions*, to accompany the *Atlas*, are now in press. R. DEC. WARD.

HARVARD UNIVERSITY.

CURRENT NOTES ON ANTHROPOLOGY.

AMERICAN CRANIOLOGY.

PROF. HAMY, the distinguished successor to de Quatrefages, has an article in *L'Anthropologie*, for April on the Malayan and the American races. Following older authorities, he treats both as offshoots from the Mongolian variety or subspecies. When he comes to the difficult task of classifying the refractory red men he relies wholly on craniology and his results are, to say the least, sweeping. He groups as one all the mound builders, cliff dwellers and Pueblo Indians. The same group 'extends from the Atlantic to the Pacific, and from the Great Lakes to the Isthmus of Tehuantepec.' They are all brachycephalic, short in stature, with narrow noses and prominent cheek bones. It is needless to say that the researches of Boas, Virchow, Matthews and others lend no support to this statement, and indeed contradict it. Nor is Prof. Hamy's discussion of the South American skull-forms in accordance with the measurements adduced by Ehrenreich and others.

The skull is as variable among the American aborigines as it is among the Aryan nations to-day, and no classification of stocks can be founded upon it. The linguistic classification is the closest to an exact one that we can have for the race of the new world, and has been accepted by all modern American authorities.

MAN AND THE MEGALONYX.

THE Megalonyx was a hugh sloth who lived about these parts for some time after the Champlain depression of the pleistocene. His remains abound in what are are called the 'Megalonyx layers,' a horizon which Gilbert has offered evidence to place post-glacial. In these layers no trace of man has yet been found; but in April last Mr. Henry C. Mercer, exploring for the University of Pennsylvania, found in a cave in Tennessee bones of this sloth, fresh in appearance, and with remains of attached tissue and ligaments, mingled with fragments of reeds used as torches by the Indians. Along with these were other bones of living fauna, cave rats, porcupines, etc. Mr. Mercer has issued a brief announcement of this discovery, with an illustration of the bones. Copies can be had by addressing him (University of Pennsylvania, Philadelphia).

This does not necessarily remove man to remote antiquity. The sloth might have survived to comparatively recent centuries in the mild valleys of Tennessee; but it does seem to make the red man and the animal contemporaries.

D. G. Brinton.

University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS.

LORD KELVIN.

The jubilee of Lord Kelvin's professorship was celebrated by the University of Glasgow, and the corporation of the city on June 15th, 16th and 17th. More than two hundred delegates were present, representing British and foreign universities and learned societies, and congratulatory messages and telegrams were sent from all parts of the globe. At a conversatzione in the University on the evening of June 15th Lord Kelvin's numerous inventions and the diplomas, medals, addresses, etc., presented to him by various scientific and other learned societies, were exhibited, and more than two thousand guests offered their congratulations to Lord and Lady Kelvin. A cablegram from the University was sent by way of San Francisco and traversed the circuit of 20,000 miles in 7½ minutes. On the morning of June 16th numerous addresses were presented to Lord Kelvin and the degree of LL.D. was conferred upon him and on several of the distinguished guests, including Prof. Simon Newcomb and Prof. Cleveland Abbe. A banquet was given by the corporation in the evening, and on June 17th there was an excursion on the Firth of Clyde.

Prof. A. Gray writes to *Nature:* "As these words are being printed, the Jubilee of Lord Kelvin's professorship is being celebrated in the most enthusiastic and magnificent manner at Glasgow. Delegates from all parts of the world are present, and among them are many of the most eminent representatives of science at home and abroad. From Paris to Moscow, Canada to Mexico, India to Australia, the whole civilized world unites in congratulating Lord Kelvin on the great work for science and the good of his fellow men which he has achieved, and in offering good wishes that he may have health and strength for the continuance of his glorious career. Though for fifty years he has been professor of natural philosophy at Glasgow, has seen pass through his classes several generations of students, has been one of the greatest leaders in what has been preëminently a century of scientific discovery and advancement, has worked as few men can work, and withal has taken the keenest interest in all that ought to interest the true citizen of a great country, yet is his eye not dim nor his natural force abated. It is the hope of all his friends and of all the great army of scientific workers who now are unanimous in doing him honor that he may have before him many long years of happy and successful work." All American men of science will join in offering their most sincere congratulations, for there is no one living when they honor more highly than Lord Kelvin.

THE TEACHING OF ANATOMY.

The last number of the *Bulletin of the Johns Hopkins University* (May–June, 1896) contains interesting accounts of the anatomical courses and laboratories of the University, including the work on normal histology and microscopic anatomy and the photographic room and apparatus. The articles are illustrated by ground plans and photo-engravings and deserve careful study by those engaged in teaching anatomy or indeed any natural science. Prof. Mall holds that anatomy should be taught in the dissecting room and not by lectures. He writes:

"I have asked many professors, even of anatomy, where they had learned their anatomy, and in nearly all cases the reply was 'in the dissecting room.' They all admitted that, in addition to demonstrations, lectures were of little use to students, and some believed them worse than useless. The zoologists and botanists have long ago learned the absurdity of the lecture method of teaching, but the anatomist patiently keeps up this slow and stupid method of instruction. It is stupid because no anatomist would use this same method if he were to learn instead of to teach.

"We know very well that the burden of responsibility is removed, to a great extent, if the instructor goes over the whole subject carefully once a year. He then can tell his student to go to the dissecting room to see for himself.

If the student does not attend the lectures, the professor carries no responsibility, no matter how uninteresting or how uninstructive they may be. Yet the beauty of the courses of lectures is that the professor carries no responsibility if the student does not know his anatomy.

"I believe that there is but one way to learn any subject, and that is through study. The very name *student* tells what the person so named should be doing; and with a natural science, dealing with a most complex object, extending through the three dimensions of space, any other method besides studying the object itself is practically useless.

"Lectures with demonstrations are certainly valuable—more valuable than the lectures with text-books alone. Yet analyzing the object itself is infinitely more valuable than to watch the results exposed by another. Wrestling with the part which is being studied, handling it and viewing it from all sides, and tabulating and classifying the parts worked out, give us the greatest reward. All this may be accomplished by practical laboratory work. If we can make the student work thoughtfully and carefully a great result is achieved. It makes of him an artist, an actor, an expert, not a dilettant. He is upon the stage, not in the audience."

GENERAL.

THE degree of LL. D. has been conferred by Harvard University on Prof. Alexander Graham Bell, of Washington; on Prof. William R. Ware, of Columbia University, and on Prof. William G. Farlow, of Harvard University; by the University of Michigan on Prof. E. L. Mark, of Harvard University, and by Amherst College on Prof. C. H. Hitchcock, of Dartmouth College.

THE discovery of Rayleigh and Ramsay is being extended into unexpected fields of research. Wm. Schlœsing (fils) and Jules Richard have recently read before the French Academy a paper in regard to researches upon Argon in the gas within the swim-bladders of fishes.

THE national collection of plants placed many years ago by the Smithsonian Institution in the custody of the Department of Agriculture has been returned to the Institution by Secretary Morton, who is unwilling longer either to be responsible for work in botany, except as related directly to agriculture, or to keep so valuable a collection in a building which is not fire proof. It is now arranged in the east balcony of the National Museum building. The following members of the museum staff are assigned to the Department of Plants: Curator of Plants, (Honorary) Mr. F. V. Coville, Botanist of the Department of Agriculture. Assistant Curators, Dr. J. N. Rose, Mr. O. F. Cook, Mr. Charles Louis Pollard. Aid, Mrs. Carrie Harrison. Clerk, Miss Flora N. Vasey. Mounters, Mrs. Anna T. Moore, Miss Louise Zimmerman, Miss Frederica Wernheimer, Miss L. V. Schaeffer. Messenger, Felix Moore.

AN International Congress of Maritime Fisheries, Oyster culture and Marine Agriculture will be held September 3d to 7th at Sables d'Olonne, in Vendée, under the auspices of the Society *L'Enseignement Professionnel et Technique des Pêches Maritimes*. M. E. Perrier, of the Institute, professor in the Museum of Natural History in Paris, will preside.

Observations sur les prestidigitateurs by Joseph Jastrow, an article translated from SCIENCE, appears in the *Revue Scientifique* for June 20th.

PROF. S. P. LANGLEY sailed for Europe on July 8th, for a two months' stay.

DR. C. A. DOREMUS, of New York City, has been appointed, by the Secretary of State, delegate from the United States to the International Congress of Applied Chemistry in Paris.

Garden and Forest states that the old home of the naturlist Audubon, in Pennsylvania, is on the south bank of the little River Perkiomen, about three miles to the eastward of Phœnixville. The house, which is locally famous as the Mill Grove House, was built nearly a century and a-half ago, and stands on a knoll which affords a fine prospect. It is of stone, solid and substantial, thickly overgrown with ivy and shadowed by a number of tall pines, under the branches of which Audubon produced some of his best work. In spite of certain interior changes, the chimney-corner where his studying was done still remains as he knew it.

The New York *Evening Post* states that some changes in the competitive system of appointment as related to the scientific bureaus of the Department of Agriculture are now under consideration, and may be announced in a few days. The system of special examinations for scientific positions has not proved satisfactory. It is said that besides being troublesome and expensive these examinations put a premium upon the narrowly educated specialist and do not sufficiently recognize experience and intellectual breadth. The reforms proposed are a permanent list of eligibles, based on lines of broader scientific training and a longer period of apprenticeship for those who are taken into the scientific bureaus, so that the higher positions need never be filled directly from the special examination, but by promotion on basis of examination of tried assistants.

D. Van Nostrand & Co. announce for publication in August a work on *Röntgen Rays and Phenomena of the Anode and Cathode*, by Edward P. Thompson, assisted by Louis M. Pignolet, N. D. C. Hodges and Ludwig Gutmann, with a chapter on Generalizations, Arguments, Theories, Kindred Radiations and Phenomena, by Prof. Wm. A. Anthony.

The next meeting of the American Microscopical Society will be held at Pittsburg, Pa., August 18, 19, 20, 1896, under the presidency of Prof. A. Clifford Mercer, of Syracuse, N. Y. The meeting, which promises to be of special interest, will be held in the Carnegie Library Building. It is hoped that there will be a full attendance of members, as the question of having a permanent home in which the accumulated property of the Society is to be considered. Membership blanks and general information regarding the Society may be obtained from the Secretary, Prof. W. C. Krauss, 382 Virginia street, Buffalo, N. Y.

The United States Civil Service Commission will hold an examination in Washington and other cities where there are applicants, on July 30th, to fill a vacancy in the position of assistant in the division of chemistry, Department of Agriculture, at a salary of $1,200 per annum ; also an examination on August 13th and 14th to fill a vacancy in the position of botanical artist, Department of Agriculture, at a salary of $1,000 per annum.

Mr. Flinders Petrie has been appointed executor-in-chief of the Egypt Exploration Fund, and the work will doubtless be prosecuted with vigor under his administration.

William T. Brigham, of Honolulu, left for Washington June 26th, to visit the Smithsonian Institution. He is director of the Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History at Honolulu, left the latter place last Janurry, and has been making a tour around the world for the purpose of studying the chief ethnological exhibits in various countries. He has been especially interested in studying the marine zoological stations at Naples, Berlin, Amsterdam and Portsmouth, as he expects to organize a marine zoological station near Honolulu for the Hon. Charles R. Bishop, Vice-President of the Bank of California. The proposed new station, he says, will cost three-quarters of a million dollars.

We learn from the *Revista de la Instrución Pública Mexicana* that a law is being considered by the Mexican Chamber of Deputies making all the archæological monuments and remains in the country the property of the nation and forbidding their exploration, restoration and removal without express authorization of the executive. The archæological map of the republic is to be revised, the monuments are to be examined, and as much of the material as possible is to be preserved in the National Museum. It is to be a penal offence to injure the remains or to export them from the country without legal authorization.

Sir John Evans has presented to the London Geological Society an oil portrait of Huxley.

The steam yacht Ohio sailed for Norway on June 27th, with two hundred passengers, including a number of men of science, to observe the total eclipse of the sun at Bado.

In order to encourage kite-designing and kite-flying, the Boston Aëronautical Society offers for the best kites, cash prizes amounting to one hundred and fifty dollars. The competition is to take place between September 15 and October 15, 1896. Octave Chanute, Esq., offers, through this Society, a special prize of one hundred dollars for the best Monograph on the Kite, giving a full theory of its mechanics and stability, with quantitative computations appended. Further information may be obtained from the Secretary, Mr. A. A. Merrill, P. O. Box 1197, Boston, Mass.

MR. ROBERT M. PIRS, 320 E. 14th street, New York, will, beginning with July, edit and publish a quarterly journal entitled *Journal of Communication*, devoted to linguistic, metric and numeric progress.

THE *Atlantic Monthly* for July contains an interesting article by Mr. John Fiske, entitled 'The Century's Progress in Science.'

MAJOR J. W. POWELL will be engaged during the summer on a scientific expedition to the coast of Maine, for the purpose of studying the shell mounds.

WE learn from *Nature* that a preliminary meeting has been held in Liverpool for the purpose of taking steps for the establishment in that city of a Zoological Garden on a scientific basis, and on the model of that in Regent's Park, London. On the motion of Prof. Herdman, seconded by Dr. Forbes, the following resolution was unanimously adopted: "That in the opinion of this meeting it is desirable, in the interests of science and education in this city, to establish Zoological Gardens, containing a collection of living animals, and that those present form a committee, with power to add to their number, for the purpose of advancing this object." The question of a site was considered, and it appeared that there was just now a favorable opportunity of securing land in a central position very suitable for the purpose. It was resolved that the following gentlemen be asked to form a sub-committee to inquire fully into the matter and prepare a report: Prof. Herdman, Dr. Forbes, Messrs. A. L. Jones, A. A. Paton, A. S. Hannay, W. H. Picton, W. E. Willink, F. J. Leslie and F. Radcliffe.

THE Macmillan Co. will issue shortly an Elementary Solid Geometry by Prof. Henry D. Thompson, of Princeton University.

THE Council from the London Mathematical Society has awarded the De Morgan Medal to Mr. Samuel Roberts.

IN a paper presented before the London Physical Society on June 12th Prof. S. P. Thompson stated that he had been unable to obtain true reflection of the Röntgen rays, though most bodies, including air, gave diffuse reflection.

LORD KELVIN calls our attention to the fact that in a letter to the London *Times*, subsequent to the one quoted in our issue of May 22d, he added the sentences: "The weight of a cubic mètre of water is a French ton. The cubic decimètre of waters weighs a kilogramme, the cubic centimètre, a gramme." These sentences may be added at the middle of the second line at the top of the second column of page 166 of the last volume of this JOURNAL.

THE *International Medical Magazine* for June contains articles on X-ray photography in its application to medicine by Prof. Arthur W. Goodspeed, Prof. W. W. Keane and Dr. Thomas G. Morton. The articles are illustrated by ten full-page plates showing the details of the skeleton in health and disease with remarkable clearness. In the photographs of the trunk and pelvis taken by Prof. Goodspeed, the cervical vertebræ, the articulations of the shoulder joint, etc., are shown with as great clearness as the bones of the hand in the earlier experiments.

THE bill permitting the use of horseless carriages on highways in Great Britain has passed the House of Lords, but it is feared that the pressure of business before the House of Commons will prevent the bill from becoming a law before the vacation. In the meanwhile several companies have been incorporated for the manufacture of horseless carriages, one with a capital of $5,000,000.

UNIVERSITY AND EDUCATIONAL NEWS.

THE University of Vermont dedicated, on June 23d, two new buildings, Converse Hall, a dormitory presented to the University by John H. Converse at a cost of $125,000, and a science building presented by Dr. Edward H. Williams which, with its equipment, will cost about $200,000. The dormitory was formally presented to the University by Mr. Converse, and the science building, in the absence of Dr. Williams, by his son, Prof. Edward H. Williams, jr., of Lehigh University. The latter building, designed by Messrs. Wilson Brothers, of Philadelphia, has a front of 175 ft. and a depth of 53 ft., with a wing in the rear 51 × 49 ft., and is built of brick and terra cotta on a basement of granite. On the front are three medallions with the heads of Agassiz, Henry and Prof. Marsh. The building contains ample accommodations for the departments of physics, chemistry, biology, electrical engineering and metallurgy.

The Butterfield Museum of Dartmouth College has been completed, and the departments of geology, zoology and botany have been removed to the new building.

The New York University is about to erect a building to be used as a geological museum and library. It is to be one story in height, of rubble stone and brick, and is expected to cost about $50,000.

The Johns Hopkins University conferred this year the degree of Bachelor of Arts on 37 candidates and the degree of Doctor of Philosophy on 31 candidates. The following candidates presented theses in the sciences coming more especially within the scope of this Journal: A. D. Chambers, An Investigation of the Composition of Certain Oxides of Maganese; F. S. Hollis, On the two Clorides of Nitro-orthosulphobenzoic acid; E. Mackay, A Contribution to the Study of Double Salts in Water Solution; R. M. McKenzie, Some Double Clorides of Ferric and of Ferris Iron with some Aromatic Bases; M. D. Sohon, An Investigation of Some Derivatives of Orthosulphobenzoic Acid; E. F. Gallaudet, Relations between Length, Elasticity and Magnetization of Iron and Nickel Wires; B. M. Roszel, The Action of the Asteroids on Mars; H. A. Sayre, On the Generation of Surfaces by the Motion of Plane Curves; T. H. Taliaferro, The Congruensis formed by the Tangents to the Lines of Curvature of a Given Surface; G. O. Smith, The Geology of the Fox Islands, Me., A. C. Spencer, The Geology of Massanutten Mountain, Va.; H. M. Nower, The Embryology of the Termite; G. Lefevre, Budding in Perophora.

Of the twenty-one fellowships this year awarded at the Johns Hopkins University, we note the following: *Physics*, N. E. Dorsey, W. T. Mather, J. F. Mohler; *Chemistry*, W. E. Henderson, C. D. Ragland; *Biology*, H. L. Clark, D. S. Johnson; *Mathematics*, A. Pell; *Pathology*, E. P. Carter; *Geology*, G. B. Shattuch.

Prof. C. D. Woods has been elected Director of the Maine State College, at Orono, in the place of Prof. W. H. Jordan, who has been elected Director of the New York Experiment Station, at Geneva.

The following public lectures will be given in connection with the Harvard University summer school from July 3d to August 14th:

July 7, 'University Study of Education and Teaching,' Prof. Paul H. Hanus. July 9, 'The Fine Arts in Elementary Education,' Prof. C. E. Norton. July 14, 'The Teaching of the Modern Languages: Aims, Means and Methods,' Prof. Hugo K. Schilling. July 16, 'Rational vs. Empirical Geography,' Prof. Wm. M. Davis. July 21, 'Certain Peculiarities of Australasian Vegetation; Illustrated by Stereoptican Views,' Prof. Geo. L. Goodale. July 23, 'The Teaching of Physical Science: Aims, Means and Methods,' Mr. Joseph Y. Bergen. July 28, 'Military Drill in the Public Schools,' Dr. D. A. Sargent. July 31, 'Psychology and Relaxation,' Prof. Wm. James. August 4, 'The Teaching of English: Aims, Means and Methods,' Mr. Byron S. Hurlbut.

DISCUSSION AND CORRESPONDENCE.

THE FORM OF THE HEAD AS INFLUENCED BY GROWTH.

To the Editor of Science: I was much interested in Dr. W. Z. Ripley's contribution on the question of the growth of the head which appeared in the issue of June 19th, of Science. The author's observation that the cephalic index of Americans decreases with increasing age is certainly correct, but I think the contrary observations of European investigators admit of an interpretation different from the one given by Dr. Ripley, who is inclined to believe that in long-headed races the index decreases with increasing age, while in short-headed races it increases with increasing age. The European material seems to me hardly adequate to form a far-reaching conclusion of this kind.

Zuckerkandl based his conclusions that children have more elongated heads than adults on measurements of 156 children and 197 adults from the interior parts of Austria. But in selecting these individuals he excluded what he calls the Slavic type, including only the elongated heads which he ascribes to the Teutonic type. This arbitrary selection makes the results of his comparison of doubtful value for a treatment of the question of growth; Zuckerkandl discusses this point at length and points out that his statistics must not be considered final. (*Mitt. der Anthrop. Ges. in Wien* XIV. 1884, p. 127.)

Holl has based his statement on the measurement of only 16 skulls of children, and consequently no weight can be attached to it.

Mies to whom Dr. Ripley refers does not make—so far as I can make out—any statement in regard to the question at issue in the passage quoted (ibid. XX. 1890, p. 39 ff.).

The statistics of Dr. Livi which were published in the *Archivio per l'antropologia e la etnologia*, 1886, p. 235, are based on observations by Calori, Brennsohn, Waldhauer, Wæber and Broca; but they are classified in two groups: of more and of less than 33 years of age, and can therefore not be utilized for treating the question of the influence of growth upon the form of the head, as they are rather directed to detecting retrogressive changes which begin after the 35th year of life.

While these European data are open to serious objections, we find in America that with few exceptions long-headed tribes as well as short-headed ones, show a decrease in the value of the cephalic index with increasing age. I have compiled the following table in order to make this point clear:

CEPHALIC INDEX OF

Tribe.	Adults.	Children.	Difference.
Micmac.....	79.0 (136)	80.9 (84)	+ 1.9
Eastern Ojibwa...	81.8 (396)	81.6 (309)	— 0.2
Cherokee...	82.0 (140)	81.0 (75)	— 1.0
British Columbia...	83.6 (284)	85.3 (138)	+ 1.7
Moqui	84.0 (116)	86.4 (77)	+ 2.4
Navajo......	84.2 (77)	86.8 (76)	+ 2.6

The cause for this decrease is not far to seek. With maturity the frontal sinuses and the occipital protuberance begin to grow, particularly in males, while there is no corresponding local growth on the parietal or temporal bones. This has the effect that the length grows more rapidly than the breadth and that the index begins to decrease. The lesser development of the frontal sinuses and of the occipital protuberance in women is also a sufficient explanation for their greater brachycephalism.

Nevertheless, I believe that the breadth of the head increases as long as the length, although at a slower rate, and that Dr. Ripley would have obtained this result if his series had been more extensive. I cannot find that Schaaffhausen, who held this opinion, has substantiated it by any extensive series of observations. The best series that is available is that of Dr. Venn (*Jour. Anthrop. Institute.* XVIII., p. 152, ff.) which when arranged from this point of view gives the following results:

Year.	Length of Head. Inches.	Breadth of Head. Inches.	Index.	Individuals.
19	7.54	5.87	77.9	139
20	7.57	5.93	78.3	305
21	7.58	5.93	78.2	248
22	7.63	5.98	78.4	189
23	7.54	5.97	79.2	83
24	7.71	6.03	78.2	52
+25	7.62	6.00	78.7	79

But the growth of the head does not close with the twenty-fifth year. The following table shows that among the Indians it continues to grow until near the thirtieth year, and the period will certainly not be found shorter among people of European descent, while it may be shorter among the negroes:

Years.	Length of Head.
20–21	193.0 mm.
22–23	193.7 "
24–25	193.8 "
26–27	194.3 "
28–29	194.8 "
30 and more	194.8 "

FRANZ BOAS.

NEW YORK.

BIOLOGY, ZOOLOGY AND BOTANY.

TO THE EDITOR OF SCIENCE: Prof. Conway MacMillan, who claims (SCIENCE, III., p. 634) to have single-handed banished a 'sham biology' from two of our leading universities, still has work to do. As Prof. Brooks tells us (SCIENCE III., p. 708), the Johns Hopkins University had not in the twenty years of its history examined a candidate for the doctorate in 'biology.' Yet this year, perhaps as a declaration of independence from the influence of Prof. MacMillan, it has conferred the degree of Doctor of Philosophy on a candidate who chose 'biology' as one of his subjects.

Questions of nomenclature seem to be more interesting to the botanist than to the zoologist, and it is not the present writer's intention to discuss this one. But the occasion seems favorable for asking Prof. MacMillan why it is that zoology has become to such a large extent synonymous with biology. Is it not, perhaps, because the zoologist is usually a biologist, whereas the botanist is usually only a botanist? The great advances which, during the past forty years, have transformed biology, have come almost exclusively from the side of the zoological sciences. Zoologists have not hesitated to use botany when they could, but in the advancement of biology, botany, even as a silent partner, does not seem to have contributed its share of capital.

Y.

AN UNCOMMON AFTER-IMAGE.

SOME days since, while traveling by boat, I awoke in the early morning, and, thrusting my head out of the window, was almost overpowered by the yellow glare. I then raised the blind with its yellow horizontal slats, and for a moment noticed the glare pouring through them. Then, shutting my eyes, I had for a few seconds an after-image of some half-dozen *vertical* green lines gradually fading away into *vertical* violet lines.

HIRAM M. STANLEY.

MACKINAC ISLAND, June 20.

THE NINE-BANDED ARMADILLO.

TO THE EDITOR OF SCIENCE: In his recent paper, in the *Bulletin of the American Museum of Natural History*, on mammals collected in Bexar County and vicinity, Texas, Prof. Allen refers to the capture of specimens of the nine-banded armadillo at several places north and west of Bexar County, but mentions none from that county. It may be of interest, therefore, to note that five specimens were taken in the county in May, 1895, about four miles from San Antonio. There were two adults and three young, all captured immediately after a heavy rain which had driven them from their burrow. This family of armadillos was presented by Mr. F. Hardman, of San Antonio, to the National Zoological Park in this city, where two of its members may still be seen, apparently in excellent health.

A. B. BAKER.

WASHINGTON, D. C., June 22, 1896.

ROCHEFORT ON THE CARIBBEANS.

TO THE EDITOR OF SCIENCE: Appropos of the wonderful explorations of Mr. Frank Hamilton Cushing and his party in San Marco, Florida, last winter, under the auspices of the University of Pennsylvania, I would call attention to the following sentence in Rochefort (Caribby Islands, London, 1666, p. 291). Speaking of the Caribbeans he says: "Their Habitations are somewhat near one to another, and disposed at certain distances after the manner of a Village; and for the most part they plant themselves upon some little ascent, that so they may have better air and secure themselves against those pestilent flies which we have elsewhere called *Mosquitos* and *Maringoins*, which are extreamly troublesome, and whereof the stinging is dangerous in those parts where there is but little wind stirring. The same reason it is that obliges the *Floridians*, beyond the bay of *Carlos* and *Tortugues*, to lodge themselves for the most part at the entrance of the Sea in Huts built on Piles or Pillars."

O. T. MASON.

U. S. NATIONAL MUSEUM, July 2, 1896.

SCIENTIFIC LITERATURE.

Handbuch der paläarktischen Gross-Schmetterlinge für Forscher und Sammler. Zweite gänzlich umgearbeitete und durch Studien zur Descendenztheorie erweitete Auflage, etc. VON DR. MAX STANDFUSS, mit 8 lithographischen Tafeln und 8 Textfiguren. Jena, Gustav Fischer, 1896. 8°. Pp. 392.

This is much more than an ordinary handbook for the lepidopterist, since it comprises a great deal of new matter relative to the hybridization and seasonal dimorphism of Lepidoptera, the result of some twenty-five years of work. It is therefore a most important contribution to biology, and is another in the series of notable works called out by the epoch-making essays of Weismann contained in his 'Studies in the Theory of Descent,' published over fifteen years ago, when the author was an orthodox Lamarckian.

The practical topics discussed relate to the mode of collecting, the breeding of larvæ, including pairing of the sexes of the same and of different species. This portion is succeeded by lengthy accounts of certain special cases of hybridization and of hybrids between different European species of Saturnia, with details regarding the biological, anatomical and physiological peculiarities of the hybrids, including a very neat and obviously correct phylogeny of the genus as concerns the European species. This part is followed by generalities on hybridization and hybrids, and on pairing both in confinement and in nature.

The egg-state, larva and pupa, their care, artificial hibernation, diseases, etc., are fully treated from the point of view of one who has reared thousands of specimens in the most successful, careful and scientific manner.

Next to the subject of hybridization that of seasonal dimorphism as discussed by Standfuss is of special value, since he brings forward many new facts. It is treated under the following heads: Albinism, melanism, change of color, exchange of colors, local races, local forms, local varieties, seasonal dimorphism, based on experiments on butterflies (species of Papilio, Rhodocera, Vanessa, Argynnis, and on a moth, *Dasychira abietis*.

The paper succeeding, devoted to thoughts relative to the question of species-formation, contains the author's general views, and the book ends with the directions for collecting the imagines.

It would have been better, we think, if Dr. Standfuss had divided the work into two parts, separating the practical directions from the scientific part, but the result will be that the amateur and collector will be perhaps, in some cases at least, insensibly led to become a scientific observer, and thus great good will result in placing the study of insects on a higher plane.

The results of the experiments in keeping the pupa of *Papilio Machaon* at a temperature of 98–99° F. produced not only changes in markings and hue, but also in form, such as the lengthening of the 'tail,' while the specimens were lighter in color, some bearing a perfect resemblance to those that fly in August, near Antioch and Jerusalem. On the other hand, the pupa subjected to cold gave out butterflies which resembled the Swiss and German forms emerging from hybernated chrysalids. The experiments were numerous and confirm the earlier results obtained by Weismann, W. H. Edwards, Merrifield and others.

Dr. Standfuss is a neo-Lamarckian, believing that, as the result of his experiments, seasonal and local varieties or species are the result of direct changes in the environment—a logical conclusion from the facts. And if this is the case in the laboratory it logically follows that it must be so in nature, especially where isolation occurs. His observations afford him proof of the inheritance of acquired characters. He states that the results of his experiments on the effects of change of temperature render it impossible to bring them into harmony with the views of Weismann, and he is in accord with the conclusions of Eimer as to the direct influence of the environment and of the inheritance of acquired characters in species-building. He thinks that natural selection is limited in its operation, many species having originated and become established without its aid. Finally, he gives us the following definition of the idea of a species: "Species are groups of individuals which, through the direct influence of certain factors of the external world, have diverged so far from the nearest allied types that they can no more cross with these in their sexually developed forms; that the completely developed offspring resulting from this crossing, should it occur, are absolutely incapable of breeding with one another."

It is to be hoped that an English translation of this important work may be published, so as to infuse a more scientific spirit into the minds of the many who are interested in the collection and rearing of Lepidoptera. The plates are most excellent and add greatly to the interest and value of the book.

A. S. Packard.

A Compendium of General Botany. By Max Westermaier. Translated from the German, by Albert Schneider. New York, John Wiley & Sons.

In the preparation of the English edition of this book the translator has endeavored, as stated in his preface, to 'adhere as closely as possible to the author's form, style and concept of the science of botany,' and 'to make it a translation in the true sense of the word.' The title of the German edition, 'Kompendium der allgemeinen Botanik für Hochschulen,' indicates that the work was intended for the higher grade of institutions in Germany, *i. e.*, for the universities; and so, in the translation of the author's preface, the literal rendering of the word 'Hochschulen' as 'high school' in this country is misleading as to the place which the book was intended to occupy. That the book was not intended for the high school, as that term is used in this country, can be seen from even a hasty examination of the text, and the preface states that "it is assumed that the pupil has a general knowledge of chemistry, of physics, of the proper use of scientific terminology, and has the ability to estimate the value of hypotheses and undecided problems."

A similar notion of the *Hochschule* caused adverse criticism to be made of the German edition, as being too technical and advanced for the 'high school.'

The work is divided into five parts which treat of the following topics: The cell, tissues and simple organs, organs and systems of organs, reproduction, the general chemistry and physics of plant life, classification of plants, taxonomy.

In Part I., the cell, the author treats of the primordial utricle and cell wall in their mutual relationship, turgor, plasmolysis, both the living and dead inclusions of the cytoplasm, as well as the cell sap, etc., the internal structure and method of growth of the cell wall, its chemical composition, subsequent changes, and the products of growth in thickness and surface of the cell walls. The chemical and physical aspects of the cell and its contents are treated more fully than the phenomena of the active cell, indirect division of the nucleus being passed by with a few illustrations and very brief descriptions of the stages represented.

Part II., tissues and simple organs, has received greater consideration than any other part of the subject, 107 pages being covered in the discussion, which with the 37 pages devoted to the Cell make 144, or more than one-half of the entire work. This part is divided into eleven chapters as follows: 1st, the function of formative tissues (meristum and cambium); 2d, structure and function of the epidermal tissue system; 3d, function of mechanical tissues; 4th, the function of the conducting system; 5th, protection of the meristematic areas of the plant body; 6th, food substances derived from the atmosphere; 7th, the function of aeration; 8th, the function of roots; 9th, the appropriation of assimilated food substances; 10th, the storing and function of reserve material; 11th, secretion.

Under the function of the conducting system a full discussion is given of the various cell forms of the system, the stem structure of mosses, vascular cryptogams, monocotyledons, dicotyledons and gymnosperms, the structure of roots, and the special physiology of the movements of food substances and water in plants.

Part III., organs and systems of organs, treats of the morphological and physiological relations of organs, their principal forms and modifications, metamorphosis, correlation, phyllotaxy, and the various kinds of inflorescence.

Part IV., reproduction, receives very brief mention, being merely an outline, with illustrations, of the development and reproduction of representative plants in the larger groups, the morphology and physiology of the seed and fruit of phanerogams, the general physiology of reproduction, pollination, hybridization, heredity, special creation and the 'so-called theory of natural descent.'

Part V., the general chemistry and physics of plant life, includes chemical physiology, the physiology of growth, the relation of light, gravity and other factors to plant life, and the physiology of plant movements.

It will be observed that the book differs greatly from most books on general botany in the great emphasis laid on the chemistry, physics and physiology of plants, less stress being put on the morphology and development. This is in accordance with what we should judge to be the taste of the author, who was long a pupil of Schwendener. In the general treatment of the subject-matter the author makes frequent use of and reference to the works of Naegeli, Sachs, Pfeffer, de Bary, Frank, Goebel and Warming, but more especially to those of Schwendener, Haberlandt and others of Schwendener's pupils. For this reason the book will be a welcome addition as a condensed reference book of the work of these investigators.

The author is a fervent disciple of the idealistic school of special creation, and accepts only those processes to be governed by natural law which have been revealed by scientific investigation as facts. Relationship and relative position of groups of plants is, in the mind of the author, only "a process of thought which the comparative study of the plant series creates in our minds; that such a series is genetic is an unverified postulate of the dogmatic teaching of descent, which allows fantasy to supplant that which empirical investigations leave unanswered." Hypnotized by the fathomless depth of life, he accepts the miraculous creation, under the influence of which the mind is closed to the philosophical consideration of fundamental relationships and modes of progress as suggested by phylogenetic evolution, and it does not appear to be realized that God working through natural law, and by processes of evolution through time, has developed the universe in accordance with the same plan which is wonderfully shown in the ontogeny of the present. Geo. F. Atkinson.

SCIENTIFIC JOURNALS.

AMERICAN JOURNAL OF SCIENCE.

The July number opens with an article by Carl Barus, describing the lecture-room experiment with carbon dioxide, showing the passage of the liquid through the critical temperature. Suggestions are given in regard to the arrangement of the tube with respect to the sunlight used for illumination and the projecting lens, in order to give the best results. The experiments performed by the author seem to prove that there is no "real continuity between CO_2 gas and CO_2 liquid at the critical temperature. There is continuity between the liquid and *a gas which preserves the same molecule*, the same molecular structure as the liquid from which it issues. Doubtless at still higher temperature the gas with the liquid molecule will break up into the true gas with the gaseous molecule."

H. H. Clayton discusses in detail the question of a seven-day weather period. The investigation, the results of which are here detailed, was carried on under the auspices of the Elizabeth Thompson fund, and is a continuation of an earlier work by the same author, published in the *Journal* for March, 1894. In all, twenty-one stations were selected for the discussion; three in the Arctic regions, four in the United States, five in Europe, two in Asia, two in Oceanica near the Equator, three in middle South America, one in Mauritius, and one in Australia. The results of the investigation show that in general there are two maxima and two minima frequencies during the seven days, and at some stations there appear to be three. Charts are introduced showing the progression of these periods around the world. The author regards this department of investigation as a promising and important one in connection with weather forecasting, since "it is possible to say that in all parts of the world barometric minima will be from 10 to 20 per cent. more frequent on certain days than on certain other days, provided the interval taken is sufficiently long. It is also possible to say that certain days will average colder than other days."

S. L. Penfield describes a sulpharsenite of silver, Ag_9AsS_6 or $9Ag_2S, As_2S_3$, analogous to polybasite Ag_9SbS_6, to which the name pearceite is given. He calls attention to the fact that arsenical varieties of the species polybasite have long been recognized, but regards it as advisable that they should be grouped together as an independent species, in accordance with the general method of distinguishing between the antimonial and arsenical members of this series of minerals. The pearceite here described was from a mine at Marysville, Montana, which has not only yielded material admitting of excellent analyses, conforming to the theoretical composition, but also beautiful crystals. These crystals are shown to belong to the monoclinic system, with an angle of inclination differing but little from 90°, and a rhombohedral symmetry in the distribution of the faces. In connection with this investigation the crystalline form of polybasite was also studied, particularly on specimens from Colorado; and it is shown that they also are monoclinic with the same habit as that which characterizes the pearceite. An interesting summary of a number of metallic species among the sulphides, which have a prismatic angle of nearly 60°, is given.

James L. Greenleaf describes in considerable detail the hydrology of the Mississippi. The special points considered are the volume, flow, the annual rainfall and its distribution, and the relation of flow or run-off to the rainfall, as depending upon the special conditions present in a particular case. The discussion is based upon a report by the writer upon certain water powers prepared for the tenth census. The data there given have been amplified to cover the flood and low water as well as the average discharge of the Mississippi and its tributaries, and have been brought up to date by a study of the subsequent gaugings conducted by the corps of engineers. A series of diagrams present the data graphically and give basis for further discussion. The first gives the average discharge for the different tributaries with their branch areas. Another diagram shows the average flow and rainfall, and still another connects the high average and low discharge and rainfall for the upper and lower Mississippi and for the principal branches.

C. R. Eastman describes the relations of certain body plates of the Dinichthyids. The subject of Tertiary floras of the Yellowstone National Park is enlarged upon by F. H. Knowlton. His paper belongs with that on *The Age of the Igneous Rocks of the Yellowstone* by Arnold Hague, published in the June number. The region is shown to be remarkably rich in species, and three distinct flora are distinguished. The first is referred to the Fort Union or Lower Eocene; a second is regarded as Miocene, but older than the auriferous gravels, and the third is regarded as Upper Miocene. The entire flora embraces 147 forms, distributed among 33 natural orders. The remarkable contrast between the richness and variety of the vegetation at that time with the comparative paucity at present, and the bearings of this upon the change in climate, are brought out. The whole subject will be developed in detail in a monograph to be published under the auspices of the United States Geological Survey. O. C. Marsh describes a remarkable specimen of a Belodont reptile found in the red sandstone of the New Haven region. His paper is accompanied by a plate showing the portion of the back of the reptile which is preserved. A. E. Verrill gives an article on a new cephalopod of the genus *Opisthoteuthis*, illustrated by a number of figures. Remarks are added on the general subject of molluscan morphology. The subject of separation or isolation in its bearings on geology and zoography is discussed by A. E. Ortmann. He finds in it an explanation of the distribution of animals as well as of the origin of species. T. L. Walker gives observations on percussion figures in mica, and shows that, contrary to what has been hitherto held, the angles between the lines developed are not 60°, but vary somewhat widely from this. I. K. Phelps describes an iodometric method for the determination of carbon dioxide.

PSYCHE, JULY.

R. A. Cooley describes and figures on a plate a new structural character in insects, consisting of a 'spiny area,' a small patch of short sharp spines on the under side of the fore wing near the base posteriorly, related to a corresponding patch on the thorax, at the point which the spines touch when the wings are in repose. He has demonstrated its presence in nearly five hundred moths, all of which fold their wings over the abdomen, and also in some insects of other orders. W. S. Blatchley continues his notes on the winter Coleoptera (sixty species) of Vigo Co., Ind., and A. P. Morse his notes the Tryxalinæ of New England, the new genus Clinocephalus being considered. Brief notes on butterflies are given by Miss Soule and Messrs. Folsom and Symthe.

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CONTENTS:

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

A CENTRAL WISCONSIN BASELEVEL.

The crystalline rocks of central Wisconsin north of the Potsdam sandstone, in the district including Grand Rapids, Stevens Point, Mosinee, Wausau, Marshfield, Merrill, and other towns, are of a very complex character.* In the southern part of the district is found a large area of the typical rocks of the Archean. North of this is an area composed of sedimentary and igneous rocks belonging to the Huronian. The igneous rocks have the greatest variety, including plutonic and volcanic varieties, as well as basic, acid, and intermediate facies. The whole region is one of intense folding and metamorphism. The schistosity of the rocks is at most places nearly vertical, and the beds of quartzite on Big Rib and Mosinee hills are on end.

Notwithstanding the complicated folding and great variety of rocks, resulting in different resisting powers, there is in this district as nearly perfect a baseleveled plain as it has been my good fortune to see. One of the most convenient localities in which to see this plain is near Mosinee. Following the wagon road which is east of the Wisconsin river a short distance south, so as to get above the valley of the Wiscon sin, an almost perfect plain is seen to the northwest, west, south and east, large areas of which are but little dissected by any of

*See Geology of Wisconsin, Vol. IV., pp. 623–714; also Pl. I., Geol. Atlas of Wis.

the tributary streams of the Wisconsin. South and west of Mosinee the streams wander about in an area which is largely swamp, and as yet has not been fully divided between them. This swampy plain is crossed between Knowlton and Centralia by the Wisconsin Valley Division of the St. Paul Railroad. This baseleveled plain is easily recognized because over it is spread only the very thin mantle of drift of one of the earlier glacial epochs, the ice of the later Wisconsin epoch not having reached it.*

From the plain south of Mosinee the eye sweeps to the north over the Wausau area, where the plain is much dissected by the Wisconsin and a number of its larger tributary streams, on the west side the Little Eau Pleine, the Big Eau Pleine, and the Big Rib rivers, and on the east side the Eau Claire river. Rising from this lowland, about 1,850 feet above sea level, is Big Rib Hill, one of the highest points in the State of Wisconsin. As determined by aneroid measurements by E. R. Buckley and Samuel Weidman, the summit is about 450 feet above the ancient baseleveled plain. Another hill, some 12 or 15 miles to the west, of unknown character, rises to a lesser elevation above the plain. The exceedingly resistant character of the Big Rib Hill quartzite sufficiently explains the existence of this monadnock.

From the top of Big Rib Hill itself, about 5 miles southwest of Wausau, the immediately surrounding country is seen to be dissected by the large tributary rivers of the Wisconsin already referred to. However, to the northward, 12 or 15 miles away, is again seen the horizontal line marking the extension of the baseleveled plain in that direction, and to the southward at an almost equal distance may be seen the almost perfect plain already described which extends southward from Mosinee.

Along the Wisconsin river from Wausau to Mosinee, and adjacent to the larger tributary streams, is seen a beautiful system of terraces. The higher glacial flood plain of the Wisconsin and its tributaries is here very extensive. Descending a steep embankment 20 or 25 feet high, one reaches a lower terrace, which has very considerable width in proportion to the size of the streams, both in the case of the Wisconsin and in the tributary streams. The present channels and flood plains of the rivers are cut in this intermediate terrace. The subordinate streams are but a few feet below its surface, and as the material is soft sand and gravel they have taken different courses at different times. One may see old channels of these subordinate streams so recently abandoned, that as yet, no forests have sprung up. Older channels have forest growths in different stages of development. On account of not having any topographic map of the area and lack of time, no attempt was made to work out in detail the drainage history of the district.

South of Stevens Point and Grand Rapids is the plain of Potsdam sandstone which extends to the Baraboo bluffs, upon the south, and west to the Mississippi river. This is part of the driftless area of Wisconsin. At numerous points in its eastern part may be seen various sandstone buttes with flat tops. It has often occurred to me that these all rise to approximately the same elevation, and at various times I have suggested to my students that their tops probably represent an ancient baseleveled plain. While not demonstrated by a comparison of levels, I have little doubt that the tops of the Potsdam buttes are a continuation of the plain in the crystalline area to the north. The advanced stage of denudation of the Potsdam is due to its softness. Above the

*The Driftless Area of the Upper Mississippi Valley, by T. C. Chamberlin and R. D. Salisbury. Sixth Ann. Rept. U. S. Geol. Surv., 1885, Pl. XXVII.

Potsdam, as a consequence of differential erosion, rise the ranges of the Baraboo bluffs, which also are probably monadnocks reaching a considerable height above the baseleveled plain of central Wisconsin. As to the extent of territory over which this central Wisconsin plain may be traced, I can say nothing, but I anticipate that the area will be found to be large.

While accurate measurements were not made, the plain in the crystalline rocks apparently has a southern slope. From numerous aneroid measurements from the railroad, near Wausau, by Messrs. Buckley and Weidman, the dissected plateau both east and west of the Wisconsin River rises at many places to a uniform elevation of about 1,400 feet. At the Wausau bridge the river is about 1,180 feet above the level of the sea. In order to reach the baseleveled plain, one must therefore climb to a height of about 320 feet above the river. At Mosinee the river is about 1,100 feet above the level of the sea, and here the plain is estimated to be 200 feet above the river level. This gives a southern slope to this plain between Wausau and Mosinee, a distance north and south of about 12 miles, amounting to at least 100 feet.

On the geological map of Wisconsin* it will be seen that the Paleozoic formations about the pre-Cambrian core of central Wisconsin constitute a very gently southward plunging anticline. How far erosion had gone toward a baselevel in the crystalline area before Cambrian time is undetermined, but the uniform fashion in which the streams cut the Potsdam and strike the crystallines at about the same level for considerable distances away from the main Archean area indicates that if not baseleveled at the time of the Cambrian transgression, the area approached a peneplain.

As to the age of the central Wisconsin baseleveling no more than conjectures can at present be given. One naturally connects it with the Cretaceous transgression, which extended very far over the Upper Mississippi valley, and perhaps over all of it.

* L. c., Pl. I.

As to the agent or agents which accomplished the baseleveling, no evidence was obtained, but because calculations show that running water is far more potent as a denuding agent than the ocean, I incline to the belief that the major part of the work was done by rivers, although it is possible that as a result of the transgression of the ocean some of the final work may have been that of marine denudation.

Observations upon which the above article is based were made by me while on a trip with some of the advanced students of the University of Wisconsin, the primary purpose of the trip being to study the crystalline formations of central Wisconsin. It is hoped at a future time to take accurate measurements of the heights of the river terraces and of the baselevel at various points, in order to give a more exact account of them.

C. R. VAN HISE.

DECIMAL NUMERATION IN THE UNITED STATES.

MR. HERBERT SPENCER'S arguments against the adoption of the metric system, republished in the June number of *Appleton's Popular Science Monthly*, are chiefly based upon the idea that the division of measures into tenths is so inconvenient that men 'under the pressure of business needs' tend to abandon the decimal system in favor of the duodecimal. Whatever may be the case in England, it is evident that in the United States the tendency is quite the opposite, and that we are gradually bringing the divisions of our weights and measures into accord with our notation. This evolution is not being accomplished by 'Bureaucratic Coercion,' but by the free action of natural forces, the beneficient results of which process we have learned from Mr. Spencer to expect with such confidence.

We may first note the prevailing tendency in the division of units of length. In land surveying, where a change of the mode of measurement causes more inconvenience than elsewhere, the advantages of the decimal division are so strongly felt that hundreds of feet and tenths of a mile and a foot are being used to a considerable extent instead of rods and inches. This is true, I think, to a greater degree in the West than in the East. Even in common speech it is more usual to estimate a distance as, say, sixty feet or two hundred feet, than in yards or rods. The division of the foot into tenths has come into use in spite of the inconvenience of a unit so nearly like the inch, yet so difficult to reduce to it. The subdivision of the inch into twelfths originally in vogue is almost unused, while tenths of an inch are superseding not only the line, but also the fractions, of quarter, eighth and sixteenth. Fine measurements are more often expressed in hundredths of an inch, and even where the old terms are used in speech they are often written .50 or .125. This change has been made not by scientists, but by machinists and practical men, who have most occasion to use such measurements.

In weights the same evolution toward the decimal system is noticeable. The ton of 2000 pounds, because it is capable of decimal division, has almost entirely driven out the ton of 2240 pounds. A Western man does not know of the existence of the 'long ton' except from his arithmetic. The bushel has become in common practice a unit of weight and, being a useless incumbrance, is being displaced by the hundred weight. Measurements of grain and vegetables are taken in pounds and hundreds of pounds, and then, if necessary, reduced to bushels.

Units of volume apparently have not been subjected to decimal division, but it is more customary to speak of ten, one hundred or five hundred quarts or gallons than it is to use other multiples, and receptacles are made to correspond with this custom. In the measurement of area the same is true. Our city streets, blocks and lots are measured in multiples of ten more often than of any other number.

In the measurement of time, where the laws, not of Nature, but of the Chaldeans, have prevented the use of decimal division, the existing duodecimal division is almost ignored. The division of the hour into halves, quarters and thirds, which appears to Mr. Spencer such a great advantage, is entirely disregarded by railroad men and o a large extent by everybody. 'Ten thirty' and 'nine forty-five' are rapidly superseding the expressions 'half past ten' and 'a quarter before ten.' We even write 5:25 and 9:41.5 as though it were in decimal notation. As for the third of an hour I never heard of its use either in speech or practice. Days are coming to be used in multiples of ten both in business and in ordinary life. We go for a ten-days' trip or give our notes for one hundred days instead of using weeks or months.

In arithmetical operations decimals are being used more and more in the place of vulgar fractions. This is a commercial age and country, and 'the business man' thinks in per cents. He says his health is fifty per cent. better than the day before and he discounts the newspaper twenty-five per cent. Notwithstanding the statement of Sir Frederick Bramwell that the decimal system is absolutely incompatible with mental arithmetic, the ordinary man persists in using it, and if vulgar fractions are given him to add or subtract he will change them over to decimals before performing the operation and the result back again rather than use them. In some of our best schools children are taught the use of decimals before common fractions, as they are virtually familiar with decimals when they have learned their notation, and the transition to fractions of other denominations than ten is more easy than the reverse. In common life we are discarding vulgar fractions, except the simplest, and using decimals.

The increasing use of multiples of ten in place of the dozen and gross is another indication of the same disposition to gravitate toward a decimal system. Vegetables are now often sold in bunches of tens and fives, and many small articles of dry goods are put up in the same way. As this makes the pricing of the articles so much simpler it seems likely to prevail.

Judging from present progress in the United States, 'the pressure of business' and the necessity of simplification is forcing the American people to a decimal division of weights and measures. People *will* use tenths in practice whether the government favors it or not. The only question is whether the units will be those of all the world except England or a separate system. If the metric system is not adopted it will not be long before we shall be using mostly tenths and hundreds of pounds, feet and inches. While this would be better than the present chaos, it would not be so good as the metric system in which all the units are in simple relations to one another.

As for the objections raised against the metric system on the ground of inconvenience, we know by experience with our decimal coinage how groundless they are. The most ignorant among us have no practical difficulty with those divisions which appear so unnatural to the English. Mr. Spencer objects to the metric system on the ground that ten is not divisible by three, and thinks the present customs preferable on account of 'the widow's thirds and in Parliamentary Acts the two-thirds majority.' The illustrations are unhappily chosen; since the English pound is no better divisible by three into shillings than the American dollar into cents, and it is hard to see how the adoption of a duodecimal system would insure the division into thirds of a Parliament consisting of a varying number of men. The question is often asked what is a shopkeeper to do when a customer wants a third of a kilogram. If such a case should occur the shopkeeper need only pile 2's and 1's of each denomination on his scalepan until the weight was reached within the limits of delicacy of his scales. But what is he to do if asked for the third of a pound? If calculation in our present system is as easy as claimed, he would instantly perceive that he could get the weight by laying on the scalepan five ounces, five drams, nine and eleven ninety-sixths grains. This also is a 'makeshift third.'

The objection is also urged that the metric system would not be in accordance with our division of time. But since the natural units of time, the day, the month and the year are incommensurable no system of numeration can agree with them. As it is, our notation and our measures of weight, length, area, volume and time have no relation to each other. With the adoption of the metric system our notation and all our measures except time will agree. The value of the Centigrade thermometer need not be discussed, since it is not a part of the metric system, and the adoption of that system does not carry with it the Centigrade thermometer. As there is no relation between the boiling and freezing points of water at an arbitrary atmospheric pressure and any system of weights and measures, the Fahrenheit scale is just as well suited to the metric system as any other. It should be noticed, however, that in both scales the fractions of a degree are reported in tenths, not in halves quarters and thirds. A thermometer scale might be devised, based on absolute zero, which would be really decimal, have no minus readings and be in accordance with the metric system.

It is unfortunate, theoretically, at least, that the meter is not exactly a ten-millionth of the earth's quadrant. But the question with us in America is, shall we adopt as a unit the platinum-iridium bar in Paris, accurate copies of which are in all the national archives and the length of which is known in terms of the wave-length of light, or shall we continue to use as our unit a broken brass rod riveted in the middle which differs from everything else in creation.

Compound numbers, which to the French are known in ancient history, are to us a daily nuisance. They take up a good third of our arithmetics, by far the hardest third at that, and require about a year of a child's school life to learn even passably. If the 'English accountant' can add guineas, pounds, shillings, pence and farthings as rapidly as an American accountant can add dollars and cents, it must be because the greater difficulty of his task has caused a greater mental development. If Sir Frederick Bramwell can calculate by mental arithmetic how many grains of water there are in a gallon as quickly as a child can tell how many grams there are in a liter he is indeed a mathematician.

The requirements of scientific work are not so different from those of commerce as has been imagined. It is not a matter of indifference to the scientist whether his measures are capable of easy division. A chemist has to make more divisions into aliquot parts than a shopkeeper, as I know by personal experience in both capacities.

It is probable that the duodecimal notation would be preferable to the decimal, though it is not certain that it is the best that could be devised. Notations based on eight, sixteen and two have, I believe, been more favored by mathematicians than that based on twelve. The difficulties of a change are, however, almost inconceivable, perhaps as great as a change to a more perfect language would be, and it seems hardly worth while to take into consideration its possibility. The fact is that for the period intervening between that geological epoch when our saurian ancestor lost his sixth digit, to that perhaps equally remote date when men shall become intelligent enough to choose a better system of notation than the present, the world is doomed to a decimal system. Let us then make the best of it by bringing weights and measures in accordance with it and, instead of complaining, rather be thankful that the first human arithmetician had five fingers instead of seven, since he did not have the happy medium. It seems that the English, in spite of their national genius for devising incommensurable units, are moving as fast in the matter of adopting a better system of weights and measures as the Americans, and we may put faith even in the prophecy made by Matthew Arnold in one of his optimistic moods, that the time will yet come in England when the fact that an institution is an anomaly will be regarded as an objection, not an advantage.

E. E. Slosson.

University of Wyoming.

THE USE OF THE HAIR HYGROMETER.

For some time past there has been an increasing demand for a direct reading hygrometer, so constructed that it would indicate the relative humidity of the air with reasonable accuracy.

Among those hygrometers which have been considered as possibly suitable for this purpose is the Saussure's or hair hygrometer. Although formerly this hygrometer was looked upon merely as a hygroscope, and was supposed to give only the approximate hygrometric state of the air, now it has reached a higher place among hygrometrical apparatus by virtue of certain improvements in its construction.

I have recently tested a form of hygrometer based on the Saussure principle, with a view of observing its action when subjected to different changes in the degree of saturation of the air.

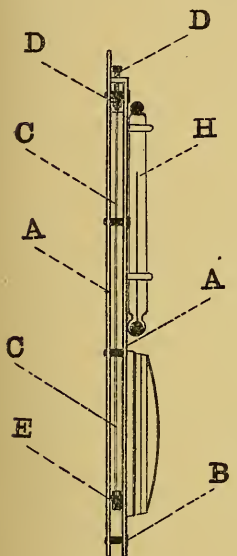

Fig. 1.

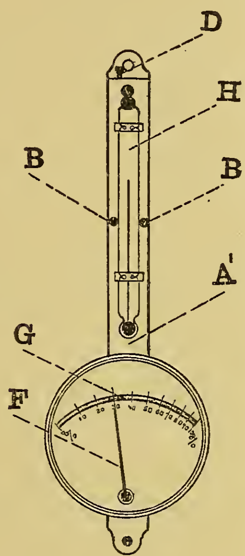

Fig. 2.

The hygrometer which was tested is shown in the accompanying cut, Figs. I. and II.; the essential parts of the instrument are designated by letters, and the parts so indicated are explained in the following paragraph :

A and A′ are two thin brass supports, respectively 23.7 centimeters and 22 centimeters long and 2 centimeters broad.

B, small rivets which connect the supports A and A′, but leave an air space which separates the latter by .7 of a centimeter.

C, six fine hairs about 18 centimeters long, placed parallel, and laid close together, so as to hang like one large hair in the air space between A and A′.

D, an adjusting screw, from which the six hairs, C, are suspended.

E, a short lever, to which the lower ends of the hairs, C, are fastened (a small weight is attached to this lever in such a way that the hairs are kept at a slight tension).

F, an indicator, 4 .7 centimeters long, fastened to the lever, E, which shows changes in the length of the hairs, C ; by the use of this indicator the actual change in the length of the hairs is multiplied a convenient number of times.

G, a scale of percentages of relative humidities, from 0 to 100 per cent.

H, a thermometer fastened to the support A′, which is used in dew-point determinations.

It was important that the scale of percentages, G, Fig. II., should be carefully tested and either verified or the corrections obtained throughout; therefore observations were made with all possible different percentages of saturation of the surrounding air.

The readings of the air hygrometers in each case were compared with the relative humidity obtained from observations made with wet and dry bulb thermometers, and the percentage of saturation deduced from the Smithsonian hygrometrical tables of Guyot. This was done as a relative comparison, since the wet and dry bulb thermometers, or Auguste's psychrometer, is the means almost entirely used at the U. S. Weather Bureau stations for obtaining the relative humidity of the air.

Of course, in the present investigation, the determinations made with the wet and dry bulb thermometers were themselves subject to some error ; yet this method is so generally accepted, and is the means which is so often used for obtaining the relative humidity, that it seemed fair to compare the readings of the hair hygrometer with those calculated from observations made with wet and dry bulb thermometers.

The results of the comparisons which were obtained indicated that for the middle section of the instrument under consideration, say from 20 to 85 per cent., only a difference of from one to three per cent. could be observed.

But for the extremities of the scale, from 0 to about 20 per cent. and from about 85 to 100 per cent, the reading indicating the relative humidity seemed unreliable, and especially so at low humidities, differing in some cases as much as 10 per cent. from the calculated degree of saturation.

Thus, in cases of either very low or very high humidity, when two or more hair hygrometers were placed in the same atmosphere, their readings were very apt to indicate different relative humidities, and also when the same hair hygrometer was placed at different times in an atmosphere of a constant hygrometric state (of either very low or very high relative humidity) it gave different percentages.

These variations of course presented a difficulty in drawing a correction curve for the extremities of the scale on the hair hygrometer.

Prof. Rood called my attention to an article in the *Beiblätter zu den Annalen der Physik und Chemie*, Vol. 19, No. 11, page 875—'Theorie des Haarhygrometers, by B. Sresnevsky,' in which it is stated that the change in the length of the hairs for degrees of saturation of the air ceases to be regular when the relative humidity becomes as low as 7.8 per cent. This is in agreement with the statements just made.

In the tests which were carried on, it was also invariably found that if the degree of saturation of the air was altered, some time had to elapse before the hairs became adjusted to the new conditions surrounding them, and therefore ample time was always given for the hairs to become adjusted when the hygrometric state of the air was changed. Thus, when the hair hygrometers were placed in an entirely new atmosphere differing 15 per cent. or more in relative humidity, 5 to 25 minutes elapsed before the hairs responded perfectly to the change and gave approximately correct readings. It was further observed that the length of this time depended on whether the change was to a higher or to a lower percentage of humidity, and also in what part of the scale the change occurred.

For example: A change from

15 to 90	per cent.	required	about 10	minutes
30 to 90	"	"	" 10	"
15 to 30	"	"	" 15	"
90 to 15	"	"	" 20	"
90 to 30	"	"	10 to 15	"
30 to 15	"	"	about 20	"

which indicated that it takes longer for the hairs to dry out than for them to take up the moisture, and that the change is slower at the lower parts of the scale than elsewhere.

A knowledge of the relative humidity of the air is important, not only in various branches of science and the arts, but also in the treatment of the sick, particularly in cases of certain pulmonary disorders.

Although it may be probable that a perfectly accurate direct reading hygrometer cannot be obtained, this drawback should not condemn the hair hygrometer, for such great exactness is seldom required, a knowledge of the relative humidity of the air to within two or three per cent. being, in most cases, all that is necessary.

The precaution of allowing considerable time to elapse for the hairs of hair hygrometers to become adjusted to a changed atmosphere, before taking a reading, is only really necessary where a possibility exists that a decided change in the relative humidity has suddenly occurred.

The table which is given below has been constructed from results obtained by comparing the readings of relative humidity shown by the hair hygrometer with those calculated from observations made with wet and dry bulb thermometers, and it is meant to exhibit the amount of error to be expected when the former is compared with the latter in different parts of the scale.

Sections of Scale of Percentage.	Probable Limit of Error.	Error Ordinarily to be Expected.
0-- 10 %	10 %	From 0 to + 6 %
10-- 20 "	6 "	" 0 " + 4 "
20-- 30 "	4 "	± 3 "
30-- 40 "	3 "	± 2 "
40-- 50 "	2 "	± 1 "
50-- 60 "	3 "	± 2 "
60-- 70 "	3 "	± 2 "
70-- 80 "	4 "	± 3 "
80-- 90 "	4 "	± 3 "
90--100 "	7 "	From 0 to — 5 "

C. C. TROWBRIDGE.

COLUMBIA UNIVERSITY.

INSTRUCTION IN NATURAL HISTORY AT THE JARDIN DES PLANTES, PARIS.

IT has been my good fortune to have spent the past winter in carrying on investigations in the paleontological laboratory of the Jardin des Plantes, Paris, and while there I took the opportunity to study the methods of instruction at the Muséum D'Histoire Naturelle. I am especially indebted to MM. Albert Gaudry, Alphonse Milne-Edwards, Henri Filhol and Marcellin Boule. These gentlemen have placed exceedingly valuable material in my hands for study, and I am greatly obliged to them all for their extreme kindness during my stay in Paris.

The instruction at the Jardin des Plantes consists of the 'cours' or lectures, the 'conférences' or practical work in the laboratory, and the 'enseignements specials' or special instruction, generally for the benefit of travelling naturalists. During the year there have been eighteen courses of lectures on various scientific subjects, eleven of which were biological, the remaining being on agriculture, physics, geology, etc. Some of the subjects treated of by the professors are certainly not intimately connected with natural history, but we must remember that the Jardin des Plantes was previously founded as a school of pharmacy, and in connection with the same there was a large garden for the cultivation of plants for medical purposes. It was not until 1793 that the reorganization of the Jardin des Plantes took place and regular courses of public lectures were opened. It is interesting to note that in this year two brilliant men were added to the faculty of the 'Jardin;' these were the Chevalier de Lamarck and the young Etienne Geoffroy Saint-Hilaire. The latter commenced a course of lectures at this time, and later in 1798 accompanied Napoleon on his Egyptian expedition, as naturalist.

As a rule almost all of the naturalists who have held professorships in the Jardin des Plantes have been men of broad learning and have worked in many fields of biology. This is noticeable in the public lectures given at the 'Jardin,' and I can safely say that even the systematists are well grounded in comparative anatomy. When we consider that the French naturalists have had so great a teacher as Georges Cuvier to follow, it is not strange that the professors at the Muséum D' Histoire Naturelle fully appreciate the fact that the curators, etc., of the Muséum who lecture should be well grounded in the morphological relation of animals.

The numerous lectures on biology given at the Muséum D' Histoire Naturelle are in strong contrast with the few that are held in other natural history museums of the world. The lecture hall of the British Natural History Museum has been given up entirely and there are no lectures now given in this institution. In fact, it is a great question with the trustees of some museums whether a natural history museum is a place for teaching at all or simply a great store-house, in which vast accumulation of specimens are preserved, labelled and placed by the hundreds in glass cases for exhibition and for the general public, who have had no previous instruction in natural history whatever.

The natural history museum is for the benefit largely of the public, who have had no preliminary training in biology, and if lectures are not held to instruct them, how they can appreciate the specimens which they see by the countless thousands on exhibition in the museums.

I am convinced that the lectures given at the Jardin des Plantes, Paris, do an immense amount of good, and they reach a class of people, like teachers, who are unable to follow the courses given in the colleges and universities. In Paris, as in many other places, there is a considerable amount of feeling as to how much general work in biology should be done at the Muséum, and if the professors or curators make their courses too general, they will encroach upon the work of the learned professors at the Sorbonne or in the universities. In general the courses in natural history in the colleges are more in detail; they are often prepared for students who are going to become professional naturalists. On the other hand, the museum work, owing to the nature of the specimens, is less detailed and more general in its character. Museum lectures on natural history must necessarily be rather superficial, owing to the class of hearers, and these lectures would be rather on the broad facts of general morphology in its bearing on classification and of geographical distribution of animals. Detailed embryological and histological lectures would be of little use in a museum curriculum. At the Jardin des Plantes courses are given in embryology and histology, but I believe there are very few students who take them. The 'cour' in general comparative anatomy is very popular at the 'Jardin' and well attended, and I see no reason why a course of this kind could not be given in museums in this country. At the Jardin des Plantes there are a number of laboratories for practical work, where the students can go and study the specimens on which the professor lectures. These laboratories for practical work are an absolute necessity, as natural history taught without seeing and studying the specimens is of little benefit.

The department of comparative anatomy is one of the strongest, if not the best at the Muséum. Prof. Filhol, who is so well known for his extensive investigations in vertebrate paleontology, is at the head of this department. The material which M. Filhol has at his command for teaching is immense, and the osteological collection alone is the largest in the world. The collection of skeletons was largely made by Cuvier and used by him for comparison with the extinct fossil vertebrata, which he so ably described in his 'Ossemenes Fossiles.' M. Filhol is now having prepared a beautiful collection of the internal organs of the vertebrata, which are injected and colored to immitate the hues of the living viscera. This collection will be of immense value in laboratory work and in the lecture room.

Prof. Gaudry's department of paleontology is about to be greatly enlarged, owing to the new museum which is rapidly approaching completion. This new building is for the department of comparative anatomy, including under this term the anatomy of recent and extinct types. Vertebrate paleontology has suffered too long being placed under geology, and most naturalists who are workers in vertebrate paleontology realize that the true position of this division of biology is under comparative anatomy and not geology. Vertebrate paleontology as studied by the methods of anatomy is now making great progress, the old and dry geological methods as applied to paleontology only prevented the progress of this science from a morphological and phylogenetic standpoint.

The new museum at the Jardin des Plantes for comparative anatomy will have the paleontological specimens placed on the second floor. The fossils will be well arranged for study and the gallery is splendidly lighted. Immediately at the end of the building is Prof. Gaudry's lecture room and a working laboratory for students. Here you have the ideal museum, well arranged specimens, not too many of them so as to be a burden to the student's mind, a laboratory for studying the objects, and lastly, a well planned lecture room for the 'cour.'

Vertebrate paleontology has at least one great advantage over recent mammalogy and ornithology; there is no danger of exhibiting too many specimens of vertebrate fossils, especially mammals, as these specimens themselves are exceedingly rare and very costly in procuring. In most museums the hundreds of grinning owls and the forty eleven species, illustrating the forms of the *Muridae* for example, are only a hindrance to the appreciation by the public of what an owl or a mouse is. Synoptical collections, I believe, do a great deal more good for general exhibition purposes than all the species representing the numerous genera of the animal kingdom. Let us have on exhibition the complete life-histories of a number of well selected types of animals, as illustrated by the metamorphosis of an arthropod or the changes in plumage of a bird. I believe the beautifully arranged collection of comparative osteology and the cases illustrating adaptation of birds and mammals to their environment in the British Natural History Museum, London, do more good in the way of educating the public than miles of so-called species arranged in cases. I have always particularly noticed, in passing through the central corridor of that great Natural History Museum in South Kensington, that many people were collected around the cases in this main hall, whose specimens illustrate the structure and variation of the animal kingdom.

A great innovation was introduced in biology by the publication of Huxley and Martin's 'Practical Biology,' taking up the the study of animal types, and placing aside for the time being the old method of hammering at species all the time, which leads to small results in getting at the real affinities of animals. I think if, in arranging museums, this idea of illustrating the structure and life-history of animals were more followed, better results in educating the public would be attained.

Charles Earle.

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CURRENT NOTES ON ANTHROPOLOGY.

THE IRON AGE IN AMERICA.

In the *American Anthropologist* for June, Prof. Otis T. Mason has a well-prepared article on the introduction of the iron age into America. Of course, this was post-Columbian, but its history is important and has never before been presented. The use of the metal extended rapidly, and often reached tribes long before the first white men wandered to their abodes. The influence of this new material was felt immediately, and not always to the best advantage. "The technique may be better, but the motive, the underlying conception and the composition may be incalculably worse." The author most judiciously insists on the truth that "the unadulterated aboriginal product reveals to our gaze the living processes by which men have always progressed to higher life."

The article closes with a strong and a much needed appeal to those who have in charge public and private collections to cultivate coöperation and to show greater liberality to students in the same field. Some very pointed statements of facts could be made in this connection. There are too many owners and custodians of collections who seem to think that specimens should be locked up and concealed, rather than exhibited and offered for examination.

ON ENDO-CANNIBALISM.

By this term is meant eating members of one's own tribe, while 'exo-cannibalism' signifies the consumption of the dead bodies of strangers and enemies. Dr. R. S. Steinmetz, of Holland, well known for his excellent treatise on the development of punishment, has a study of endo-cannibalism in Vol. XXVI. of the *Mittheilungen* of the Anthropological Society of Vienna. He collects a large array of facts about the custom from numerous writers and from all parts of the world. These he tabulates with reference to motives, and then proceeds to deduce conclusions.

The question arises, was primitive man a cannibal? It has already been answered in the affirmative by various archæologists, and Dr. Steinmetz agrees with them. He believes the usual disposition of the dead body in early times was as a delicacy for the table. This will easily explain why we do not find, according to Mortillet, any signs of tombs or burial places in palæolithic ages.

Of course, as the author observes, there could have been no abhorrence of a corpse when it was a favorite article of diet. That sentiment came later, when the belief in a soul and an after-life arose, and the fear that the ghost would not like his body to be so treated. The memoir will be found replete with interesting suggestions.

D. G. Brinton.

University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS.

LORD KELVIN.

At the banquet given to Lord Kelvin by the Corporation and University of Glasgow on the evening of June 16th, he spoke (according to the report in the London *Times*) as follows:

I thank you with my whole heart for your kindness to me this evening. You have come here to commemorate the jubilee of my University professorship; and I am deeply sensible of the warm sympathy with which you have received the kind expressions of the Lord Provost regarding myself in his review of my 50 years' service and his most friendly appreciation of practical results which have come from my scientific work. I might perhaps rightly feel pride in knowing that the University and City of Glasgow have joined in conferring on me the great honor of holding this jubilee, and that so many friends and so many distinguished men, friends and comrade-day-laborers in science have come from near and far to assist in its celebration, and that congratulations and good wishes have poured in on me by letter and telegram from all parts of the world, I do feel profoundly grateful. But when I think how infinitely little is all that I have done I cannot feel pride; I only see the great kindness of my scientific comrades and of all my friends, in crediting me for so much. One word characterizes the most strenuous of the efforts for the advancement of science that I have made perseveringly during 55 years; that word is failure. I know no more of electric and magnetic force or of the relation between ether, electricity, and ponderable matter, or of chemical affinity, than I knew and tried to teach my students of natural philosophy 50 years ago in my first session as professor. Something of sadness must come of failure; but in the pursuit of science inborn necessity to make the effort brings with it much of the *certaminis gaudia*, and saves the naturalist from being wholly miserable, perhaps even allows him to be fairly happy, in his daily work. And what splendid compensations for philosophical failures we have had in the admirable discoveries by observation and experiment on the properties of matter, and in the exquisitely beneficent applications of science to the use of mankind with which these 50 years have so abounded! You, my Lord Provost, have remarked that I have had the good fortune to remain for 50 years in one post. I cordially reply that for me they have been happy years. I cannot forget that the happiness of Glasgow University both for students and professors is largely due to the friendly and genial city of Glasgow in which it lives. To live among friends is the primary essential of happiness; and that, my memory tells me, we inhabitants of the University have enjoyed since I first came to live in it in 1832, 64 years ago! And when friendly neighbors confer material benefits, such as the citizens of Glasgow have conferred on their University, in so largely helping to give it its present beautiful site and buildings, the debt of happiness due to them is notably increased. I do not forget the charms of the old college in the High street and Vennel. Indeed, I remember well when in 1839 the old natural philosophy class room and apparatus room (no physical laboratory then) was almost an earthly paradise to my youthful mind. And the old College Green, with the ideal memories of Osbaldistone and Rashleigh and their duel, created for it by Sir Walter Scott, was attractive and refreshing to the end. But density of smoke and of crowded population in the adjoining lanes increased, and pleasantness, healthiness and convenience of the old college, both for students and professors, diminished year by year. If, my Lord Provost, your predecessors of the Town Council, and the citizens of Glasgow, and well-wishers all over the world, and the government, and the great railway company that has taken the old college, had not given us our new college, I do not believe that attractions elsewhere would have taken me away from the old college; but I do say that the fifty years of professorship which I have enjoyed would have been less bright and happy, and I believe also less effective in respect to scientific work, than they have been with the great advantages with which the University of Glasgow has been endowed since its migration from the High street. My Lord Provost, I ask you to communicate to your colleagues of the Town Council my warmest thanks for their great kindness to me in joining to celebrate this jubilee. Your Excellency, my lords and gentlemen, I thank you all for the kind manner in which you have received the toast of my health proposed by the Lord Provost, and for your presence this evening to express your good wishes for myself.

THE ROYAL GEOGRAPHICAL SOCIETY.

THE anniversary meeting of the Royal Geographical Society was held on June 12th. According to the report in the London *Times* the Society presented the Royal medals for the encouragement of geographical science and discovery. The Founder's medal was awarded to Sir William Macgregor for his long-continued services to geography in British New Guinea. This was received on Sir William's behalf by Sir Henry Norman. The Patron's medal was awarded to Mr. St. George R. Littledale for his valuable Asiatic expeditions. The following other awards were also declared: The Murchison grant for 1896 to Yusuf Sharif Kahn Bahadur. Yusuf Sharif is the first native assistant who has acted entirely on his own resources and knowledge, and who has carried systematic and really scientific surveys right through the most difficult and dangerous country which lies between Makran, Kurman and Bandar Abbas (Persian Baluchistan). His work embraces the extension of direct triangulation from Makran to Bandar Abbas and the topographical survey of Persian Baluchistan. He has done other similar work in Arabia and elsewhere, and is now about to retire from the service. The Back grant for 1896 to Mr. J. Burr Tyrrell, for his five explorations in Labrador. The Gill Memorial for 1896 to Mr. A. P. Low, for his two expeditions in the Barren Grounds of northeast Canada, during which he went over much new ground. The Cuthbert Peek grant for 1896 to Mr. Alfred Sharpe, for his journeys during several years in Central Africa.

The President, Sir Clements R. Markham, delivered the anniversary address, in which he reviewed the work of the past year. He said that their progress was, on the whole, satisfactory. The Congress was a great success. Excellent work had been done in Asia, in Africa and in the Polar regions. Above all, there was evidence of a great revival of geographical interest in the rising generation. Volunteers for all kinds of enterprises were numerous, zealous and of the best sort. That was a good sign, and was of excellent augury. It betokened a future for the Society of continued activity.

230 fellows and 9 honorary corresponding members were elected during the year. The

total number of fellows on the list was 3744 and the income for the financial year was over £10,000.

TIDAL WAVES IN THE PACIFIC.

The Eastern papers quote from the Oregon *Gazette* a description of a tidal wave which has been seen at Victoria and along the North Pacific coast, doubtless caused by the recent Japanese earthquake. On June 15th the residents at the mouth of Rogue River witnessed a series of tidal waves. The fishermen, out in the river with their boats, noticed soon after noon a series of waves coming into the river, increasing the volume of water considerably. The waves continued to grow in size until they became dangerous, and boatmen had to watch carefully to keep from being swamped. Between two and three o'clock the waves were from three to six feet high. The inrushing volume of water made itself felt for over a mile up the river, beating against the banks in waves several feet high, while the water of the river was backed up for several miles. The disturbance lasted all the afternoon, being at its height from two to three o'clock, gradually diminishing until the waves disappeared about six o'clock. During the afternoon the bar and sea were smooth, with a light swell running. A number of the largest waves in the river were timed, and it was found that they came about a mile apart and travelled the mile in about three minutes.

A correspondent of the Washington *Star* writes from Honolulu that the western coast of the island of Hawaii was visited by tidal waves of destructive force from 7 a. m. to 2 p. m. on June 15th. At Keanhou the water reached points 35 feet above the sea.

The shocks of the earthquake were, it appears, registered by instruments in Italy.

PROTECTIVE SOUNDS AND COLORS.

In the July number of *Natural Science* Mr. R. I. Pocock describes the stridulating organ in the Indian and African scorpions and argues that it is protective in character. He writes: "Since the organs that have been here described are equally well developed in both males and females, and appear in the young long before the attainment of maturity, there is no reason to suppose that they are of a sexual nature, serving, like the chirrup of the cricket or the call of the cuckoo, to inform the one sex of the whereabouts of the other. If this were the case we should expect to find, firstly, that the organs were exclusively confined to one sex, or, at all events, better developed in it than in the the other; and, secondly, that they put in an appearance either just before or simultaneously with the reaching of the adult stage. Again, in spite of the opinion of many authorities, who maintain that the existence of a sound-producing organ implies of necessity the existence of an auditory apparatus in the same individual, we can only assert again that there is not a particle of evidence that either the large spiders or the scorpions can hear the sounds that their own stridulating organs emit. All the available evidence goes to show that in these groups of arachnids the organ is brought into use when its possessor is under the influence of irritation or fright, exactly as in the case of the rattlesnake's rattle. Like the snake too, both the scorpions and the spiders are furnished with highly developed poison glands, and it is a well known fact in natural history that animals so gifted are frequently rendered conspicuous by bright and staring colors, so that they may not be destroyed by carnivorous creatures in mistake for other harmless and edible species. Nature, in fact, for purposes of protection, has labeled them with her poison badge; and apparently with the same end in view, she has supplied the rattlesnake and the large spiders and scorpions with a sound producing apparatus, which, when in action, serves as a danger signal to meddlesome intruders, warning them to beware of hostile interference."

On the other hand it appears from experiments made by Mr. Frank Finn that the lizard eats indiscriminately plain-colored and bright-colored butterflies, the supposed protective coloring not being of use in this case.

NEUROLOGIC NOMENCLATURE.

The following Report of the Committee on Neuronymy, Prof. Burt G. Wilder, Chairman, was adopted unanimously by the American

Neurological Association at Philadelphia, June 5, 1896.*

It is recommended:

1. That the adjectives Dorsal and Ventral be employed in place of *posterior* and *anterior*, as commonly used in human anatomy, and in place of *upper* and *lower*, as sometimes used in comparative anatomy. 1880; 1882; 1889; 1889, A; 1890; 1892; 1895.

2. That the cornua of the spinal cord and the spinal nerve-roots be designated as Dorsal and Ventral rather than as *postorior* and *anterior*. 1880; 1882; 1889; 1889, A; 1890; 1892.

3. That the costiferous vertebræ be called Thoracic rather than *dorsal*. 1880; 1889; 1889, A; 1890; 1892; 1895.

4. That other things being equal, mononyms (terms of a single word each) be preferred to polyonyms (terms consisting of two or more words). 1880; 1882; 1889; 1889, A; 1890; 1892.

5. That the *hippocampus minor* be called Calcar; the *hippocampus major*, Hippocampus; the *pons Varolii*, Pons; the *insula Reilii*, Insula; *pia mater* and *dura mater*, respectively Pia and Dura. 1880; 1882; 1889; 1889, A; 1890; 1892; 1895 (excepting that the German Committee retain *calcar avis*, *pia mater* and *dura mater*).

6. That the following be employed in place of their various synonyms:

Mesencephalon. 1880; 1882; 1895.
Pallium. 1895.
Oliva. 1882; 1889; 1895.
Clava. 1882; 1889; 1895.
Operculum. 1889; 1895.
Fissura centralis.* 1882; 1889; 1895.
F. calcarina. 1889; 1895.
F. collateralis. 1889; 1895.
F. hippocampi. 1882; 1889; 1895.
Cuneus. 1889; 1895.
Praecuneus. 1889; 1895.
Claustrum. 1889; 1895.
Fornix. 1880; 1882; 1889; 1895.
Infundibulum. 1882; 1889; 1895.
Vermis. 1882; 1889; 1895.
Hypophysis. 1882; 1889; 1895.
Epiphysis. 1895.
Chiasma. 1880; 1882; 1889.
Oblongata. 1889.
Lemniscus. 1889; 1895.
Monticulus. 1889; 1895.
Tegmentum. 1889; 1895.
Pulvinar. 1889; 1895.
Falx. 1882; 1889.
Tentorium. 1882; 1889.
Thalamus. 1880; 1882; 1889; 1895.
Callosum. 1880; 1882; 1889.
Striatum. 1880; 1882; 1889.
Dentatum. 1889.

* The dates after the names refer to earlier recommendations as follows:

1880. Paper by the chairman before the American Association for the Advancement of Science.

1882. 'Anatomical Technology,' Wilder and Gage.

1889. Articles, 'Brain' and 'Anatomical Terminology.' Reference Hand-book of the Medical Sciences, Vol. VIII.

1889, A. Report of the Committee of the Association of American Anatomists, adopted unanimously at Philadelphia, December 28th.

1890. Report of the Committee of the American Association for the Advancement of Science, adopted unanimously at Indianapolis, August 25th.

1892. Report of the Committee on Biological Nomenclature of the American Association for the Advancement of Science, adopted unanimously August 23d.

1895. Report of the Committee of the Anatomische Gesellschaft, adopted at Basle, 1895.

* The German Committee adopt *Sulcus* in this case, but the replacement of *Rolando* by *centralis* is the more essential feature.

GOVERNMENT CONTROL OF PRINTING OFFICES IN GERMANY.

THE Berlin correspondent of the *Lancet* states that a bill providing for hygienic improvements in printing offices has been proposed to the Federal Council by the Imperial Chancellor. It specifies that the rooms of the offices must be 4 meters in height, and must contain at least 15 cubic meters of air for every man employed therein. The floor must be smooth, and the walls must be painted with oil paint renewed every five years. The type cases must be provided with pedestals to avoid the accumulation of dust beneath them. Stereotype work is to be done in special rooms efficiently ventilated. The type cases are to be cleaned in the open air and by the aid of bellows only. Ample lavatory accommodation is made compulsory by the bill, which gives very precise directions in this matter. One washhand basin at least must be furnished for each five workmen; soap and towels are to be supplied to them free of charge, and a cloakroom separated from the workrooms is to be provided. This bill, which is viewed very unfavorably by the employers, is on the other hand declared by competent medical men to be very useful. Dr. Lewin, a lecturer on toxicology at the Berlin University, points out that whilst the German insurance laws oblige employers' associations to indemnify workmen in case of accidents, they are entirely unprotected against the chronic influence of poisons. As printers are liable to suffer from the effects of lead—one of the strongest poisons—he thinks that preventive measures are necessary, but the bill ought, in his opinion, to be extended to other trades where lead is used, and he specially mentions some of the home industries where the workmen's children inhale dust impregnated with lead. The children of dial-plate painters, for instance, even if born healthy, die in a few months with convulsions. In a village of Hesse, where pottery is glazed by home workers, 71 per cent. of the children were sickly, 50 per cent. died within the first five years, and the survivors suffered from hydrocephaly or macrocephaly.

GENERAL.

The seventh session of the International Geological Congress will be held at St. Petersburg toward the end of the month of August, 1897, and will continue about one week. A committee has been organized in Russia consisting of the leading geologists, paleontologists and mineralogists, with A. Karpinsky as president, and the Grand Duke Constantine as honorary president. The committee has held several meetings and has sent out a circular describing the plans of the Congress and the extensive excursions that have been arranged. Before the opening of the Congress there will be an excursion to the Ural Mountains lasting some 25 days, and after the close of the Congress there will be an excursion to the Crimea and the Caucasians lasting about a month. Shorter excursions have also been arranged to Finland and elsewhere, and the longer excursions have been divided into various parties that will visit different regions under the direction of leading Russian geologists. Those proposing to attend the Congress are requested to inform the committee which excursions they propose to take part in before October of the present year. The Czar of Russia has ordered that geologists attending the Congress be allowed free transit (first-class) on all the railways in Russia, before and after the Congress and including the excursions.

Dr. D. Gill, of the Cape of Good Hope Observatory, has been unanimously elected corresponding member of the Paris Academy in the room of the late Prof. Cayley.

The physico-mathematical section of the Berlin Academy of Sciences has made the following appropriations: Prof. Weierstrass for the continuation of the publication of his collected works, M. 2,000; Prof. Klein, of Göttingen, for apparatus for researches in crystallography, M. 118.75; Dr. Bürger, of Göttingen, for zoological explorations in the Andes, M. 3,000; Prof. Fütterer, of Karlsruhe, for geological explorations in the Alps, M. 1,000; Dr. Tornquist, of Strasburg, for geological explorations in Vicenza, M. 1,500; Prof. Wernicke, of Breslau, for a photographic atlas of sections of the brain, M. 2,000.

The Munich Academy of Sciences has been presented by citizens of the city with M. 71,200, which it is hoped further to increase. The interest is to be used for the promotion of research in the mathematical and physical sciences.

We noted last week that on the occasion of Lord Kelvin's jubilee the degree of LL. D. was conferred on Profs. Newcomb and Abbe. The other guests on whom the degree was conferred were: Prof. C. Christiansen, Royal Danish Society of Science, Copenhagen; Prof. Per Theodor Cleve, University of Upsala; General Ferrero, Italian Ambassador, London; Prof. Dr. Izidor Frohlich, Academy of Sciences, Budapest; Prof. Lippmann, University of France, Paris; Prof. Liversidge, University of Sydney; Prof. Eleuthere Mascart, Collége de France, Paris; Prof. Henri Moissan, University of France, Paris; Prof. Nicholaus Oumor, of the University of Moscow; Prof. Emile Picard, University of France, Paris; Prof. George Quincke, University of Heidelberg, and Prof. Woldemar Voigt, Royal Society of Science, Göttingen.

THE new volume of *The Dial*, which in twenty volumes has maintained a high standard of literary criticism, opens with an editorial article on science in the secondary schools, taking as its text Prof. Shaler's Presidential address before the Geological Society (SCIENCE, April 24th). The editor writes: "We must resolutely seek to subordinate the ideal of information to the ideal of discipline, and be willing to relegate to personal tastes and later opportunities the acquisition of knowledge upon many subjects of the highest scientific importance. What is all important to the student is a comprehension of the *method* of science; he may safely be left, if this is once given him, to possess himself of as much of the *matter* as his inclinations and interests may demand."

WE regret to record the death, on June 17th, at the age of 63, of Lord Lilford, who was well known for his contributions to natural history and especially to ornithology. He published many papers in the *Ibis*, the journal of the British Ornithologists' Union, of which, at the time of his death, he had been president for many years. He also contributed papers to *The Zoologist* and to the Proceedings of the Zoological Society of London. The thirty-second part of his colored figures of the birds of the British Islands, nearly completing the work, was published in April, and last year he published an excellent volume on the birds of his native county, Northamptonshire, with beautiful illustrations. Lord Lilford had an extensive collection of living animals at his country seat in Northamptonshire.

THE death of Lord Lilford reminds us how much science in England is indebted to the class having ample means and time, which are in so many cases devoted to the pursuit of science. Many of the greatest leaders, such as the Darwins and the Herschels, belonged to this class. It is perhaps not generally known in America that Sir Joseph Prestwich, whose death we were compelled to record last week, was a wine merchant in London until he was sixty years old, being called to the chair of geology at Oxford when he was 62. It would probably be impossible to instance in America examples similar to those offered by Lord Lilford and Sir Joseph Prestwich.

THE *Boston Transcript*, which perhaps devotes as much space to scientific matters as any daily paper published in America, contains in its issue of July 7th an editorial article beginning, "Everything seems to be possible to science" and going on to describe a paper which, it says, was read by 'Dr. Baraduc, of Paris,' before the Paris Academy of Medicine, on the photography of thought. "In the official confirmation of the experiments it is shown that the new psychology expects to capture the secrets of the universe with the utmost readiness. It is extremely interesting that one of those sensitive and imaginative persons known as 'mediums' proved an excellent subject in the experiments. The medium was desired by the man of science to will that some historical personage should appear. The first plate merely showed a chaotic, cloudy shaping of thought; but the next was a portrait thrown upon the film, giving the medium's idea of what Mahomet looked like. Photographs of the thought of other persons who fixed their gaze upon the sensitized films which are used have been obtained." Indeed, everything seems to be possible to the daily newspapers!

THE twenty-eighth annual meeting of the American Philological Association was held at Brown University from July 7th to 10th.

MR. GIDEON H. DIALL, DePauw University, Greencastle, Ind., wishes to secure data to investigate the psychology of the aggregate mind or of crowds, and would be glad to send a circular with questions on the subject to public speakers and others who would be willing to answer them.

AT the recent meeting of the American Pediatrical Society in Montreal, a committee reported statistics secured from 615 physicians on the use of anti-toxin. The total mortality was 12.3 per cent., but if cases are excluded in which anti-toxin was not used during the first three days and those in which the patients were moribund at the time of injection or died within twenty-four hours, the mortality is reduced to 4.8 per cent. The report is regarded as very favorable to the use of anti-toxin. There is no question but what the reported percentage of mortality is much lower than formerly, but such reports are not entirely convincing, partly because they are likely to come from physicians who have secured favorable results, and partly because all cases in which the Lœffler bacillus is found are reported as diphtheria, whereas formerly mild cases might not have been recognized.

The steamer *Hope*, chartered by Lieut. Peary, has sailed for Sydney, Cape Breton. As we have already stated, Lieut. Peary will be accompanied by two parties, one in charge of Prof. Tarr, of Cornell University, and one in charge of Prof. Burton, of the Massachusetts Institute of Technology. The latter party will include, besides Prof. Burton, Prof. George H. Barton, of the Institute of Technology, geologist; Mr. G. R. Putnam, assistant in the United States coast and geodetic survey, detailed to make pendulum and magnetic observations; Mr. Russell W. Porter, a student in the architectural department of the Institute of Technology, artist and photographer; Mr. John C. Phillips, student at Harvard, assistant geologist. This party will be landed on the Umanak Fjord, and have planned a topographical survey of a portion of the uncharted northern shore of this fjord, with its main glaciers; the detailed geological study of these glaciers and measurements of their motion; the determination of the force of gravity and the deflection and dip of the magnetic needle at several different points of the west coast of Greenland.

We regret to announce that Dr. H. B. Pollard, lecturer on biology and comparative anatomy at Charing Cross Hospital, died on June 14th. *Nature* states that, elected a scholar of Christ Church, Oxford, in 1885, Dr. Pollard graduated B. M. with first-class honors in morphology in 1890, and concurrently gained similar distinction in the London intermediate and final B.Sc. examinations. He subsequently studied for two years under Prof. Wiedersheim at Freiburg, and in 1892 was appointed to the Oxford table at Dr. Döhrn's laboratory at Naples. In 1893 he was elected Berkeley Fellow of the Owens College, Manchester, and in 1895 lecturer at Charing Cross Hospital. He was granted the degree of D.Sc. by London University for a thesis on Polypterus. Dr. Pollard made a special study of fish, and in a series of papers contributed to German scientific periodicals he originated a theory of their development which has received considerable attention from biologists. He was writing a text-book on the subject at the time of his death, which took place at Dover, in his twenty-eighth year. He was apparently stunned by a fall while bathing and drowned.

Como is the birthplace of Volta, and will celebrate in 1899 the 100th anniversary of his invention of the voltaic battery by an electrical exhibition and congress.

The President of the New York Board of Health has reported to the Mayor that the death rate of New York during the first six months of the year 1896 is less than for the same period in any recent year. The deaths reported and the death rate since 1890 are as follows:

	Deaths reported Jan. 1 to June 30.	Death rate.
1891	22,495	27.11
1892	22,953	26.88
1893	23,734	27.00
1894	21,555	23.83
1895	22,355	23.79
1896	21,585	22.32

The President of the National Geographic Society, the Hon. Gardiner G. Hubbard, has issued a circular giving a synopsis of a popular course of lectures for 1896–7. "The course will show the effects of environment on the development of civilization from the earliest to the most recent times, as illustrated by different peoples and races, and also the geographic agencies and conditions which have shaped human progress, and the forces which, affecting institutions, industries, arts, commerce and religion, have contributed to the development of the successive stages of civilization." In addition to the first lecture, which will be of a general character, opening the course and explaining its plan and purpose, lectures are proposed on Assyria, Syria, Tyre and Sidon, Greece, Rome, Constantinople, Venice and Florence and Paris.

The British Medical Journal states that a geological excursion from Aberdeen to Penrith, Cumberland, will take place next month. The party will leave Aberdeen on Monday, July 20th, and under the guidance of Prof. Alleyne Nicholson (natural history), University of Aberdeen, visit the most interesting localities in the Lake District, returning on Saturday, July 25th.

AFTER October of this year a new review, *The Journal of Physical Chemistry*, will be published from Cornell University, edited by Wilder D. Bancroft and Joseph E. Trevor, assistant professors of physical chemistry in the University. The journal will be issued on the first of each month, except July, August and September.

THE army worm is reported to be doing serious damage in New York, Rhode Island, Maryland and elsewhere.

A CABLEGRAM to the daily papers states that Larnica (island of Cyprus) has been suffering from earthquake shocks since July 1. The disturbances have been increasing in violence, and extend to Limesol. A panic prevails at Larnica, and the government and military authorities have been providing tents for the frightened people. The town is deserted and the government offices, banks and telegraph offices were under canvas.

IN the absence of Mr. G. F. Becker, who is making a study of the origin and mode of occurrence of gold in South Africa, the investigations in Alaska, under the U. S. Geological Survey, will be continued by Mr. J. E. Spurr, who has by this time reached his field of work in the Upper Yukon.

THE President of the National Academy of Sciences, Prof. Wolcott Gibbs, has written to Secretary Hoke Smith: "I have the honor to inform you that the members of the forestry commission, appointed at your request by the President of the National Academy of Sciences, will leave for the West on or before July 2d, and will at once enter on their duties. I have every reason to believe that the work of the commission will be of an inestimable benefit to the country, and that it will justify the opinion which the public has, from the inception of the plan, entertained of the wise foresight and patriotic spirit which you have shown in its conception and advancement."

THE Russian Society of the Red Cross has established ten scholarships in the Warsaw School of Dentistry for the widows of officers in the army. It seems that the widows of officers who have not been long in the service do not receive pensions, and it is hoped by this means to give them an opening to support themselves.

AT the meeting of the British Astronomical Society on June 24th, Dr. Downing, Secretary of the committee having charge of the arrangements for the approaching solar eclipse expedition, announced that information had reached him that several excellent sites for observation in the neighborhood of Vadsö were available, two quite close to the landing place. There appeared to be a prospect of plenty of room being found for all observers. The President, Mr. E.W. Maunder, gave an outline of the work proposed to be undertaken by members of the eclipse expedition, showing that the ground would be covered pretty thoroughly in respect of the different classes of observation. It appeared from this statement that drawings of the corona would be made not only with the naked eye, but also with the aid of binoculars and telescopes. A large number of cameras would be taken out, both wet and dry plate photography being brought into requisition. There would be polariscopic and spectroscopic observations, and other sections would undertake time determinations, photographic determinations of the general brightness of the corona and meteorological observations.

OF recent deaths we note that of Dr. William Cholmeley, a distinguished London physician and for ten years editor of the *Medical Times and Gazette*, on June 18th, at the age of 73; of Dr. Leloir, professor at the Lille School of Medicine and the author of treatises on skin diseases and other maladies, at the age of 40; on June 13th, of Prof. John Henry Middleton, director of art at the South Kensington Museum and formerly Slade professor of the fine arts at

Cambridge, at the age of 49; and on July 6th, of Mr. James Emerson, to whom we owe a system of heating cars by steam from the engine and other inventions.

Mr. H. Harries read a paper before the Royal Meteorological Society on June 17th, on 'Arctic Hail and Thunderstorms,' in which he showed that the commonly accepted opinion that hail and thunderstorms are almost, if not quite, unknown in the Arctic regions is incorrect. He had examined 100 logs of vessels which had visited the Arctic regions, and found that out of that number no fewer than 73 showed that hail was experienced at sometime or other. Thunderstorms were not so frequent as hail, but they have been observed in seven months out of the twelve; the month of greatest frequency being August. Mr. Harries is of the opinion that the breeding place of thunderstorms in these high latitudes is in the neighborhood of Barent's Sea.

UNIVERSITY AND EDUCATIONAL NEWS.

The foundation plans for a four-story building for Barnard College were submitted to the Department of Buildings by Lamb and Rich, architects. The new building will be of brick, terra cotta and Indiana limestone. It will be erected on the new site, the block bounded by 119th and 120th streets, the Boulevard and Claremont avenue. The cost of construction is estimated at $132,000.

A lectureship in comparative psychology, under a bequest of Dr. William Anderson of the value of £350 per annum, has been established in Aberdeen University. The appointment will be made at the next meeting of the University Court.

Mr. Ernest Gardiner, recently director of the British school at Athens, has been elected to the Yates chair of archæology, University College, London, which has been vacant since the death of Reginald Stuart Poole.

Prof. Sigmund Exner has been chosen Rector of the University of Vienna for the year 1896.

Dr. F. A. Werf, nowdirector of the experimental station in Java, has been appointed professor of botany in the University of Munich in the place of Prof. Rauwenhoff, who has retired.

We learn from the *Academische Rundschau* that the first University Extension courses in Russia have been opened by professors in the University of Odessa. The numbers present at those courses having the largest attendance were as follows: anatomy 350, bacteriology 340, physics 300, zoology 280, chemistry 150, botany 150, mineralogy 130. The courses extend from the first of October to the middle of December, and from the middle of January to the end of April, the fee charged for each course for the term being only three roubles (about $1.50).

On the occasion of the recent coronation of the Czar he gave 300,000 roubles (about $150,000) for the foundation of a students' dining hall in the University of Moscow.

A building devoted to physical chemistry was dedicated at Göttingen on June 4th, the address being made by the director, Prof. Nernst.

At a meeting of the convocation of the University of London, on June 23d, Mr. Rivington was elected a member of the Senate, 963 votes being given him as compared with 846 for Sir Joseph Lister. The vote is regarded as on the whole favorable to the establishment of a teaching University of London, for, though Sir Joseph Lister, who favors the plan, was defeated by a majority of 117 votes, at the election in 1895 the candidate in favor of the plan was defeated by a majority of 498 votes.

DISCUSSION AND CORRESPONDENCE.

REMARKS ON PROF. W. S. FRANKLIN'S REVIEW AND THE NOTE SIGNED 'M.'

To the Editor of Science: In Vol. III., No. 74, of this Journal, Prof. W. S. Franklin publishes a review of my papers on Solar and Terrestrial Magnetism; in Vol. III., No. 76, a note endorsing his position, signed 'M,' is to be found. In its manner and matter Prof. Franklin's article is so unusual that it had not occurred to me to be desirable to answer it till 'M.,' after apologizing for the manner, implies that the matter is deserving attention. But, in fact, the few points Prof. Franklin specifies are faulty to an unnecessary degree.

1. In determining the 26.68-day period of the solar rotation, Prof. Franklin insists (p. 808, cols. 1 and 2) that I used the 'aspects of the solar corona as photographed during several eclipses' for that purpose. It is true that in my earlier papers an attempt was made in this direction, but it was not employed in my final computation. On p. 712 Astron. and Astro-Physics, No. 118, Oct., 1893, it is said, "the results there published have been entirely superseded by the method which will now be described." There is no possible excuse for having thus confused my work, even spreading out the erroneous conception over an entire page of SCIENCE.

2. Prof. Franklin does not seem to know whether I used the ordinary Gaussian method of least squares in dealing with the residuals, but is inclined to think I did. As a matter of fact, I did not use that method, but avoided it as incapable of reaching the desired results; it having been demonstrated to be so by many previous investigations. My method is described on pp. 713, 714, A. and A. P., No. 118, and bears no resemblance to Gauss's process, uses the variations of the earth's magnetic field and not the visible coronal lines. It involved a large amount of labor in computation, and the details have not yet been published. In this instance as well, a confusion of mind, to such an extent, is inexcusable in a critic.

3. On p. 808 Prof. Franklin says: "At this place we interpose the remark that the position is regarded as proven that the sun and the moon do not continuously influence the terrestrial field by direct action as magnets?" This is an old view, held by students generally, I admit, but it was the very essence of my research to inquire whether it is sound or not. A critic may throw the entire case out of court by such a remark, and then proceed to abuse the author of the investigation, but it is not criticism and it is not science. The old view is based upon a very off-hand computation of magnets (Mascart & Joubert, Elect. & Mag., p. 417, Vol. I.), adduces no study of observations to test it, and in general lets the case go by default. Yet the experimental evidence is abundant that the sun does *in some way* send its energy to the earth, in peculiar periodic variations, aside from the ordinary light field. To go no deeper now, we know that the sun spots and corona, as well as the faculæ and prominences, vary in an eleven-year period; synchronously on the earth there are variations of the magnetic field, the aurora, the pressure, temperature, rainfall, the position of the storm tracks and the velocity of eastward movement; also there are two barometric periods, in the polar and equatorial belts, as yet entirely without explanation. How is this sympathetic condition to be accounted for except by solar action? I have given my explanation of what the nature of the energy is, and the experimental evidence is decidedly on the side of my statements.

My treatment of the magnetic observations has been entirely simple, following the lines of Bulletin No. 2, and the process is too obvious to need any defence. The result is to show that the earth is surrounded by two great systems of magnetic vectors (see *Astron. and Astro-Phys.*, No. 118, and *Amer. Journ. Science*, Vol. L., August, 1895). Both indicate that the earth acts like a conducting spherical shell, with its magnetization at right angles to one field and nearly parallel to the other field, the former therefore parallel to the plane of the ecliptic, and the latter at right angles to the same plane. In the *Meteorol. Zeitschrift*, September, 1895, Dr. W. van Bemmelen, in an interesting paper, finds that the large magnetic disturbances enter the earth along lines nearly orthogonal to the auroral ovals, and gives their relation to the magnetic meridians more in detail than I had done. His work confirms my result published two or three years earlier: 'Die Theorie und Ergebnisse *Bigelow's* scheinen aber ein sehr beachtenswerther Versuch, dieses ganze System zu erklären,' u. s. w., p. 327. The scientific character of my residuals, and my use of them are similar to those commonly employed in determining the diurnal, annual and secular variations of the terrestrial magnetic field, and if Prof. Franklin proposes to throw mine out he must needs accompany them with the entire subject of terrestrial magnetism. I have merely pursued my analysis into deeper conditions, heretofore neglected by my predecessors. After the reading of the paper referred to before the Congress of Astronomy and Astro-Physics, Chicago, 1893 (No. 118, p. 746): "in the discussion Prof. H. A. Rowland expressed his belief in a magnetic condition of the sun, and remarked that he considered its effect upon terrestrial magnetism a subject well worthy of careful investigation."

Prof. Franklin should properly have attempted to show some defect in the magnetic observations themselves or in my handling of them; also he should show that some other interpretation of them can be given than the one I have offered. A very little mathematics, all well known, has been introduced at certain passages, but nothing of the kind was employed when it could have influenced the nature of the residuals. On the other hand, having obtained the residuals, it was proper to seek the corresponding mathematical solution.

4. Our reviewer now proceeds to remark on the ether fields: "The idea that vortex motion of the ether constitutes magnetic field is, as yet, mere speculative theory intensely interesting, coming from such masters as Lord Kelvin and Clerk Maxwell; supremely foolish as coming from one who, for example, uses the word 'spiral' in speaking of it, or from one who thinks a magnetic field to be a stream of energy." While I admit my intellectual debt to Thompson and Maxwell in my study of these subjects, I must also confess that it seems to me that Heaviside and Hertz are the real masters of modern electricity and magnetism, and that their duplex-law of circuitation is the fundamental principle.

For example, Heaviside summarizes his views (Electromagnetic Theory, p. 35) as follows: "The electric current is the curl of the magnetic force. The magnetic current is the negative curl of the electric force." In a word, any change in the ether stress is accompanied by an electric and a magnetic current; p. 79, "in the case of a simple progressive plane wave disturbance, in which a distribution of electric force and magnetic induction mutually perpendicular in the plane of the wave is propagated unchanged through a medium at constant speed, it is a self-evident result that the energy of the disturbance travels with it;" page 80, "the only dynamical analogue that is satisfactory in this respect is that furnished by Sir W. Thompson's rotational ether, when interpreted in a certain manner;" p. 110, "this is the pressure exerted by solar radiation;" and much more to the same effect. The essence of this view is that whatever may be predicated of the electric system can be transformed to the magnetic system by a simple interchange of words in the notation (Hertz, Waves, p. 225); and in harmony with it an ordinary steady magnetic field surrounding a uniformly magnetized sphere is in reality a dynamic system. Certainly when the magnetization varies for any cause the effect is a propagation of energy throughout the entire system till equilibrium is regained. It is true that the mechanical analogue is lacking in the relations of electricity and magnetism. Fleming (Transformer, p. 11): "The question which yet remains unanswered is, what is that action or operation along certain lines in this medium which causes a line of force to exist? The future of electric and magnetic investigation will perhaps conduct us step by step to the solution of this supremely important problem."

Prof. Franklin continues his comment as follows, p. 809: "Now the magnetic field in light and heat waves is at right angles to the ray and is reversed *in direction* millions and millions of times per second! It is to be noticed that Prof. Bigelow considers the coronal field to be a stream of energy. If such is the case it is of course not a magnetic field, but he surely so considers it and he has also determined its C.G.S." In reply to the first case, the radiant flux of energy from the sun is W=V. EH, vector product of electric force and magnetic induction. The rapid reversal, incident upon the passage of a magnetic wave with lag of a quadrant on the electric, makes the field equivalent to a steady field when falling upon a mass whose moment of inertia, like a common magnet, gives a much slower time of swing, and will always be so to any magnets not of atomic and molecular dimensions. The electro-magnetic field at the earth has, therefore, the effect of a uniform field surrounding a conductor, and its lines are disturbed accordingly. In answer to the second case, Heaviside says, Electrical Papers I.,

p. 441: "As the rate of increase of displacement in a non-conducting dielectric is the electric current, so the rate of increase of $\frac{B}{4\pi}$ may be called the magnetic current. Then $G = \frac{\dot{B}}{4\pi} = \frac{\mu \dot{H}}{4\pi}$. Like electric displacement currents, magnetic currents are transient only, *i. e.*, they cannot continue indefinitely in one direction, like an electric conduction current. Also, like electric currents in a dielectric, they are unaccompanied by heat generation. *In ether the electric current and magnetic current are of equal significance.*" Also p. 455: "Imagine the impressed forces to be put on suddenly. We know that a certain definite distribution of magnetic induction is set up, which is steady when the arrangement of matter is fixed. During the transient state there is magnetic current everywhere unless $\mu = 0$ somewhere, which we must believe to be impossible, since μ is very little less than unity for any known substance. Magnetic currents are wholly closed." The author then goes on to treat of energy, work, mechanical forces and the entire correlated system. The sun, if magnetized at all, is not steady; during the changes magnetic currents convey the energy to all space, and if to the earth then some of this energy is consumed in the atmosphere and substance of the earth. Among other things I claim that the time order in the eastward drift formation of the North American Highs and Lows seems to be inverted by such solar action, and that these are in part products of this magnetic field. When the sun is steady it impresses a certain C.G.S. upon the earth's lines of force, which are also given in C. G. S. units. The total force observed at any moment in an observatory is the combined magnetic H. If Prof. Franklin thinks this is absurd I claim the privilege of my own view.

My position is simply this, two different sets of *force radiations* penetrate space surrounding the sun to the distance at least of the earth, because the observations of magnetic instruments yield on computation two definite systems of vectors, one from the electro-magnetic or linear field, and the other from the magnetic or curvilinear field, and their existence finds a suitable explanation on my hypothesis of two radiations. Even if my view is wrong the vector systems yet remain to be accounted for, because the theory in no wise enters into the computation that afforded them. My expressions, flow of energy, lines of force, mean so much as modern science understands of those relations, and nothing more. If the sun is non-homogeneous in its magnetization, and rotates on an axis, if the intensity varies in part or as a whole for any cause, then at the earth there will be corresponding changes in the magnetic elements, and our observations show that this is the case. If the space between the sun and the earth is a *vacuum* as to electric and magnetic forces, my words are meaningless; if it is a *plenum* then, as 'M' admits, the importance of the results is tremendous.

5. Going for a moment aside from Prof. Franklin's article, in reply also to certain objections or difficulties sometimes raised against this magnetic action of the sun, I may remark as follows: (a). *Difficulty:* the sun is so hot that it cannot be a magnet, because a steel magnet loses its force at high temperatures. *Answer:* a steel magnet is not the true analogue to the sun, because it is an induced and not a primitive magnet; a more correct analogue is the *earth itself*, which, though very hot in its interior, yet sustains a permanent magnetic field. Consequently the primitive masses of planetary matter may be magnetic and at high temperatures simultaneously. The sun is a body of the same kind and it should be magnetic. It is important not to confuse energy with heat, which is only a form of energy in molecular relations and does not exclude high temperature magnetization as a potential energy. (b). *Difficulty:* The distance of the sun is so great as to imply an excessive expenditure of energy to reach out to the earth. *Answer:* Laboratory experiments are all conducted within the atmosphere, oxygen and nitrogen, which is a powerful damper of magnetic lines. Artificial observation must therefore be faulty unless reduced to the pure medium ether, which conducts and sustains magnetic energy *without loss by heating.* The solar magnetic force at the surface of the earth as measured gives a normal intensity of mag-

netization in the sun a little more or less than a saturated steel magnet, which does not violate the probable balance of physical forces, A. and A. P., No. 118, p. 717. (c.) *Difficulty:* 'M.' remarks, "A complicated scientific hypothesis receives its confirmation from verified prediction rather than from an analysis of methods and material." *Answer:* This is true of simple or such other processes as are fully understood; many scientific problems have not reached this stage of perfection. On the other hand my 26.68-day period meets the requirement to a remarkable degree, for the ephemeris and solar curve are found to be applicable to available data between the dates 1841 and 1896, without sliding. The same phenomenon of inversion of direct and inverse types occurs throughout this interval, and the law of inversion is distinctly related to the orbital aspects of the sun's and the earth's equators, giving a semi-annual period, that is two direct and two inverse type systems each year. The same period classifies, European magnetic forces, North American pressures and temperatures, and sun spot frequencies, in an unequivocal though loosely constructed manner; it promises the solution of the semi-annual barometric period of the arctic regions, besides the elucidation of other important terrestrial phenomena. I have found the period and curve useful in forecasting the daily maps; with a suitable magnetic outfit this efficiency will probably increase. Will 'M.' indicate any other period in solar or terrestrial physics of similar power!

6. It is perhaps unnecessary to remind your readers that these papers, which Prof. Franklin condemns, were submitted to the Board of Award of the Hodgkins Prize Fund, together with the manuscript, and, although in an unfinished state, they received *honorable mention*, being one of the four American papers reaching that standard of excellence.

At the time of the late China-Japanese War, a distinguished American diplomat had occasion to exhibit a barometer to a very eminent Chinese viceroy, and to explain among other things that it was useful in foretelling the weather and was so employed in his country. The dignitary received the information quietly, but without comment. A few weeks later the same viceroy came to the diplomat in high glee and displayed a fine, new barometer just obtained from Paris. He then declared that he was under certain vows to make a long and expensive journey to the graves of his ancestors, but that fine weather was always indispensable to a propitious result. He stated that he would *start in six months*, and, to the consternation of the diplomat, demanded to know whether the weather would be favorable for the preliminaries and for his journey. After the viceroy reluctantly became aware of the true state of the matter he dashed his barometer upon the ground in vexation.

Prof. Franklin's course in his criticism appears to have been somewhat like that of the eminent official.

The research, therefore, now stands as follows: The program and methods of computation laid down in Bulletin No. 2 have been rigidly adhered to throughout the work. The details have been inspected freely by a score of scientific men, capable of pointing out an erroneous procedure. The published results represent accurately the outcome of the computation, and no elaborate publication can change them. There is no reason for anyone to doubt the value of the scientific work, or to 'suspend judgment' till the final appearance of the work. The conceptions are simple, the results are surprising and important, and will never be brushed aside by imperfect criticism.

In spite of the usual fine phrases 'dielectric polarization' and 'displacement,' electro-static and magneto-static lines of force are a mystery, and no mechanical analogue has matched them fully. Electro-magnetic radiation is fairly well understood. What I have called magnetic radiation is not so well within our comprehension. Nevertheless observation shows that the magnetic polar field exists, and the evidence is very strong that it is in some way the bearer of energy. (1) It may be that the physical condition of the solar seat of magnetization is so very unsteady as to cause the transient magnetic currents to become, by integration, a type of real radiation; (2) it may possibly be that this solar system illustrates the *missing magnetic conduction current*, needed to complete the balance in the duplex electro-magnetic system;

(3) or it may result from the variation of the static magnetic field at the earth, that other energy derived from the electro-magnetic field is more or less readily absorbed in the atmosphere than it would otherwise be. Whatever the mechanism is, there is a synchronous dependence of terrestrial elements upon the solar energy to be accounted for in the solution of the cosmical problem.

FRANK H. BIGELOW.

WASHINGTON, D. C.

SCIENTIFIC LITERATURE.

A GENERAL HAND-BOOK OF BUTTERFLIES.

A Hand-book to the Order Lepidoptera. Part I. *Butterflies.* By W. F. KIRBY. 2 Vols. London, W. H. Allen & Co. 1894, 1896. (Allen's Naturalists' Library, edited by R. Bowdler Sharpe.)

This work is a rewriting of Duncan's two volumes on British and Foreign Butterflies in the old issue of Jardine's Naturalists' Library of sixty years ago, the principal point common to the two being the sixty odd plates, the coloring of which, we regret to say, is far inferior in the present issue. A few new plates are added, and the British species are very fully illustrated, for woodcuts from Newman's work are also introduced.

The plan of the new edition is, however, very much better, for the old British and Foreign volumes are combined in one series and make a systematic presentation of the subject to which the old series did not aspire. The introduction is largely rewritten, the memoirs of Lamarck and Werner (!) omitted, and the body of the work has a continuity which is much more evident than in the old and actually forms a hand-book to our present knowledge. It is, however, too formal to be as useful as it might be, and quite too much space is given to synonomy, which in a work of this sort is quite out of place or should be reduced to its lowest possible terms. The affinities of the different groups are not made evident as they should be in a hand-book, so that it is a guide to a knowledge of names rather than to a knowledge of structure. The early stages are not neglected, but are dealt with in too general terms to make the work of any value as to them; and what might have been a seductive guide to the study of butterflies savors too strongly of the Catalogue.

Mr. Kirby has, in fact, rather missed an excellent chance; notwithstanding which he has produced a useful book for the museum and cabinet, which reflects prevalent views of the classification of butterflies and presents the whole in a systematic and orderly fashion. The first volume contains the Introduction and the Nymphalidæ, the second the remaining families, excepting the Hesperidæ, which did not appear at all in Jardine's series, and which are here relegated to a third volume, with the higher moths yet to appear. The whole series of the Lepidoptera is contemplated to occupy five volumes. The printing is very unequal and in some places execrable, though the type is good.

SAMUEL H. SCUDDER.

The University Geological Survey of Kansas. Conducted under authority of the Board of Regents of the University of Kansas. By ERASMUS HAWORTH and assistants. Vol. I., 1896. pp. xii + 320, text figures 11, plates XXXI. Topeka, Kansas.

During the last few years the State University of Kansas, under the liberal and progressive administration of Chancellor Snow, and through the zeal of its geological professors, has begun a geological survey of the State. The above work is the first volume of this survey, in which is described the stratigraphy of the Coal Measures and Permian of Kansas.

To a large extent this is pioneer work covering the eastern third of the State, and is the first accurate detailed report of the geology of this region that has ever been published. It is stated that a companion volume will describe 'the stratigraphy of the Cretaceous and the Tertiary in a similar manner.'

The men associated with Professsor Haworth as assistants for the present volume are Rev. John Bennett, Prof. E. B. Knerr and Messrs. M. Z. Kirk, George I. Adams and John G. Hall. Of the fifteen chapters composing the work, seven are credited to the assistants, one is by Prof. Haworth and Mr. Bennett, and the remaining by Prof. Haworth.

The first eight chapters are devoted to detailed descriptions of geologic sections crossing different parts of the region and have been prepared largely by the assistants. In chapter IX. Prof. Haworth gives a 'Résumé of the Stratigraphy and Correlations of the Carboniferous Formations.' This chapter of fifty pages contains an excellent account of the survey's classification of the Carboniferous system and will probably prove the most interesting to the general geologist. Prof. Haworth divides the Carboniferous system into three series, the Mississippian, Coal Measures and Permian. The Mississippian only covers about thirty square miles in the southeastern part of the State; but it contains the rich deposits of lead and zinc, and belongs in the 'Keokuk group' of Keyes' Augusta formation.

The next series is divided into the Lower Coal Measures with a thickness of 800 feet, and the Upper Coal Measures with a thickness of 1,950 feet, making the total thickness of the Coal Measures 2,750 feet. It is stated that they 'cover an area of approximately 20,000 square miles.' The names of the subdivisions of the Lower Coal Measures in ascending order are Cherokee shales, Oswego limestone, Pawnee limestone and Pleasanton shales. The Cherokee shales 'are exceedingly rich in coal, producing at the present time more than two-thirds of the whole amount mined within the State,' the well known Pittsburg and Weir City coal being in this formation. The line of division between the Lower and Upper Coal Measures is drawn at the top of the Pleasanton shales, and the basis of division is stated to be 'principally paleontologic and dependent upon the disappearance of the species of the brachiopod fossil *Chonetes mesoloba*, and upon the first appearance of different species in the Erie limestone above, but also partially dependent upon the great physical change which marks the line between the two extensive and characteristic formations, the Pleasanton shales and the Erie limestone.' The subdivisions of the Upper Coal Measures are the Erie limestone, Thayer shales, Iola limestone, Carlyle limestone, Lane shales, Garnett limestones, Lawrence shales, Oread limestone, Osage City and Burlingame shales, above which are the Wabaunsee and Cottonwood formations of Prosser. The Osage coal, which is the most important coal stratum in the Upper Coal Measures, lies at the top of the Osage City shales and is extensively mined from Osage City and Scranton to Topeka. The Cottonwood limestone, which forms the lower part of the Cottonwood formation, is a massive limestone from five to ten feet thick and is the most valuable dimension stone in the State, extending from north to south across Kansas.

In the discussion of the Permian series Prof. Haworth states that he follows the classification of Prosser, who drew the dividing line between the Upper Coal Measures and the Permian at the top of the Cottonwood formation, since in the overlying rocks the Permian species of Lamellibranchs first appear in any considerable number. The series consists of the three following formations: Neosho, Chase and Marion. This classification applies to the central part of the State, where the Permian has a thickness of 800 feet, and does not include the 'Red-beds,' of doubtful age, in the southern central part of the State.

The Chase formation contains massive limestone strata in which are thick layers of flint, alternating with shales. This alternation of hard and soft strata has produced a marked topographic feature for the region—a country broken by streams lined by steep bluffs—known as the 'Flint Hills.'

The Marion formation contains the rock salt, varying from 75 to 250 feet in thickness in the wells and mines. Large quantities of salt are produced from this deposit, Kansas ranking in 1894 as the third State in the production of salt.

Next follows an interesting chapter by Prof. Haworth on the 'Physiographic features of the Carboniferous;' while the two following chapters, by the same author, on the 'Coal Fields,' and 'Oil and Gas in Kansas' are of particular interest to the economic geologist. The oil and gas are found in the geologic formations, ranging from 'the Mississippian upward to the Lane shales,' and the area covers about 8,500 square miles in the southeastern part of the State. Prof. Haworth concludes: "It is evident that the oil and gas are more uniformly disseminated in Kansas than in any other territory yet developed in America. * * * * With our present knowledge of the case, it would seem that there is considerable encouragement for any village or city within the productive area to drill wells, expecting to obtain gas in sufficient quantity to be of great importance for domestic purposes."

'A preliminary catalogue of the Invertebrate Paleontology of the Carboniferous of Kansas,' by Mr. Bennett, based on university and survey collections, with additions from the reports of Beede and Prosser, finishes the text.

The large number of sections, 'all drawn to an exact scale,' add greatly to the clearness of the presentation of the subject. The physiographic features are well illustrated by a number of half-tones, and the final plate is a preliminary geologic map of Kansas.

Finally, it might be mentioned, that the publication of these investigations, which were conducted almost entirely by Prof. Haworth and students of the university, indicates very clearly the advanced nature of the instruction given by the Geological Department of the University of Kansas.

CHARLES S. PROSSER.

SCIENTIFIC JOURNALS.

THE JOURNAL OF COMPARATIVE NEUROLOGY, VOL. VI., NO. 2, JUNE, 1896.

The Comparative Anatomy of the Insula: By TRACY EARL CLARK. The importance of the insular region in the human brain, and in particular its supposed relation to the speech centers, have led to a thorough investigation of the morphological relations of this area in all groups of the mammals. The insula is present in the Primates, Carnivora, Proboscidia, Ungulata and Cetacea, though with great variation in size and fissuration. The insula and the claustrum may be considered as parts of the same cortical area; the claustrum may be present without the insula; both may be present or both may be absent. The primitive insula, if such exists, is a somewhat elevated area of greater or less size surrounded by a circuminsular fissure and located in the Sylvian fossa or in the fissure, if the fissure is continuous with the rhinal. The paper is illustrated by five plates.

Review of the Golgi Method: By OLIVER S. STRONG. In this paper Dr. Strong undertakes a critical review from the technical side of the method of Golgi and its subsequent modifications. The writer speaks with authority born of long and successful experience with the method. The 28 pages which constitute this instalment of the paper are devoted chiefly to a full translation of the technological portions of Golgi's original memoir.

Two author's abstracts by Prof. B. G. Wilder: *The Dorsal Sack, the Aulix and the Diencephalic Flexure* and *The Ectal Relations of the Right and Left Parietal and Paroccipital Fissures*, a brief editorial on the recent action of the American Neurological Association concerning Anatomical Nomenclature and the usual book reviews complete the number.

SOCIETIES AND ACADEMIES.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, JUNE 16, 1896.

THE following papers were presented for publication: 'On a collection of fishes obtained in Swatow, China, by Miss Adele M. Fielde,' by Cloudesley Rutter. 'On a collection of fishes made by the Rev. Jos. Seed Roberts, in Kingston, Jamaica,' by David Starr Jordan and Cloudesley Rutter.

Prof. Edw. D. Cope continued his report on the vertebrate remains from the Port Kennedy Bone Fissure. Among the Mustellidæ were five new species of the genera *Lutra*, *Mephitis*, *Osmotherium* and *Putorius*. They were represented by at least forty individuals and were described and named. Remains of the largest known tortoise from this section of the country were described as belonging to a new species of *Clemmys*. *C. insculpta* was also represented, together with a new box tortoise belonging to the genus *Loxaspis*. A close ally of the black snake, genus *Zamænus*, was also described.

JUNE 23, 1896.

REV. H. C. McCOOK, D. D., reported a series of observations of the California Trap-door Spider, *Ctenizа Californica*, made by Dr. Davidson, who had been able to determine the time required for the construction of the burrow in confinement, and other matters connected with the life history of the animal. It had taken ten hours to construct the nest with its hinged door, another spider having made a hole large enough to conceal itself in two hours. The method of digging was the same in the main as that described by the speaker for the tarantula. The young when they emerge at once build their own miniature nests, which are renewed every spring until they reach the full size. Based on his study of a Lycosid, the speaker had predicted that the enemy of the trap-door spider would be found to be a diurnal wasp. Dr. Davidson had established the fact that such is the case and that the attacking species is *Parapomphilis planatus* Fox.

Mr. H. C. Mercer made a report on his recent exploration of certain caves in Tennessee which he had been able to prosecute under the patronage of the University of Pennsylvania, mainly through the liberality of Dr. William Pepper. In Zirkel's cave, on Dumpling Creek, Jefferson county, Tennessee, crusts of breccia projected from the walls and hung from the roof. From this material the teeth of the tapir, peccary, etc., projected, while in the cave earth below were found bones, nuts, two pieces of Indian pottery and fragments of mica, probably indicating Indian cave burial. There were therefore two ages indicated: one ancient, by the breccia, and the other by the cave earth, comparatively recent. All the fossil remains belonged to the breccia and there was no association between them and the indications of human life.

Another cave, on the Tennessee river, under Lookout Mountain, Hamilton county, Tennessee, presented a floor of two layers, the black top one of three or three and a-half feet in thickness composed of Indian relics, and another of yellow earth containing a few animal remains, but no indication of human existence. *Mylodon* and *Tapirus* fragments found some time ago close to the bottom of the upper layer had probably been scraped up from the lower. Neither, therefore, did this cave present any certain data for the advancement of the date of man's antiquity. On the contrary, the evidence supported the belief that pleistocene or paleolithic man had not existed in that region.

On penetrating the forbidding entrance of Big Bone Cave, near Canly Fork River, Van Buren county, Tennessee, he had found nine hundred feet in, the bones of *Megalonyx* still bearing articular cartilages. Fragments of torches were found beneath the Sloth bones, probably buried by burrowing rats.

Prof. Edw. D. Cope commented on the fossil bones collected in the caves described by Mr. Mercer. The presence of cartilages on the *Megalonyx* bones indicated for them an age certainly not more remote than the existence of man on this continent. Other bones belonging to young individuals were larger than corresponding ones found at Port Kennedy, indicating the validity of the two species, *Megalonyx Wheatleyi* and *M. Jeffersonii.* Mr. Mercer had also collected remains of fifteen or twenty species of birds, six fishes, one batrachian, four tortoises, one rattlesnake and nineteen mammals. The special value of Mr. Mercer's careful work was commented on. The peccary is found in Zirkel's cave, although no trace of it appears in the Lookout Mountain cave. Several undescribed species were indicated.

Edw. J. Nolan,
Recording Secretary.

NEW BOOKS.

Analytic Psychology. By G. F. Stout. London, Swan, Sonnenschein & Co. New York, Macmillan & Co. 1896. Vol. i. Pp. xv+289. Vol. ii. Pp. v+306.

A System of Medicine. By many writers. Edited by Thomas Clifford Allbutt. New York and London, Macmillan & Co. Vol. i. Pp. xxxix +978. $5.00.

Der Lichtsinn augenloser Tiere. By Dr. Wilibald A. Nagel. Jena, Gustav Fischer. 1896. Pp. 120. M. 2.40.

Familiar Trees and their Leaves. By F. Schuyler Mathews. New York, D. Appleton & Co. 1896. Pp. vi+320. $1.75.

A Concise Hand-book of British Birds. By H. Kirke Swain. London, John Weldon & Co. 1895. Pp. viii+210.

Proceedings of the American Association for the Advancement of Science, 44th meeting held at Springfield, Mass., August-September, 1895. Salem, published by the Permanent Secretary. 1896. Pp. cxix+414.

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CONTENTS:

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

*THE ADVANCEMENT OF MEDICINE BY RESEARCH.**

Mr. President and Fellows of the Massachusetts Medical Society:

The recent attempt by the Society for the Prevention of Cruelty to Animals to secure legislation for the restriction of biological research in Massachusetts, and the probability that the attempt will be repeated during the next session of the Legislature, may serve as my excuse for asking you to consider the history and significance of the movement, the inevitable result of its success, as well as the moral principles which here find their application.

That the Legislature of Massachusetts should be requested to restrict the right of physicians to study their profession, and of the higher educational institutions of the State to teach the sciences on which the practice of medicine rests, is a phenomenon which surprises no one who has watched the progress of the so-called 'anti-vivisection' agitation during the last quarter of a century. At various times within this period have the efforts of misguided benevolence been directed to checking the progress of medical science by interfering with one of the most important methods by which advances can be made. Fortunately for humanity, these efforts have, in nearly all

* The annual discourse, delivered June 10, 1896, by the President before the Massachusetts Medical Society.

cases, been rendered futile by the sound common sense of the community. In England alone, of all civilized countries, has a certain amount of success crowned the efforts of fanatical agitators and, by the enactment of a restrictive law, a serious blow has been inflicted upon English physiology.

In the presence of such an agitation it is, of course, to the members of the medical profession that the community, distressed by the constant repetition of tales of imaginary atrocities, will naturally turn for the assurance that teachers of the medical sciences are not brutes and criminals, and that medical students are not young ruffians who delight in blood and suffering. It is, therefore, important that physicians should be at all times ready to explain to the laity how, as Dr. J. G. Curtis has happily expressed it, 'in the slowly woven fabric of achievement pure science and applied science, biology and medicine, have always been warp and woof.'

It requires no professional training to comprehend that a knowledge of the bodily functions in their normal state is essential for the understanding and treatment of those derangements of function which constitute disease, and that physiology, which deals with these normal functions, must, therefore, form the basis upon which medical science and medical practice alike must rest. Now nearly all the phenomena of life which form the subject matter of physiology are either physical or chemical in their character. In fact physiology must be regarded as the physics and chemistry of living bodies. Therefore, just as the physicist and the chemist build upon the basis of experiment the solid superstructure of their sciences, so the physiologist can hope to advance firmly and successfully to the discovery of the laws of life only on the condition that the same experimental method supplies the stepping stones for his progress.

Self-evident as this proposition seems to the student of nature's laws, certain persons are ready to deny the legitimacy of the experimental method of research when applied to living bodies, while they admit it to be absolutely indispensable in the case of non-living matter. The cause of this attitude of mind is not difficult to discover. In fact, it has its origin in the noblest feelings of human nature, in the sentiment that bids us be merciful as we would obtain mercy. Those who hold these views, profoundly impressed by what they conceive to be the painful nature of experiments performed on living animals, and by the alleged indifference to animal suffering shown by the experimenters, have not hesitated to bring charges of cruelty against those who are engaged in seeking to penetrate the mystery which still surrounds the actions and reactions of living organisms, and thus to lay, broad and deep, the foundations on which the medical science of the future is to be built up.

I have used the words 'misguided benevolence' in speaking of this agitation, and there is no doubt that many, though unfortunately not all, of the persons engaged in this crusade are benevolent in their disposition and conscientious in their attitude, but it should be remembered that, as Mr. Roosevelt recently remarked, "Conscience without common sense may lead to folly which is but the handmaiden of crime."

In judging of the moral and mental attitude of those who are engaged in this mischievous agitation it is important to distinguish carefully between the leaders and the followers. The former are fortunately very few in number, but by their activity and apparent ubiquity they easily create an impression of being in much larger force. Dominated by the single idea that vivisection is an 'abominable thing and hateful in the sight of God,' they presume to teach lessons of humanity to the members of a profession which exists for the relief of suffering. Unable to comprehend the reports of biological investigations published for professional readers, they recklessly denounce perfectly painless experiments as cases of fiendish torture. Deliberate and authoritative statements setting forth the necessity of animal experimentation for the advancement of medical science, the vast amount of good already accomplished and the comparatively trifling amount of the suffering involved, are treated simply as falsehoods such as might naturally be expected from the 'cowardly criminals' who practice vivisection.

This movement is, therefore, by no means to be regarded as a simple humanitarian effort to reduce to a minimum the amount of animal suffering connected with vivisection. Restrictive laws like that of England are denounced as useless, and the total abolition of the practice is imperatively demanded. That this will have the effect of seriously checking the advance of medical science some of the leaders ignorantly deny, while others contemplate this result with satisfaction, for they deny the right of the human race to profit by animal suffering, and condemn the saving of a human life by the sacrifice of that of a dog. That this is not an exaggerated statement of the position assumed by anti-vivisectionists, a single quotation from the writings of Henry Bergh will suffice to show. Mr. Bergh was for many years President of the New York Society for the Prevention of Cruelty to Animals, and was throughout his life the acknowledged leader of the anti-vivisectionists in America. In a lecture on this subject delivered in 1880 occurs the following passage: "As another proof of the profane extremes to which these dissectors of living animals will go, Robert McDonald, M. D., on being questioned, declared that he had opened the veins of a *dying person*, remember, and had injected the blood of an animal into them, many times, and had met with brilliant success. In other words, this potentate had discovered the means of thwarting the decrees of Providence, where a person was dying, and snatching away, from its Maker, a soul which He had called away from earth!" It seems to me that this blasphemous denunciation of a physician for saving a human life needs absolutely no comment.

It might naturally be supposed that such extravagances of statement would carry their own refutation, and would demand no more attention from serious people than the utterances of those medical philosophers who deny the utility of vaccination. Acting upon this supposition, and unmindful of the fact that lies travel faster than truth, biological investigators have, as a rule, not thought it necessary to contradict specifically the various misstatements which have been published with regard to their work. The result has been that certain excellent people, of emotional dispositions, and without the special training which would enable them to judge correctly of such a question, have been led to believe that so much smoke must indicate some fire. They have, therefore, by joining anti-vivisection societies, lent the weight of their names and their purses to a movement fraught with danger to the welfare of the State. That members of our own profession have occasionally expressed themselves in such a way as to encourage this agitation is to be deplored, but not wondered at, for no one listens more sympathetically to a tale of suffering than a true tender-hearted physician; and if he does not happen to be in a position to contradict from his own knowledge the heart-rending stories which are poured into his ears, he may be readily convinced of the existence of abuses requiring legislative interference.

Recognizing the true nature of the anti-vivisection agitation, it is evident that educated physicians would be false to their high calling did they not resist with all their energy the attacks of an enemy whose success would destroy all hope of establishing medicine in the position to which it is rightfully entitled, that of the most important branch of biological science.

In thus maintaining their right to study and teach their profession, physicians are not called upon to maintain that unnecessary pain has never in the history of the world been inflicted in connection with vivisection. Their true contention should be:

1. That the men in charge of the institutions where vivisections are practiced in this State are no less humane than those who desire to supervise their actions, while they are, at the same time, vastly better informed with regard to the importance of animal experimentation and the amount of suffering which it involves.

2. That no abuse of the right to vivisect has been shown to exist in these institutions.

3. That the governing bodies of these institutions possess both the will and the power to put a stop to such abuses should they arise.

4. That the existing statutes furnish sufficient protection against cruelty in vivisection as well as against cruelty in general.

5. That for the reasons above given legislation on this subject is wholly uncalled for.

These propositions define substantially the position assumed by this Society in the resolution adopted four years ago in response to a communication from the Massachusetts Society for the Prevention of Cruelty to Animals, and, with the medical profession united in their defence, no fear need be felt that our Legislature will ever yield to the pressure of fanatical agitation to the detriment of the best interests of the community.

A full account of the origin and progress of the anti-vivisection agitation would, of course, be impossible within the limits of this discourse, but it will be well to refer briefly to the history of the movement in other communities, calling attention to certain points which are full of instruction and warning for ourselves.

The first serious attack upon biological research in England seems to have been made in an essay entitled 'Vivisection, is it Necessary or Justifiable?' published in London in 1864 by George Fleming, a British army veterinary surgeon. This essay is an important one, for though characterized at the time by a reviewer in the London Atheneum as 'ignorant, fallacious, and altogether unworthy of acceptance,' its blood-curdling stories, applied to all sorts of institutions, have formed a large part of the stock in trade of subsequent anti-vivisection writers.

A fresh stimulus to the agitation was given by the publication, in 1871, of a work edited by Prof. J. Burdon Sanderson, entitled 'Handbook for the Physiological Laboratory.' This book was intended to be used by students of physiology under the guidance of their instructors, and contained a description of the experimental basis on which modern physiology rests. Unfortunately, however, it fell into the hands of excitable men and women, who were ignorant of many things which had properly been taken for granted in writing for members of the medical profession. That anæsthetics, for instance, would be used in all cases to which they are applicable, was tacitly assumed just as it would be in a work on operative surgery. In consequence of this failure to comprehend the object for which the book was written, many well meaning but too impulsive people jumped 'to the conclusion that raw medical students were being encouraged to repeat, for their pleasure, every experiment that had ever yielded results, careless whether the subjects were conscious or unconscious of pain.' This misconception tended to produce an excited state of popular feeling which was intensified by the performance, at the meeting of the British Medical Society in 1874, of some experiments on dogs, showing the difference between alcohol and absinthe in their physiological action. The excitement culminated in the appointment of a Royal Commission to inquire into the subject. The result of the investigation was a report which cannot be better described than in the language of Lord Sherbrooke (better known as the Right Honorable Robert Lowe): "The commission entirely acquitted English physiologists of the charge of cruelty. They pronounced a well-merited eulogium on the humanity of the medical profession in England. They pointed out that medical students were extremly sensitive to the infliction of pain upon animals, and that the feeling of the public at large was penetrated by the same sentiment. * * * They then proceeded to consider to what restriction they should subject the humane and excellent persons in whose favor they had so decidedly reported. They acquitted the accused and sentenced them to be under the surveillance of the police for life." Remarkable as was this conclusion of the commission, the action of Parliament based upon it was still more extraordinary, for a law was enacted which, taken in connection with the previous legislation, has brought about a state of things in England which has been well described as one "in which it is penal to use domestic animals any way cruelly, but in which any one may torture wild creatures in whatever fashion he likes, *provided it is not for scientific purposes.*"

The amount of mischief which may be produced by this English law depends very much upon the good judgment of the Home Secretary, to whom its enforcement is entrusted. The most eminent members of the medical profession in England have at times been refused a license to perform experiments which they declared to be of the greatest importance for medical science, and, in general, it may be said that the system of licensing and government inspection under which biological research work must be conducted is, under the most favorable conditions, a source of serious annoyance to investigators, while it does not secure any better guarantee for the humane treatment of animals than is afforded by the character of the man engaged in the work.

The system, moreover, fails entirely to satisfy the anti-vivisectionists, who, in support of their demand for a prohibitory law, continually circulate the most exaggerated and perverted accounts of experiments performed in licensed and inspected laboratories.

The first outbreak of the anti-vivisection agitation in this country occurred in New York some fifteen or sixteen years ago, when the State Society for the Prevention of Cruelty to Animals, under the leadership of Henry Bergh, attempted to secure the passage of a law prohibiting the practice of vivisection. The agitation was conducted with so much fanaticism, and the method of garbled quotation employed by Mr. Bergh was exposed so effectively by the late Dr. J. C. Dalton, that the Legislature not only declined to enact any restrictive laws, but maintained in full force an amendment to the general law against cruelty to animals adopted in 1867, providing that "nothing in this act contained shall be construed to prohibit or interfere with any properly conducted scientific experiments or investigations, which experiments shall be performed only under the authority of the faculty of some regularly incorporated medical college or university of the State of New York."

New York has thus set an excellent example to her sister States in protecting her men of science, in their attempts to enlarge the bounds of human knowledge, from the vexatious interference of persons who can know nothing of the importance of the work or of the amount of suffering which it involves.

In Pennsylvania, also, attempts to secure restrictive legislation have been made by the American Anti-vivisection Society, which has its headquarters in Philadelphia, but the energetic protests of the medical profession have sufficed to render these attempts abortive.

In Washington, during the present session of Congress, the efforts of the local humane societies have been so far successful that the Committee on the District of Columbia has brought before the Senate a bill providing for the licensing and restricting of vivisection, but there seems to be little reason to fear that such a bill will become a law.

In Massachusetts the State Society for the Prevention of Cruelty to Animals has, until quite recently, treated this question with moderation and good sense. While regretting the necessity for sacrificing animal life for the advancement of science, and anxious, like all right-minded people, to reduce the sufferings of such animals to a minimum, it has not seen in the existing state of things any reason for demanding additional legislation or for taking any action under laws already in force. A few years ago the President of the Society publicly called attention to the failure of the anti-vivisection agitation, both in this country and in Europe, to effect any reduction in the number of animals subjected to experiment, and maintained that the proper attitude of the Society should be one of co-operation with the best men of the medical profession in seeking to prevent any abuses from arising in connection with the practice of vivisection. To the friends of the Society who rejoice in the good work it has been able to accomplish in the community, it must be a matter for sincere regret that this wise policy has been abandoned, and that the Society now finds itself arrayed in opposition not only to the medical profession, but also to the higher educational institutions of the Commonwealth. It is, however, but just to state that this position seems to have been assumed without any formal action by the governing body of the Society.

The bill first presented by the Society to the Legislature of 1896 provided that no painful experiments upon living animals should be performed in any educational institution of the State, except under the authority of the State Board of Health, and that the Massachusetts Society for the Prevention of Cruelty to Animals might supervise all such experiments. Violations of the law were to be punished by fines which, when collected, were to be turned over to the Society.

During the hearings before the Judiciary Committee of the House this bill was twice modified, first by the omission of the section relating to the State Board of Health, and of the clause requiring the fines to be paid into the treasury of the Society, and subsequently by providing that the agents of the Society employed to supervise vivisections should be doctors of medicine. The petitioners for this legislation were, one after another, compelled to acknowledge under cross-examination, that they were unable to present any evidence of cruelty practiced in the educational institutions of Massachusetts in connection with vivisection, while the remonstrants, by a straightforward account of what actually occurs in physiological laboratories and by an exposure of exaggerations and misstatements with which anti-vivisectionist literature abounds, sought to convince the committee of the mischievous character of the agitation and of the unfortunate results which would necessarily follow the proposed legislation. Shortly after the close of the hearings the committee presented a unanimous report recommending "that the petitioners have leave to withdraw."

Having thus called your attention to a few salient points in the history of the anti-vivisection movement and indicated the methods employed by the leaders of this crusade against the work of a profession whose glory is to save, let me next ask you to consider the reasons which not only justify students of medical science in resorting to experiments upon living animals, but require them to do so as a necessary condition of any important advance.

In dealing with this question I shall make free use of a work entitled 'Physiological Cruelty, or Fact *vs.* Fancy, by Philanthropos.' This book, which appeared in 1883, contains by far the most comprehensive, logical and dispassionate discussion of the subject with which I am acquainted.

The vivisection question reduced to its simplest expression may be stated as follows: "Have we a right to give pain to animals in order to study the phenomena of life?" In answering this question we perceive at once the necessity of a clear conception of what pain really is, and in striving to obtain this conception we are struck by the fact that pain is a purely subjective phenomenon. We *know* absolutely nothing about pain, except that which we have ourselves suffered. We infer, of course, when we hear another person describe a painful sensation, that his feelings are similar in a general way to those which we imagine we ourselves should experience under like circumstances. This assumption of similarity of sensation is justified by the facts of our common human nature; but we are often struck, when listening to such descriptions, by the apparent difference between the impressions produced upon different individuals by the same external cause. A trifling surgical operation, which will not be considered worth mentioning by one individual, will, to another, be apparently the source of most acute suffering. We are thus led to suspect that, even in the circle of our own acquaintances, there must be quite a wide range of sensibility to pain. If we extend our observation over a wider field, we find reason to believe that in the human race there is a certain rough proportionality between sensibility to pain and intellectual development. A case is recorded, for instance, of a Russian serf who, while splitting logs in a forest, was caught by the thumb in the crack of a large log from which the wedge had unexpectedly flown out. He tore himself free from his painful imprisonment, as a wild animal might have done, leaving the thumb in the log, with the long tendons of the forearm still attached to it. It is doubtful if a more civilized man could have subjected himself to this operation, even with the alternative before him of an indefinite imprisonment in the forest. The cruel tortures which savages inflict upon their friends and themselves, as in the initiation rites of the Mandan warriors, seem to be best explained on the supposition that their sensibility to pain is less acute than that of civilized races.

In the case of the lower animals the evidence of a low sensibility to pain is much more conclusive. Among our domestic animals the horse and dog are commonly regarded as standing nearest to man in intelligence and sensibility, and yet nearly everyone who has had much to do with these animals will recall instances of great indifference shown by them to what would be to us severe pain. A single illustration of this insensibility may suffice. A horse whose leg was badly broken was sentenced to be shot, but during the two hours which intervened between the sentence and the execution the animal limped about to graze, dragging the fractured limb dangling behind it in a way which would have caused a human being exquisite agony. It is evident, therefore, that it is entirely impossible to draw conclusions with regard to the sensations of animals by an effort to imagine what our own would be under similar circumstances. Our common human nature, which serves as a guide, though an imperfect one, in estimating the sufferings of other human beings, fails us entirely when we have to do with animals, and we are left to draw conclusions from cries, motions and other external signs of suffering. Now these external signs are apt to be misleading, for they only prove "that something is going on which the organism repels," but do not prove that the animal is conscious of what is going on. In other words, the cries and struggles of an animal whose skin is cut or burnt belong to that class of phenomena known as 'reflex actions;' *i. e.*, they are movements having their origin in impressions made on the terminations of the nerves, and not in impulses coming from the nerve centers in the brain. They may be accompanied by consciousness, but consciousness, so far from being necessary for their production, acts rather to check and interfere with their manifestation.

We are all perfectly well aware that when the spinal cord of an animal has been divided in the cervical region, an impression made upon the nerves of the skin, either by a sharp instrument or a chemical irritant, will cause the animal to execute violent movements of a very definite character, adapted to remove the source of irritation and differing in no respect, except, perhaps in increased energy, from the movements of a perfectly uninjured animal. But in this case we know that the movements are not attended by consciousness, for by division of the spinal cord the channel by which impressions are conveyed to the nerve centers, whose activity is a necessary condition of consciousness, is entirely obliterated. The movements are, in fact, no more indicative of suffering than are the convulsive flutterings of a decapitated chicken. We can speak with great positiveness upon this point, for the testimony of hospital patients suffering from injuries to the spinal cord shows clearly that violent reflex movements of the lower limbs may occur absolutely unattended by consciousness. It is, moreover, a matter of common experience that in certain stages anæsthesia consciousness may be entirely abolished, while the activity of the lower reflex centers remains unaffected. In such cases patients may struggle and scream during an operation, but subsequently declare that they have suffered no pain.

It is evident, therefore, that great caution must be exercised in drawing conclusions with regard to the sensations of animals from the external signs of suffering which they manifest when undergoing operations, and that the 'spasm of agony' of sensational writers is in most cases much better described as a nerve-muscle reaction.

We have thus seen that for the production of a painful sensation three things are necessary:

First, the stimulation of a sensory nerve or its terminations.

Second, the transmission of the stimulus to the nerve centers whose activity is associated with consciousness.

Third, the response of these nerve centers to the stimulus thus received.

Pain may then be defined as the *consciousness of the excessive stimulation of a sensory nerve.* This definition excludes those cases in which the brain is narcotized or separated from the rest of the nervous system, so that there can be no consciousness of the stimulation of the nerve, however severe it may be, and also those cases where the stimulation of the nerve is moderate in amount and therefore gives rise to agreeable sensations. The precise point where the stimulus of a nerve ceases to be moderate and agreeable and becomes excessive and painful cannot be determined with precision, for a stimulation which is moderate for one individual will be excessive for another or for the same individual at a different time. The strong alcoholic liquor, for instance, which pleasantly titillates the throat of a drunkard, will sear the delicate mucous membrane of the child unaccustomed to its use.

Having thus arrived at a definition of pain and noted that the phenomenon in man and the lower animals is similar in kind though vastly different in degree, we recur to the original question: Have we a right, in studying the phenomena of life, to inflict upon animals whatever pain may be necessary for the attainment of our object? This leads us to consider the broader question, how far it is right that one individual should suffer for the good of another; and this again involves the still broader problem, how far the prospect of future good may compensate for present evil. A full discussion of these questions would carry us far beyond the limits of this discourse. For our present purpose it will be sufficient to note the fact that we unhesitatingly submit ourselves and subject those we love to physical suffering for the sake of future benefit which we think will outweigh the present pain. Nor is this deliberate choice of present evil for the sake of future good limited to those cases in which the evil and the good are both experienced by the same individual. The law of vicarious suffering, by which pain to one individual secures pleasure to another, is a law from whose operation we cannot escape if we would, and, however much we may at times rebel against it, a calm consideration forces us to recognize its stern beneficence. The law which bids us bear one another's burdens, and that which declares that the sins of the fathers shall be visited upon the children, tend powerfully to bind the human race together and contribute perhaps more than any other causes to the development of the moral sense. We see then that there is nothing repugnant to our moral feelings in the abstract idea that one individual should suffer for the benefit of another, and if we accept this principle, as indeed we *must*, when applied to two individuals belonging to the highest grade of sentient creatures, there is still less reason for rejecting it when the suffering individual belongs to a lower grade than the individual who is benefited, since, for the reasons already given, the suffering, in this case, bears a maller proportion to the benefits obtained than when both individuals are equally highly organized. Moreover, when the sufferings of the lower animals have, as a result, not a benefit to a single individual but an increase of human knowledge, the disproportion between the suffering and the benefit becomes practically infinite, for the suffering remains a constant quantity, while the benefit, since it accrues to the whole human race and through all time, is multiplied by an infinite factor.

Admitting, then, that there is no abstract reason why animals should not suffer for the benefit of man, it remains to be considered whether we have a 'right to constitute ourselves administrators of this law of vicarious suffering and to apply it to animals for our own interest.' The right of man to inflict pain upon the lower animals for his own benefit has never been very distinctly formulated. Our relations to the wild denizens of the forest, field and stream are very largely an inheritance from those times when our savage ancestors disputed with the lower animals for the right to exist on the face of the earth. In fact, they do not differ materially, except in degree of complication, from the relation of the lion to the lamb or the hawk to the dove.

In the words of the author of the above

mentioned work on 'Physiological Cruelty,' "It is generally admitted that we may chase and kill an animal, often necessarily with much pain, not because its life and liberty interfere with ours, but because its death will render our life more complete, perhaps in the most trivial detail. We kill them (without anæsthetics) not only that we may have food and clothing, but that the food may be varied and attractive and the clothing rich and beautiful. We subject them to painful mutilations in order to make them more manageable for service, to improve the flavor of their flesh, and even to please our whimsical fancies. We imprison them in cages and zoological gardens, to improve our knowledge of natural history, or merely to amuse ourselves by looking at them. It is abundantly clear that in all our customary dealings with animals we apply to them without scruple the law of sacrifice, and interpret it with a wide latitude in our own favor. * * * So far, the general principle of dealing with animals which is in a vague way accepted by most humane persons * * * seems to be that we may kill, inconvenience or pain them, for any benefit, convenience or pleasure to ourselves, but that the pain must be within moderate limits (of course undefined), and that it must form no element in our pleasure." Now, the point to be specially emphasized in this connection is that physiologists, in experimenting with living organisms, cause an amount of suffering utterly insignificant compared with that which animals are called upon to endure in other ways, and that the suffering thus caused is inflicted with a motive and with an expectation of benefit quite adequate to justify the infliction of a much greater amount of pain that even the most serious operations in the laboratory can be supposed to produce.

In this respect the physiologist stands, it seems to me, on higher moral ground than that occupied by most persons whose occupation leads them to sacrifice animal life. Compare, for instance, the occupation of a sportsman with that of a physiologist. It is difficult to imagine how an animal such as a deer or a rabbit can be made to endure greater physical agony than in being hunted to death by hounds. It is hard to conceive of animal suffering more entirely out of proportion to the object sought and gained by it than that produced by the average sportsman whenever he fires a charge of shot into a flock of birds, since, for every bird actually killed, several more will probably be wounded, and, escaping with broken wings, fall an easy prey to their enemies or perish from starvation. Yet we inflict this suffering, not because we need the animal for food, not because its existence interferes in any way with our own, not because we expect to derive any permanent benefit from its destruction, but simply, as the word 'sport' implies, because we are in search of amusement, and the sufferings of the animal are incidentally associated with our enjoyment of the moment. It must not be supposed that I desire to bring the charge of cruelty against sportsmen, for, of course, the fact that the animal suffers pain forms no part of the pleasure of the hunter; nor do I overlook the great benefit which the sportsman derives incidentally from his pursuit in the acquirement of health, strength and skill. I merely wish to point out, first, that, as far as the charge of cruelty is concerned, the physiologist may claim the same exemption which is accorded to the sportsman, for, so far from enjoying the sufferings of the animals on which he experiments, it is his constant object to reduce those sufferings to a minimum; and secondly, that, with regard to a justification for the infliction of pain, the advantage is on the side of the physiologist, for the desire to enlarge the bounds of human knowledge and to fix firmly the foundations of the healing art must be regarded as a higher motive than the wish to secure one's own temporary amusement, and moreover the proportion between the benefit obtained and the pain inflicted is much larger in physiological experimentation than in the vocation of the sportsman.

In this connection it is interesting to contrast the fate of the victims of science with that of similar animals living in a state of nature. In doing this we are struck by the vast amount of animal suffering which the laws of nature necessitate. The weak are inevitably the victims of the strong. The chain of destruction extends throughout the animal creation, and every link involves the death of victims under circumstances which, from a human point of view, seem those of revolting cruelty. The cat plays with the mouse, apparently enjoying its terror and distress. The butcher-bird impales its living victims on the thorns of the locust tree, thus laying up in its hideous larder a store of food often far beyond its needs. The larger carnivora tear their living prey limb from limb. In fact, the relations of animals to each other are such as to fully justify, from a moral standpoint, an indictment for cruelty against nature herself. With regard to domestic animals the case is often not much better. The vagrant cur and the prowling cat lead a life of constant terror, eking out a miserable existence amongst piles of garbage, and dying finally, when physical strength fails, from sheer starvation. Compared with misery like this the fate of the chosen victim of science may well be regarded as enviable, for once within the laboratory precincts warmth and abundant food are assured, and, though the term of life is shortened, its closing scene is often absolutely painless, and is, in any case, likely to be attended with less suffering than a so-called natural death.

With regard to physiological experiments which involve operations of a painful nature upon living animals, it is desirable for us to ascertain as accurately as possible the amount of suffering thus caused. The first important fact to be here noted is that the great boon conferred upon mankind in the discovery of anæsthetics extends its beneficent influence over the animal world as well. Just as no modern surgeon ever thinks of performing a severe surgical operation without placing the patient under the influence of ether or chloroform, so no physiologist neglects to use an anæsthetic when performing a prolonged or painful experiment, except in those rare cases in which its administration would interfere with the result of the experiment. Even on the supposition, which too many sensational writers are prone to make, that a physiologist is absolutely regardless of the amount of suffering which he causes, he will still be compelled to use an anæsthetic for his own convenience in order to suppress the cries and struggles of the animal, which would otherwise disturb the adjustment of his delicate instruments and interfere with the mental concentration essential for the proper performance of his work. This very concentration of the mind upon the work in hand prevents, of course, any active feeling of sympathy with the animal experimented upon, but the same may be said of the surgeon who, however tender-hearted he may be, never in operating allows his mind to wander from the work in which his hands are engaged. Neither the one nor the other can be charged with cruelty or inhumanity.

In this connection it may be well to allude to the question whether curare, a drug much used by physiologists, is or is not an anæsthetic. This substance is the arrow poison of certain tribes of South American Indians, and has the property of paralyzing the voluntary muscles. The earlier experiments of Claude Bernard on frogs, showing that sensory nerves are not affected by the poison, led him to the conclusion that an animal poisoned by curare preserves his sensibility to pain, but has lost the power of giving any sign of suffering. Strictly speaking, Bernard's experiments only show that the drug affects the sensory nerves and the spinal cord less readily than the motor nerves, while they throw no light on the question of the persistence of consciousness, but the fact that they succeed equally well after the removal of the cerebral lobes seems to exclude consciousness from any important participation in the phenomena. The arguments which have sometimes been used to sustain the proposition that curare increases the sensibility to pain would prove also that small doses of morphia have the same effect, whereas we know that morphia in small doses diminishes and in larger doses annihilates the sensibility to pain. Thus the weight of physiological evidence seems to be in favor of the view that curare may be to some extent an anæsthetic, though it is not employed by physiologists for that purpose. Psychological evidence pointing in the same direction may also be urged, for, on the theory promulgated and ably defended by Prof. William James, that all emotions are but the conscious recognition of the reflex actions produced by the exciting cause of the emotions, it seems evident that so much of the substratum of the feeling of pain as is dependent upon the reflex contraction of voluntary muscles must, in cases of curare poisoning, be absolutely wanting.

Of the possibly painful physiological experiments which we are now considering, it has been calculated by Prof. Yeo that 75 per cent. are rendered absolutely painless by use of anæsthetics; but it must be admitted that the giving of an anæsthetic to an animal is not the same agreeable operation that it is to a human being. The animal does not understand the reason why it is compelled to breathe a vapor which is gradually depriving it of its consciousness, and usually struggles against the administration of it, thus rendering some sort of forcible confinement necessary. The inconvenience thus occasioned to the animal is, of course, overbalanced in the case of prolonged or serious operations by the exemption from subsequent suffering. When, however, the operation is of a trifling character it is doubtless more merciful to the animal to dispense with the use of anæsthetics. For the complete understanding of this portion of the subject, it should be mentioned that a large portion of the animals thus rendered insensible for physiological purposes are killed after the experiment has been performed and before the effect of the anæsthetic has passed off. Where the object of the research is to observe the subsequent effect of the operation, it is, of course, necessary to allow the animal to recover from the anæsthetic and to endure whatever pain may be connected with the healing of its wounds. This has, however, been reduced to insignificance by the modern methods of antiseptic surgery, the discovery of which was led up to by physiological experiments, and the benefits of which are now experienced by the brute creation as well as by the human race.

Accepting Prof. Yeo's estimate that seventy-five per cent. of the possibly painful physiological experiments are rendered absolutely painless by the use of anæsthetics, it remains to be considered how much suffering attends the remaining twenty-five per cent. of these experiments; and here it is important, in all discusions of this subject, to correct a rather prevalent popular notion that a wound is painful in proportion to its depth. The fact is, however, that sensibility to pain is, in a healthy body, confined almost wholly to the surface. A consideration of the function of the sensory nerves shows us why this should be the case, for these nerves are distributed only to points where under normal circumstances they can receive stimulation, and thus serve to bring the organism into relation with the outer world. Pain, caused by excessive stimulation of a sensory nerve, is the sign that the integrity of the body is threatened by some external agency, and at this signal the body reacts consciously or unconsciously to ward off the threatened danger. Now external agencies can act upon the body only at the surface. Hence sensory nerves distributed to internal organs would have no *raison d'être*; and, in the wise economy of nature, we find, accordingly, that they do not exist. The apparent contradiction to this statement furnished by the painful sensations, *e. g.*, cramps and colics which we sometimes experience in our internal organs, are really illustrations of the same general law, for the pain in this case is the indication of some *morbid* action of an organ, and is usually the sign that rest is necessary to enable the organ to recover its normal condition. It is a matter of common experience, therefore, that the cutting of the skin is the only really painful part of even quite serious operations. As the knife divides the deeper organs no pain is felt, except indeed when a sensory nerve-trunk is divided, which operation is attended by a momentary flash of pain. Even the brain, the seat of consciousness itself, is no exception to this rule, for its substance may be cut and operated on in various ways without causing the slightest pain. It is evident, therefore, that in a large proportion of the actually painful experiments performed in physiological laboratories the pain must be of the briefest duration, since it is almost wholly confined to the preliminary incision. It must also be borne in mind that a large class of experiments consists in the introduction of drugs under the skin, an operation about as painful as vaccination or as a subcutaneous injection of morphia. Bearing these facts in mind we are well prepared to accept Prof. Yeo's estimate, that of the twenty-five per cent. of actually painful experiments, twenty per cent are about as painful as vaccination, four per cent. about as painful as the healing of a wound, and one per cent. as painful as an ordinary surgical operation performed without anæsthetics.

I have thus sought to set before you the material for forming a judgment with regard to the amount of animal suffering which the practice of experimental physiology involves. It remains for me now to speak of the value of the discoveries thus made, or, in other words, to present to you briefly the evidence of the debt owed by the practising physician of the present day to the physiologists of the past. We shall then be in a position to answer the question whether on the whole 'vivisection pays.' To enumerate all the discoveries that have been made in physiology by means of experiments on animals would be utterly impossible within the limits of this discourse, for there is hardly a single organ of the human body whose functions have not been investigated and explained in this way. It will suffice at this time to call your attention to a few of the more important physiological discoveries which form the groundwork of our knowledge of the human body and to ask you to imagine, if you can, what would be the condition of the healing art if these discoveries had never been made.

To begin with, let us consider the circulation of the blood, the discovery of which bears somewhat the same relation to medicine that that of the law of gravitation bears to physics. It is well known that the ancients believed the arteries, as their name implies, to be tubes containing air. When Galen, in the second century of our era, studied the arteries in living animals, the fact that they carry blood was, of course, apparent. The circulation of the blood was, however, far from being made out. In fact, it was not till the beginning of the seventeenth century that Harvey, gathering up the learning of the time, contributed by the great Italian teachers, Vesalius, Eustachius, Fallopius, Fabricius of Aquapenbente, and others, and making important additions of his own (as he himself says) 'by frequently looking into many and various living animals,' was finally able to promulgate the true theory of the circulation of the blood. Since the time of Harvey our knowledge of the conditions under which the blood circulates has been greatly extended, and always by means of experiments upon living animals. The pressure which the blood exerts upon the walls of the vessels in different parts of its course has been carefully measured. The fact that its white globules can pass through the vascular walls into the tissues outside has been clearly demonstrated, and forms, in fact, the basis of the modern theory of inflammation. The influence of the nervous system in controlling the size of the channels through which the blood circulates, thus regulating the nutrition of the tissues, the activity of the organs and the distribution of the heat, has been studied by a host of observers, and is, indeed, one of the most fruitful fields of modern physiological research. It is difficult to imagine what the practice of medicine would be without this knowledge, which has been wholly obtained by experiments on living animals and which is now the common property of educated physicians. It has, indeed, been very pertinently asked: "How will those earnest anti-vivisectionists, who, like Miss Cobbe, prefer to 'die sooner than profit by such foul rites,' provide themselves with a medical attendant warranted ignorant of the circulation of the blood?"

The direct benefits received from animal experimentation are, perhaps, more obvious in surgery than in the other departments of medicine. The proper mode of applying ligatures to arteries and the antiseptic treatment of wounds have reached their present stage of perfection largely through experiments on the lower animals. To give you a vivid idea of the privileges which we are now enjoying, I will ask you to listen to Ambros Paré's description of an amputation as performed in his time: "I observed my masters, whose method I intended to follow, who thought themselves singularly well appointed to stanch a flux of blood when they were furnished with various store of hot irons and caustic medicines, which they would use to the dismembered part, now one, then another, as they themselves thought meet, which thing cannot be spoken or but thought upon without great horror, much less acted. For this kind of remedy could not but bring great and tormenting pain to the patient, seeing such fresh wounds made in the quick and sound flesh are endured with exquisite sense. * * * And verily, of such as were burnt, the third part scarcely ever recovered, and that with much ado, for that combust wounds with difficulty come to cicatrization; for by this burning are caused cruel pains, whence a fever, convulsion, and ofttimes other accidents worse than these. Add hereunto that, when the eschar fell away, ofttimes a new hæmorrhage ensued, for stanching whereof they were forced to use other caustic and burning instruments. * * * Through which occasion the bones were laid bare, whence many were forced, for the remainder of their wretched life, to carry about an ulcer on that part which was dismembered; which also took away the opportunity of fitting or putting to an artificial leg or arm, instead of that which was taken off."

Let us now contrast this ghastly picture with the methods of a modern amputation. The patient is first made unconscious by the use of ether or chloroform. The blood vessels of the limbs are then emptied by means of an elastic bandage. Hardly a drop of blood is shed in the amputation itself; the divided arteries are firmly tied and the wound, treated antiseptically, heals with little or no pain. At every step in the process which has led to this brilliant result experiment has been the guide. Various technical details of the method remain still to be worked out. It is this beneficent work which anti-vivisectionists seek to abolish.

I will allude to but one other benefit conferred upon suffering humanity by scientific experiment involving the sacrifice of animal life: The therapeutic use of anti-toxine, though still in its infancy, shows by the unimpeachable records of hospital practice that the physician has now within his grasp the means of successfully treating one of our most dreaded diseases. The anxiety, almost amounting to despair, with which a physician formerly approached a serious case of diphtheria, has given place to a feeling of well grounded hope of a favorable result. Who can estimate the burden of terror and distress thus removed from the anxious watchers by the bedside, and who will dare to say that the boon has been dearly purchased by the lives of some thousands of guinea pigs?

Let us now briefly review the points over which we have already passed. We have seen, in the first place, that pain is a purely subjective phenomenon, the sensibility to which differs very much in different individuals and is in the lower animals reduced apparently much below that of the least sensitive human beings, and that, moreover, the external signs of suffering are apt to be misleading, unless the conditions under which these signs are made are well understood, a knowledge which can be acquired only by careful physiological study. We have seen, in the second place, that pain is only relatively an evil, that we submit to it ourselves and subject others to it for the sake of subsequent advantages which we consider sufficiently important. Thirdly, we we have seen that our relations to animals are such that there is no well recognized objection to our causing them very great suffering for the sake of very slight benefits to ourselves. In this matter there is, of course, great room for improvement. The practical question always is "how much suffering may we inflict on an animal for the sake of how little benefit to ourselves?" In the progress of civilization there is a constant tendency to draw the line more and more in favor of the animal, but when we remember how much opposition there was, within a few years, arrayed in this State against the passage of a law to abolish pigeon shooting we cannot flatter ourselves that we have, as yet, reached any very advanced humanitarian standpoint. It is certainly no very extravagant concession to the rights of animals to enact that they shall not be set up as living targets at a shooting match, when glass balls thrown into the air will answer the same purpose. In forming and fostering a public opinion which demands a greater consideration for the brute creation the societies for the prevention of cruelty to animals have played an important part, and their work would doubtless be still more effective were they in the habit of making more frequent applications of the results of physiological research to the problems of animal life. By the efforts of these societies and by the general growth of humane sentiments in the community, we may expect that a larger and larger prospective benefit will be demanded as a justification for the infliction of pain upon animals. To this raising of the requirements of humanity physiologists will be certain to offer no objection, provided the same rule is applied to all occupations involving pain to animals; for it is evident, I trust, from what has been said, that a standard so high as to be practically inapplicable to the daily affairs of life will still leave a wide margin for the carrying on of physiological research. A questionable practice cannot of course be justified by demonstrating that another and still less justifiable practice exists, but it may be fairly urged that, while practices are permitted which cause great suffering to animals with only incidental benefits to mankind, "it is irrational folly," to quote a writer in *Nature*, "to waste the energy of humanitarian feeling in a warfare against the only kind of pain-giving practice which is directed toward the mitigation of pain, and which has already been successful in this its object to a degree out of all proportion to the pain inflicted."

Enough has been said, I trust, to demonstrate the expediency of permitting physiological research to go on unchecked, and even of encouraging it, in every possible way, as the only legitimate basis of scientific medicine. Before leaving the subject, however, it is well to notice that, whatever restrictions be imposed on the physiologist working in his laboratory, the advancement of medicine by experiment will be certain to go on. Agitation cannot check it. Legislation cannot prevent it. Once admit, what no one thinks of disputing, that physiological phenomena are chemical or physical in their character, and the position of physiology among the experimental sciences is a matter of necessity. All that legal enactments can do is to determine to some extent who shall be the experimenters and who the victims of the experiments. Shall practicing physicians grope blindly in search of methods of treatment when chance brings disease under their observation, or shall men of science, systematically studying the nature and results of morbid processes in animals, point out to the practitioner the path to be followed to render innocuous the contagion of our most dreaded diseases? In illustration of this point, permit me to quote a few lines from Dr. John Simon's address on State Medicine: "The experiments which give us our teaching with regard to the causes of disease are of two sorts; on the one hand, we have the carefully pre-arranged and comparatively few experiments which are done by us in our pathological laboratories, and for the most part on other animals than man; on the other hand, we have the experiments which accident does for us, and, above all, the incalculably large amount of crude experiment which is popularly done by man on man under our present ordinary conditians of social life, and which gives us its results for our interpretation. * * * Let me illustrate my argument by showing you the two processes at work in indentical provinces of subject-matter. What are the classical experiments to which we chiefly refer when we think of guarding against the dangers of Asiatic cholera? On the one side there are the well-known scientific infection experiments of Prof. Thiersch, performed on a certain number of mice. On the other hand, there are the equally well-known popular experiments which during our two cholera epidemics of 1848–49 and 1853–54 were performed on a half a million of human beings, dwelling in the southern districts of London, by certain commercial companies which supplied those districts with water. Both the professor and the water companies gave us valuable experimental teaching as to the manner in which cholera is spread. * * * Now, assuming for the moment that man and brute are of exactly equal value, I would submit that, when the life of either man or brute is to be made merely instrumental to the establishment of a scientific truth, the use of the life should be economical. Let me, in that point of view, invite you to compare, or rather to contrast with one another, those two sorts of experiments from which we have to get our knowledge of the causes of diseases. The commercial experiments which illustrated the dangerousness of sewage-polluted water supplies cost many thousands of human lives; the scientific experiments which, with infinitely more exactitude, justified a presumption of dangerousness cost the lives of fourteen mice."

We see, then, that in one way or another experiment must form the basis on which medical science is to be built up. The question for us to decide is, "Shall these experiments be few, carefully planned, conclusive, economical of animal life, or shall they be numerous, accidental, vague and wasteful of human life?" I think in settling this question we may safely take for our guide the words of Him who said, "Ye are of more value than many sparrows."

H. P. BOWDITCH.

THE DECORATIVE ART OF THE INDIANS OF THE NORTH PACIFIC COAST.

IT is well known that the native tribes of the North Pacific coast of America ornament their implements with conventionalized representations of animals. The tribes of this region are divided in clans which have animal totems, and it is generally assumed that the carvings represent the totem of the owner of the implement. This view is apparently sustained by the extensive use of the totem as a crest. It is represented on 'totem poles' or heraldic columns, on the fronts of houses, on canoes, on the handles of spoons, and on a variety of objects.

It can be shown, however, that by no means all the carvings made by the natives of this region have this meaning. A collection of data made in a number of museums show that certain objects are preferably ornamented with representations of certain animals, and in many cases an intimate connection exists between the use to which the object is put and its design.

This is very evident in the case of the fish club, which is used for despatching halibut and other fish before they are hauled into the canoe. Almost all the clubs that I have seen represent the sea lion or the killer whale, the two sea animals which are most feared by the Indians, and which kill those animals that are to be killed by means of the club. The idea of giving the club the design of the sea lion or killer whale is therefore rather to give it a form appropriate to its function and perhaps secondarily to give it by means of its form great efficiency. This view is corroborated by the following incident which occurs in several tales: A person throws his fish club overboard and it swims away and kills seals and other sea animals, cuts the ice and performs other feats taking the shape of a sea lion or of a killer whale. Here also belongs the belief recorded by Alexander Mackenzie (Trans. Roy. Soc. of Canada, 1891, Sec. II., p. 51): "The Haida firmly believe, if overtaken by night at sea and reduced to sleep in their canoes, that by allowing such a club to float beside the canoe attached to a line it has the property of scaring away whales and other monsters of the deep which might otherwise harm them."

Here is another instance in which I find a close relation between the function of the object and its design. Small grease dishes have almost invariably the shape of the seal or sometimes that of the sea lion, that is, of those animals which furnish a vast amount of blubber. Grease of sea animals is considered as the sign of wealth. In many tales abundance of food is described by saying that the sea near the houses was covered with the grease of seal, sea lion and whales. Thus the form of the seal seems to symbolize affluence.

Other grease dishes and food dishes have the form of canoes, and here I believe a similar idea has given rise to the form. The canoe symbolizes that a canoe load of food is presented to the guests, and that this view is probably correct is indicated by the fact that in his speeches the host often refers to the canoe filled with food which he gives to his guests. The canoe form is often modified, and a whole series of types can be established forming the transition between canoe dishes and ordinary trays. Dishes of this sort always bear a conventionalized face at each short end, while the middle part is not decorated. This is analogous to the style of the decoration of the canoe. The design represents almost always the hawk. I am not certain what has given origin to the prevalence of this design. On the whole the decoration of the canoe is totemistic. It may be that it is only the peculiar manner in which the beak of the hawk is represented which has given rise to the prevalence of this decoration. The upper jaw of the hawk is always shown so that its point reaches the lower jaw and turns back into the mouth. When painted or carved in front view the beak is indicated by a narrow wedge-shaped strip in the middle of the face, the point of which touches the lower margin of the chin. The sharp bow and stern of a canoe with a profile of a face on each side, when represented on a level or slightly rounded surface, would assume the same shape. Therefore, it may be that originally the middle line was not the beak of the hawk, but the foreshortened bow or stern of the canoe. This decoration is so uniform that the explanation given here seems to me very probable.

On halibut hooks we find very often decorations representing the squid. The reason for selecting this motive must be looked for in the fact that the squid is used for baiting the hooks.

I am not quite certain if the decoration of armor and weapons is totemistic or symbolic. Remarkably many helmets represent the sea lion, many daggers the bear, eagle, wolf and raven, while I have not seen one that represents the killer whale, although it is one of the ornaments that are most frequently shown on totemistic designs.

I presume this phenomenon may be accounted for by a consideration of the ease with which the conventionalized forms lend themselves to decorating certain parts of implements. It is difficult to imagine how the killer whale should be represented on the handle of a dagger without impairing its usefulness. On the other hand, the long thin handles of ladles made of the horn of the big horn sheep generally terminate with the head of a raven or of a crane, the beak being the end of the handle. This form was evidently suggested by the slender tip of the horn, which is easily carved in this shape. The same seems to be true in the cases of lances or knives, the blades of which are represented as the long protruding tongues of animals, but it may be that in this case there is a complex action of a belief in the supernatural power of the tongue and in the suggestions which the decorator received from the shape of the object he desired to decorate.

To sum up, it seems that there are a great number of cases of decoration which cannot be considered totemistic, but which are either symbolic or suggested by the shape of the object to be decorated. It seems likely that totemism was the most powerful incentive in developing the art of the natives of the North Pacific coast; but the desire to decorate in certain conventional forms once established, these forms were applied in cases in which there was no reason and no intention of using the totemistic mark. The thoughts of the artist were influenced by considerations foreign to the idea of totemism. This is one of the numerous ethnological phenomena which, although apparently simple, cannot be explained psychologically from a single cause but are due to several factors.

FRANZ BOAS.

RECENT HYDROGRAPHIC EXAMINATIONS IN THE APPALACHIAN AREA.*

THE systematic study of the discharges of the streams of the United States has, with one or two exceptions, been undertaken only in recent years. The expense and time required for such investigations prohibits the private engineer from undertaking them, and they can be carried on, therefore, only by large corporations, municipal or State authorities, or by the National Government. Among the most valuable contributions to this branch of engineering have been investigations ordered by the cities of Boston and New York in connection with the study of their water supply. The Sudbury records for Boston supply data since 1875 and those of the Croton for New York since 1868. These are on relatively small basins, however, the former having a drainage area of 78 square miles and the latter 353 square miles.

The army engineers in connection with the improvement of the Connecticut river carried on systematic observations of the discharge of that river at Hartford, Conn., from 1871 to 1879, inclusive, and from that period to the present time the Holyoke Water Power Company have continued the observations. The company in charge of the water powers at Lowell and Lawrence, Mass., on the Merrimac river, have carried on measurements of discharges for over fifty years, but their engineers have published little information. The State of New Jersey, in the interest of her water powers, and the city of Philadelphia, for the future development of her water supply, commenced seven and nine years ago, respectively, the study of certain drainage basins, but they are also relatively small areas. The U. S. Geological Survey, in May, 1891, established a gauging station on the Potomac at Chain Bridge, D. C., for the measurement of the discharge of the river at that place. It was started somewhat as an experimental station, the time given to it being that which could be spared by hydrographers from office work. Gauge height observations were continued until the end of 1893, when, on account of lack of time and of funds, they were discontined.

It has for years been the desire of the hydrographers of this survey to make a thorough and detailed study of the drainage system of one large river, to measure its different tributaries, and to study the relation of their discharges to that of the entire system. An opportunity was afforded for the development of this plan in the spring of 1894, and the Potomac basin was chosen as being convenient of access and as typical of large areas along Appalachian range. Gauging stations were established as follows: First, on the North Branch at Cumberland, Md.; second, on the South Branch three miles above Springfield, W. Va.; third, at Dam No. 6, ten miles above Hancock, Md.; fourth, one on the Shenandoah at Millville, W. Va., five miles above its mouth, and fifth, one on the main river at Point of Rocks, Md. Daily observations of the height of the river at Chain Bridge were also resumed, but measurements of the discharge were not made, as it was found that this point was not a favorable location for such measurements. In high water the velocity is too great, owing to the restricted channel, and in low water the daily tides introduce errors that are hard to eliminate. Work was actively prosecuted in this basin during the past spring, and a sufficient number of gaugings were made to construct

*Read before the National Geographic Society, November 15, 1895, by F. H. Newell, U. S. Geological Survey, Washington, D. C.

rating curves for each station, by means of which the daily discharge can be computed.

In July, 1895, it was decided to expand the work of stream measurements in the South. Before doing so many factors entering into the location of gauging stations had to be considered. To more clearly understand the reasons of the location of the stations established during 1895, it may be well to give a brief summary of the physical geography of the area.

The region under consideration may be divided into four great divisions. The coastal plain, extends from the coast to what is known as the fall line, and consists of very recent geologic formations, principally sands and gravels of Cretaceous, Tertiary and Post-Tertiary deposits. This fall line is the eastern outcrop of the old Archæn crystalline rocks of the second or Piedmont division, which extends to the summits of the Blue Ridge, and it also marks the last considerable fall on the rivers that cross it. It passes through Columbus, Macon, Milledgeville and Augusta, Ga., Columbia, S. C., Rocky Mount and Weldon, N. C., then through Richmond and Fredericksburg, Va., crossing the Potomac at Great Falls. It thence extends further northeastward and is finally lost at the mouth of the Hudson river. In the northern portion this fall line determines the limit of tide waters, but in the Southern States as it recedes from the coast it is often beyond the limit of navigation. The third division of this region is the greater Appalachian valley, extending from the Blue Ridge to the crest of the Allegheny front, and the fourth division is the Allegheny plateau, gradually sloping downward and westward from this latter boundary line. The greater Appalachian valley is a depressed zone traversed by a number of parallel ridges, and it is composed of a variety of different kinds of rocks, as conglomerates, sandstones and limestones, the beds of which are tilted at various angles. In the Allegheny front and to the westward the strata are seen to be nearly parallel.

The Piedmont section is the oldest of the four divisions above noted, the rocks dating from Archæan times. The Blue Ridge, the western boundary of this section, is the coast line of an old continent, but of a continent facing westward and towards an inland sea. The greater Appalachian valley would, therefore, represent the shore deposits of such a sea, and one would naturally expect to find rocks diversified in color and composition along such a strip. Further to the westward or out into the sea should be and are found rocks of a more homogeneous character.

In establishing the gauging stations during 1894 and 1895 it has been the endeavor to distribute them as much as possible in these different types of areas. An important consideration has been that of the economic value of such stations. Wherever there has been a water-power privilege developed, and especially when there is one undeveloped on the larger rivers a gauging station has been established as near such a site as possible. In the accurate determination of the value of a water power at a certain point two things should be known: first, the fall at that place, which can be measured once and for all; and second, the variation in the discharge of the river to determine which a long series of observations are necessary.

It has been too often the practice to compute the amount of water finding its way into the rivers, by assuming a certain percentage of the rain falling on the area as drained by the river at that point. Several important factors enter into the problem of run-off, beside the rate of precipitation, these being the slope of the basin, the temperature, wind movement and the conditions of soil. Thus two adjoining basins, receiving the same amount of rain, but differing, in slope or in the nature of their soils, or both, will also differ more or less in their run-off. An examination of the Georgia streams has shown that highly deceptive results would be had if for two neighboring basins a certain percentage of rain were taken as giving the run-off.

A limiting factor in the location of gauging stations is the cost and accessibility of such stations. Nearly all of the United States Geological Survey gauging stations in the eastern United States are at railroad or highway bridges. Much of the field work of 1895 has consisted in inspections of such crossings. Where a suitable locality filling the engineering requirements was found, measurments of the discharge were made and there was established a gauge rod on which the height of the river could be read daily by a man employed for the purpose and who usually resided near the bridge.

To obtain the best results the river at a measuring station should have a regular and smooth bottom, the water should have a velocity that can be measured by current meters and the channel should be straight for some distance above and below.

It seems as though bridges had been erected at points in order that gaugings could not be made from them. Either the bridge extended diagonally across the river or it was over a pool of water with little current, as in the case of the ponding of a river by a dam, or the section of the river under the bridge was rocky and filled with obstructions.

A general reconnoissance was made in July, 1895, through Virginia and West Virginia, for the purpose of inspecting the head waters of the Shenandoah, James and New rivers. As a result two stations were established at Port Republic, Virginia, one on the South Branch and the other on the North Branch of the South Fork of the Shenandoah. These stations in connection with the one at Millville, Virginia, furnish data for the satisfactory study of this stream. On the James River stations were established on the North Fork near its mouth and on the main river at Buchanan, twenty miles above the mouth of this fork. The sum of the discharges at these two points will give the discharge of the James at Balcony Falls, the point where it breaks through the Blue Ridge and where there is a fine undeveloped water-power privilege. Passing over the divide to the head waters of the New, a tributary of the Ohio River, a station was established at Alderson, West Virginia, on the picturesque Greenbrier River, and one on the New at Fayette, West Virginia. This latter river is a torrential stream, in places widening to 2,000 feet, as at Hinton, but lower down on its course, as the surrounding mountains close in, contracting to 200 or 300 feet in width. In such places the river even in low water tumbles and foams over its rocky bottom.

By the examination of a contour map of the Appalachian region, it will be seen that the rivers draining the Appalachian valley in the northern portion, as the Susquehanna, Potomac, James and Roanoke, have a general eastward course, the divide between the Atlantic coast streams and the tributaries of the Mississippi being along the Allegheny front. Passing into North Carolina, the divide bends southeastward to the summits of the Blue Ridge. Here the Appalachian valley drainage is to the westward. After a thorough inspection of the French Broad a station was established at Asheville, North Carolina. This river is not a typical mountain stream, the valley above Asheville is comparatively broad and has little fall. The rivers to the south, as the Tuckaseegee and Little Tennessee, are more nearly typical mountain torrents, but owing to their inaccessibility it was not deemed advisable to establish stations on them during 1895.

The rivers of North Carolina flowing eastward and above the fall line have many large undeveloped water-power privileges. The Yadkin River at the Narrows, about 35 miles below Salisbury, is perhaps the finest water power in the State. The river just above the canyon is 1,000 feet wide, but as it enters the gorge it suddenly contracts to a width of 75 feet, and in some places even to 30 feet. In two miles the river falls 60 feet and in four miles about 110 feet. The nearest accessible point to the Narrows where a gauging station would be established was at the Southern Railroad crossing near Salisbury. The discharge as measured here last September was 1,450 second feet or a discharge of 0.43 cubic feet per second per square mile of area drained. The past season has been one of extreme low water, and this result is large compared to the run-off of more northern rivers. In fact, all of these sand-hill streams of the Southern States have a large low-water flow. The sandy soils of their basins acting as sponges absorb the spring rains and let the water off gradually in the summer time. A station was established in 1895 on the basin of the Catawba at Fort Mill, South Carolina, also one on the Cape Fear at Fayetteville, North Carolina, and two at Clarksville, Virginia, one on the Dan and the other on the Staunton.

A partial inspection of Georgia has been made and two stations established in the State on the two most important rivers, the Chattahoochee and the Ocmulgee. The former stream is peculiar in having a very high summer flow. The gauging on October 15, 1895, near Atlanta gave a discharge of 0.69 cubic feet per second per square mile of area drained. A comparison of this run-off with the minimum flow of some other rivers is as follows:

	Drainage Area in Square Miles.	Second Feet per Square Mile.
Sudbury, Mass.,	78	0.04
Pequannock, N. J.,	63	0.13
Ramapo, N. J.,	160	0.14
Paulinskill, N. J.,	126	0.13
Neshaming,	139	0.01
Merrimac, Mass.,	4,600	0.31
Connecticut, Conn.,	10,234	0.31
Potomac, Va.,	9,654	0.12
Shenandoah, Va.,	2,995	0.30
Yadkin, N. C.,	3,399	0.43
Catawba, S. C.,	2,987	0.45
Ocmulgee, Ga.,	2,250	0.34
Oconee, Ga.,	2,973	0.36
Chattahoochee, Ga.,	1,600	0.69

Cyrus C. Babb.

AN ASTRONOMICAL CIPHER CODE.

In the last number of the publications of the Astronomical Society of the Pacific, Prof. Holden prints a suggested improvement upon the Science Observer Cipher Code, devised by Messrs. Ritchie and Chandler, that has been in use by astronomers for the transmission of telegraphic announcement of astronomical discoveries during the past twelve years.

It will be remembered that this very important matter of prompt transmission of astronomical intelligence was effected through the Smithsonian Institution from 1873 to 1883, and in the latter year arrangements were concluded by which the service was transferred to the observatory of Harvard College, the observatory thus becoming the central station for astronomical announcements in this country. A most useful code for the accurate and economical transmission of telegrams had been devised by Ritchie and Chandler, and was subsequently improved upon from time to time, and finally issued in 1888 in the shape of the Science Observer Code Book, a quarto of some 235 pages. The bulk of this is taken up by a number code covering two hundred pages and containing forty thousand words in all. The principle adopted is that each word shall differ by at least two letters from every other word in the code, and no word of more than ten letters shall be included. The words are taken from all languages, many of them from the Spanish, and the difficulty that seems to have suggested to Prof. Holden the desirability of a change has come from the common use of the telephone in the transmission of telegraphic messages to the observatory.

The words of the despatch have to be spelled out over the telephone, and in many cases the code words are entirely meaningless to the ordinary operator. Prof. Holden suggests a condensation of the code by which the forty thousand words, occupying two hundred pages, may be covered by two octavo pages, the first consisting of five hundred prefixes, and the second of ninety-nine affixes; the prefixes each of three letters, and the ninety-nine affixes each of five letters; so that by these two tables any number of five figures less than fifty thousand can be made up of a cipher word always of eight letters. It produces, of course, pure jargon, but this is no worse than most of the words in the old code.

The idea of control words to insure the accuracy of the telegraphic transmission of important data, due to Ritchie and Chandler, is, of course, retained in the suggested modification of the code published by Prof. Holden, as well as the list of phrases of the original code.

Prof. Holden publishes as an appendix to his code the circular of the Central Bureau of astronomical telegrams of Europe, from Prof. Kreutz, of the Kiel Observatory, which has not apparently been published hitherto in America.

CURRENT NOTES ON PHYSIOGRAPHY.

ICE WORK, PAST AND PRESENT.

PROF. T. G. BONNEY, of the University College, London, contributes a work of the above title to the International Scientific Series (Appleton, 1896). Its three parts discuss existing evidence of ice work from Alpine, Arctic and Antarctic glaciers, traces of the glacial epoch, and theoretical questions. The two first parts are not clearly separated, for the ancient moraines of Switzerland are described under both. Although containing much interesting material, the work is rather disappointing in its deficiency of thoroughly scientific quality. No one could learn from the associated accounts on the Deckenschotter of the Uetliberg and the Zurich moraine that an enormous erosion interval separated the formaof the two deposits, and that the former is only a remnant of a widespread sheet of drift. After the habit of the English school, the geological structure of till is largely dwelt upon, with too brief explanation of its geographical effects. A disproportionate amount of space is given to the Parallel Roads of Glen Roy; and too much authenticity is allowed to Lake Ohio by the reproduction of Claypole's hypothetical map, without reference to the very grave doubts that have been expressed as to its verity. Some once-controverted but now-settled questions are treated in a still doubting manner that hardly represents the present status of glacial geology.

DISSECTED BASALT PLATEAUS OF NORTH-WESTERN EUROPE.

SIR A. GEIKIE, for many years a student of the ancient volcanic rocks of Scotland and neighboring countries, now presents an outline of his results. (Quart. Journ. Geol. Soc., LII., 1896, 331–405.) These are largely concerned with structural features—the lava flows, the vents, the sills and dikes, the gabbro and granophyre intrusions—but they also include matters of physiographic interest—the rivers of the volcanic period, the effects of denudation, and particularly the parallel drawn with modern volcanic action in Iceland, as illustrative of the Tertiary condition of western Scotland. Not from central vents, like Vesuvius and Etna, but from fissures, have the Icelandic lavas been chiefly poured forth; the volcanic cones there are generally low, and yet from these little monticules great floods of lava have issued, forming wide volcanic plains. Plateaus are thus built up, suffering more or less dissection as they grow, sometimes assuming the form of vast domes with gentle slopes to all sides. Great volcanic plateaus of similar structure once existed where dissected remnants now form Skye, Mull and other island outliers west of Scotland or further north in the Faroes. Correlations of this kind between regions of similar structure, but in different stages of geographical development, are particularly instructive to the study of physiography.

THE GEOGRAPHY OF SILESIA.

Prof. Joseph Partsch, of the University of Breslau, has lately prepared a volume on Silesia (Schlesien: eine Landeskunde für das deutsche Volk auf wissenschaftliche Grundlage; Breslau, Hirt, 1896. 420 p.) to which the special student of European geography may refer with much advantage. It treats, among other topics, of geological structure, evolution of the land surface, drainage, climate, plants, animals, population, and Silesia as a seat of war. The plan of the more strictly geographical chapters is similar to that followed in the same author's work on Greece jointly with Naumann; that is, each subdivision is directly described for itself, rather than in its systematic relation to other geographical areas of similar structure, but perhaps in different stages of geographical development. The chapter on the evolution of the land surface is essentially a geological history of the region; not limited to the evolution of the existing surface forms, but beginning with the fundamental gneiss. The importance of northern drift as a factor in determining surface form even so far south as to the Beskiden (Carpathians) in latitude 50° is for some reason more surprising than it should be to us, who have plentiful glacial drift in latitude 40°.

NOTES.

Boule's work on the glaciation of Auvergne, noted in Science, April 17, 1896, from his brief report in the *Comptes rendus*, is now more fully described in the *Annales de Géographie*, v., 1896, 277–296, with excellent illustrations and several maps. This article would lead the scientific tourist to many points of interest in the neighborhood of the great volcanic slopes of the Cantal.

W. F. Ganong describes a delta at the outlet of Lake Utopia, New Brunswick, formed when its outflow of clear water is reversed to inflow of muddy water at time of flood in the neighboring Magaguadavic river (Occasional papers, No. 2,* New Brunswick Nat. Hist. Soc.).

W. M. Davis.
Harvard University.

CURRENT NOTES ON ANTHROPOLOGY.

A STUDY OF THE BASQUES.

One of the memoirs published last year by the Anthropological Society of Paris was by Dr. Collignon, on the Basques. The thorough manner in which that investigator does his work is well known to all students of the ethnography of France, and the present memoir is a good example of it. He begins by referring to the obscurity which has reigned concerning both the physical type of the Basques and the affinities of their tongue. His own personal ob-

* Protest should be entered against the publication by the Council of the above-named Society of such stray leaves as this 'Occasional paper, No. 2.' There are to-day plenty of regularly established mediums of publication in which two-page essays may be issued, thus avoiding the serious difficulty of preserving and protecting loose sheets.

servations are numerous and accurate. They lend solid support to the conclusions he advances, the most interesting of which are as follows: 1. The Basques present a definite physical type not encountered elsewhere in Europe and limited to their linguistic boundaries. 2. There is sufficient evidence that they migrated into France from the Iberian peninsula since the fall of the Roman Empire, and therefore the ancient Aquitanians, Ligurians, etc., were not Basques, as has so often been maintained. 3. The general anatomical peculiarities of the Basques separate them distinctly from the Asiatic or Mongolian type, and stamp them as European. 4. Their earliest home must have been in some part of the Iberian peninsula, but there is no proof that they at any time occupied all of it. Nor is it possible to say that the Basque was the primitive speech of this people. It may have been forced upon them by some conquering tribe now disappeared.

THE TOLTECS IN FABLE AND HISTORY.

THERE are still some writers who believe in the fabulous 'Empire of the Toltecs,' the shadowy realm which in Mexican myth extended its dominion over vast areas and millions of men. The historical aspects of the question are examined anew by Dr. P. J. J. Valentini in the *Zeitschrift für Ethnologie*, No. 1, 1896.

He begins by denying the legends of the Mexican chroniclers. 'There was neither an empire, nor a nation, nor a language of the Toltecs.' He pursues his inquiry along the line principally of the Mayan traditions, and analyzes with acuteness the confused accounts they have preserved. Evidently to them, Tulan or Tula was a sort of generic term and was applied to various localities. Although usually derived from the Nahuatl, it may also be explained from Mayan radicals, with equal if not greater appropriateness. In a later and general sense he believes that it answered to the notion of town or city, as contrasted to country, and consequently of all that is civil and urbane as opposed to rustic; just as we see in these Latin terms.

The article is accompanied with a map showing the location of tribes and towns in Chiapas and vicinity, and its arguments will aid in clearing away many visionary notions about this alleged ancient people.

D. G. BRINTON.

SCIENTIFIC NOTES AND NEWS.

ASTRONOMY.

THE observatory of Yale University has published the fifth part of the first volume of its 'Transactions.' It contains the results of a heliometric triangulation of the principal stars of the cluster in Coma Berenices by Dr. F. L. Chase. The final result is a catalogue of the places of thirty-three stars for the epoch 1892.0.

IN the *Astronomical Journal* of June 29th Dr. See communicates the elements of the orbits of forty binary stars computed by himself. The table of elements is of interest because all the orbits have been obtained by a nearly uniform process. Dr. See finds that the average excentricity of the forty stars considered is 0.45, but he draws no other general conclusions as to the general characteristics of binary star orbits.

IN the *Astronomical Journal* of July 8th Dr. S. C. Chandler publishes his third catalogue of variable stars. Progress in this department of astronomical science has been so rapid of late, that it has not been possible to keep pace with new discoveries by merely issuing supplements to the former catalogue of variables. The following paragraph of Dr. Chandler's introduction to his catalogue is not without interest. Dr. Chandler says:

"Very few stars within reach of the astronomers of the northern hemisphere, who have so actively devoted their energies to this class of work, have been seriously neglected. It is especially interesting to note the fact that this harmonious development has been obtained without any concerted scheme of 'cooperation,' but by the free will and independently planned efforts of individual volunteers, each discriminatingly directing his work in accordance with his means and situation. Such a satisfactory result could hardly have been reached so effectively by a formal organization of work, directed from headquarters prescribing and circumscribing the operations of each participant, and destroying, by its benumbing influence, the enthusiasm which springs from the individual initiative of the observers themselves."

We are inclined to ascribe this paragraph to Dr. Chandler's modesty, for there can be no doubt that the satisfactory progress of variable star astronomy in the United States has been the result of just such cooperation as Dr. Chandler mentions. And the supervision of the whole work has been largely in his own hands. We do not think he has had a 'benumbing influence' on the observers. Variable star astronomy furnishes a conspicuous example of the benefits to be derived from intelligent cooperation, acting with the advice or informal direction of a competent central authority.

Prof. Helmert, director of the Central Bureau of the International Geodetic Commission, has issued a circular concerning the proposed operations for the more complete study of the variation of terrestrial latitudes. It will be remembered that the International Commission has had under consideration a project for the establishment of four latitude stations on the same parallel of latitude, but distributed in longitude as nearly as possible equally around the earth. No definitive decision has been reached in the matter, but the present circular is accompanied with a carefully prepared paper by Prof. Albrecht, dealing with the question of the best possible selection of stations for the proposed work. It appears from Prof. Albrecht's paper that the best results will be secured if two of the stations are located in the United States, one in Japan and the other in or near the island of Sicily. H. J.

THE DAVY-FARADAY RESEARCH LABORATORY.

In the issue of *Nature* of July 2d will be found an account of the laboratory for research in physics and chemistry presented to the Royal Institution by Dr. Ludwig Mond. Dr. Mond formally transferred to the managers of the Royal Institution, on June 12th, a building adjoining the Institution which has been arranged and equipped with the necessary apparatus for the most exact investigation.

The Laboratory contains on the basement a room for thermochemical research; a room for pyrochemical research; mechanics' workshop; room for electrical work; battery of twenty-six accumulators; constant temperature vaults; boiler-house and store-rooms. On the ground floor, a room for research in organic chemistry; a room for research in inorganic chemistry; a fire-proof room for experiments in sealed tubes; a balance room; entrance hall and cloak room. On the first floor, the Honorary Secretary's room; a large double library connected with the library of the Royal Institution. On the second floor, a museum of apparatus. On the third floor, seven rooms for research in physical chemistry. On the fourth floor, a room for inorganic preparations; a room for organic preparations; a photographic room; four rooms for researches in physical chemistry. On the roof, an asphalted flat with a table, gas and water.

Dr. Mond has not only furnished the laboratory with the most modern instruments and appliances for research in pure and physical chemistry, but he has also placed in the hands of the managers of the Royal Institution an ample annual endowment, so that the laboratory may be maintained in a state of thorough efficiency, the object of the donor being to give every assistance and encouragement within the limits of the endowment to scientific workers. The laboratory (the affairs of which will be managed by a laboratory committee appointed by the managers of the institution) will be under the control of two directors, who will be aided in the work by competent assistants. The managers of the Royal Institution have appointed as directors Lord Rayleigh and Prof. Dewar. It is intended to open the laboratory for work by the middle of October. The trust deed provides that no person shall be admitted to the laboratory as a worker who has not already done original scientific work, or in the alternative, who is not, in the opinion of the laboratory committee, fully qualified to undertake original scientific research in pure or physical chemistry; and that no person shall be excluded from admission by reason of his or her nationality or sex.

NERVOUS DISEASES AND MODERN LIFE.

THE *Century Magazine* for May contains an article by Dr. Philip Coombe Knapp, in which he claims that there is no definite scientific basis for the common assumption that nervous diseases are increasing and that they are more prevalent in America than elsewhere. The fact that relatively more people are in asylums for the insane than formerly is probably simply because a larger proportion of the insane are now cared for in asylums and the better methods keep them alive longer. The increase in deaths due to diseases of the brain is not so great as the increase in deaths from heart and kidney diseases. The relative increase of deaths from all these diseases is the corollary from the decrease in deaths from preventable causes—infection, filth, bad habits and the like.

The *a priori* argument that the conditions of modern life predispose to nervous disease is not very convincing to those familiar with the state of things in the past, when life, family and fortune were often in daily jeopardy. The energy and restlessness of the typical American may betray a lack of culture and refinement but it does not show physical degeneracy. The mean is dependent on the extremes and we find Americans the best athletes, whereas when we wish to see the most interesting cases of hysteric and nervous diseases we must go to Paris or Vienna. We might expect to find, and do find, in America good physical and mental traits, due to their origin from energetic emigrants and the admixture of races. As Dr. Knapp writes: "We should not then chatter glibly about the increased nervousness of our age, due to the greater demand which the conditions of modern life make upon the human brain. It is not a matter to be settled by a few phrases or by tables of very general and questionable statistics. We are by no means certain that there is any increased nervousness, and even if it do exist we do not know whether it is due to these greater demands or to injury or infection. It is also doubtful whether the conditions of modern life make as great demands upon the brain as did the conditions of life in the past. Finally, without more evidence in its favor, we must regard the belief in the greater nervousness of Americans as an error."

GENERAL.

WE venture to call attention in this place to the advertisment of the publishers on page iii., asking for back numbers of this JOURNAL. It is a matter for congratulation that more copies have been sold than had been expected by the publishers, and it is a matter of editorial interest that subscribers who wish to complete their sets for binding should be able to secure the lacking numbers.

THE death is reported, by cablegram, of Dr. August Kekulé, professor of chemistry in the University of Bonn.

WE have already called attention to the seventy-ninth meeting of the Swiss Society of Naturalists, which meets at Zurich from the 2d to the 5th of August. Lectures have been arranged for the general meetings as follows: Prof. Kölliker on the 'Arrangement of the Microscopic Elements in the Cortex of the Brain;' Prof. Bamburger on 'Chemical Energy;' Prof. Henri Dufour on the 'Study of Solar Radiation in Switzerland;' Prof. Shröter on the 'Flora of Lakes.' Special papers will be read before fifteen different sections.

THE Imperial University of Kasan (Russia) announces the Lobatchefsky prize of 500 roubles to be awarded every three years for works on Geometry, 'those on non-Euclidian to have the preference.' Works in competition must be sent in before October 22, 1896 (old style). The prize will be adjudged October 22, 1897.

THERE will be held during the month of September a meeting of Austrian chemists who have had an academic education, in order to consider the formation of a society for the consideration of subjects that concern technical chemistry.

IT has been proposed, according to *Nature*, that some token of esteem be presented to Prof. N. Story-Maskelyne in recognition of his distinguished services to mineralogical science, and to commemorate his long connection with the University of Oxford. The presentation is intended to take the form, if possible, of a portrait, and it is believed that contributions not exceeding £2 in amount will be sufficient for the purpose. A number of men of science, both at home and on the continent, have already promised their support. Contributions will be received by Prof. A. H. Green, F, R. S., or Prof. H. A. Miers, F. R. S., University Museum, Oxford.

THE New York *Evening Post* states that the well-known German anthropologist, Adolf Bastian, who has nearly reached his seventieth year, has gone on an exploration trip to the interior of China.

THE arrangements made by the local committee for the Liverpool meeting of the British Association ensure much pleasure for those able to attend. University College, St. George's Hall and the Public Museum offer excellent and convenient rooms for the meetings, and there are many places of scientific interest in Liverpool and its neighborhood which will be included in the excursions. Longer excursions will be made at the close of the meeting to the Isle of Man, to the English Lakes and to the Vyrury Water Works in Wales. Receptions will be given by the local committee and by Lord Derby, the Lord Mayor of Liverpool. Parties will be entertained by Mr. Gladstone at Hawarden, by the Duke of Westminster at Eaton Hall and by the Earl of Derby at Knowsley. Liverpool is unusually convenient for American men of science, who are always entertained with courtesy.

THE fiftieth anniversary number of the *Scientific American*, to be published this week, will be enlarged to about four times its usual size, and will contain, in addition to the prize essay 'On the progress of invention during the past fifty years,' a number of special articles and reviews of the progress of science and invention during the past fifty years; some of the principal subjects to be treated being the transatlantic steamship, naval and coast defense, railroads and bridges, the sewing machine, physics and chemistry, electrical engineering, progress of printing, the locomotive, iron and steel, phonograph, photography, telegraph, telephone, telescopes, the bicycle and the history of the *Scientific American*.

SIR ARCHIBALD GEIKIE, who, as we have already stated, will give before the Johns Hopkins University the first course of lectures under the George Huntington Williams Memorial, will begin the course in the latter part of April, 1897.

THE Department of Natural Science Teaching of the National Educational Association elected the following officers: President, Chas. Skeele Palmer Boulder, Colorado; Vice-President, Albert H. Tuttle, Charlottesville, Va.; Secretary, Irwin Leviston, Omaha, Neb.

MR. WILLIAM A. INGRAM, Secretary of the Board of Commissioners, has compiled a list of the publications of the Pennsylvania Geological Survey from 1874 to 1895, to which is added an index of the more important subjects treated in the volumes.

The British Medical Journal states that the exhibits in medicine and hygiene at the Berlin Industrial Exhibition are of special interest. As an example of these may be given the municipality building, which contains complete drainage ground plans of Berlin and the suburbs, plans and models of the pumping station, their machinery, etc., models of a warehouse and a dwelling house with complete drainage arrangements. A small fountain is fed by clear and innocuous water from the sewage farms, and near it are specimens of plants and cereals and vegetables grown on, and even otto of roses obtained from the sewage farms. Here too are the plans and drawings of the different Berlin water works; the pipe systems by which the houses are supplied; drawings, models and plans of municipal asylums and hospitals, of the municipal disinfecting institute, of the heating and ventilating apparatus in the municipal schools of the public bathing establishments, etc.

MR. F. W. EDRIDGE GREEN writes that it is proposed to form, in Great Britain, a society for the purpose of making researches in color blindness, instituting proper tests and preventing color-blind and defective-sighted men from acting in capacities in the marine and railway services for which they are physically unfitted.

He will be glad to hear from those who are interested in the subject and are willing to join the society. The subscription will be 5s. per annum.

Nature states that Mr. J. H. Maiden has been appointed Government Botantist and Director of the Botanic Gardens at Sydney, in succession to Mr. Charles Moore, who has recently retired, after a service, in these capacities, of nearly half a century.

ADVICES have been received from Tromsoe, Norway, that Arnold Pike's steamer, Victoria, has arrived there after having visited the aeronaut, Herr Andrée, at Dane's Island. The erection of a balloon house had been begun, and Herr Andrée expected to be ready to start on his voyage toward the north pole early in July. Before starting, however, it was the intention of the aeronaut to test his balloon thoroughly by sending it up attached by ropes and by telephone to the steamer Virgo, which vessel conveyed Herr Andrée and his companions and their outfit to Spitzbergen. On the way back from Spitzbergen the steamer Victoria called at Advent Bay on June 29th, where it was learned that the members of the Martin-Conway party and of the Swedish Geer-Knorring expedition were well. At that time Advent Bay was full of ice. Despatches from Irkutsk announce that M. Hansen, the Norwegian trader, left that town on June 1st for the north of Siberia. His journey is primarily for trading purposes, but he will also inquire into the truth of the recent rumors regarding Dr. Nansen, and see if the store of provisions left by Baron Toll in the New Siberian Islands for Dr. Nansen is still intact. M. Hansen's mission had been confided to him by the Russian Imperial Geographical Society.

AFTER having published some fifty volumes in the series of 'Classics for Children,' it is time that Ginn & Co. should include a scientific selection. They have done well in choosing Gilbert White's *Natural History of Selbourne* and in securing an introduction from Prof. E. S. Morse. It would not be possible to place a better book in the hands of a boy of fourteen. Observers of nature, such as White, Thoreau and Audubon, seem to be lacking at the present time. Biology has perhaps become so extended and complex that the amateur is discouraged, but, as has recently been suggested by correspondents of *Nature*, boys do not now take an interest in nature, and there is no large class from which naturalists may be supplied. The growth of cities, the preponderating interest in athletic sports, and the study of biology in the laboratory, have lead the schoolboy away from contact with nature. As Prof. Morse remarks, collecting still goes on, but stamps are a poor substitute for birds' eggs, butterflies, shells and the like. Under these conditions nothing could be more useful than a copy of *The Natural History of Selbourne* in every school and in every home.

A LARGE meteor is reported to have fallen in the small mining town of Santos Reis, Chihuahua, Mex. It made its descent at noon and was accompanied by a report louder than that made by a cannon. It struck the house of a miner and demolished the building, killing two children, and then buried itself in the ground to a great depth. The stone will be sent to the National Museum in the City of Mexico.

M. GABRIEL COLIN, formerly professor of physiology in the Veterinary School of Alfort, has died at the age of 71.

IN *The Journal of Mental Science* for July, Mr. John Turner gives some statistics dealing with hereditary insanity, based on 1,039 cases in the Essex County Asylum. It appears that daughters suffer most from insanity in the parents, but that insanity in the father is more likely to be hereditary. Thus 106 insane fathers had 117 sons and 138 daughters who were insane, and 236 insane mothers had 113 sons and 182 daughters who were insane. The statistics support Darwin's law of heredity, adult paternal characteristics being more liable to be transmitted to male offspring, and adult female characteristics to female offspring.

THE annual chart prepared by Mr. David T. Day, Chief of the Division of Mineral Resources, shows that the products of the United States for the year of 1895 were in nearly all cases in excess of those of the preceding year. The value of the products in 1894 was, however, less than in any year since 1887. The total value of the metallic products in 1895 was $270,453,979 and of non-metallic products $340,341,311. No tin was mined in 1895. The quantity of petroleum produced has remained nearly constant since 1892, but it appears that its value (?) has more than doubled.

The U. S. Geological Survey has just issued a number of important bulletins, of which we hope to give later some account. These bulletins are as follows: No. 123, A dictionary of geographic positions, Henry Gannett, pp. 183. No. 124, Revision of the American fossil cockroaches with descriptions of new forms, H. S. Scudder, pp. 176. No. 125, The constitution of the silicates, pp. 109. No. 126, A mineralogical lexicon of Franklin, Hampshire and Hampden Counties, Mass., B. K. Emerson, pp. 180. No. 128, The Bear River formation and its characteristic fauna, Charles A. White, pp. 108. No. 129, Earthquakes in California, Charles D. Perrine, pp. 23. No. 131, Report of progress of the division of hydrography for the calendar years 1893 and 1894, pp. 126. No. 132, The disseminated lead ores of southeastern Missouri, Arthur Winslow, pp. 30. No. 133, Contributions to the Cretaceous paleontology of the Pacific coast; The fauna of the Knoxville beds, T. W. Stanton, pp. 132. No. 134, The Cambrian rocks of Pennsylvania, Charles D. Walcott, pp, 46.

The Division of the Biological Survey of the Department of Agriculture has sent out a circular signed by Mr. T. S. Palmer, recommending that 'Bird Day' be observed in the schools. 'Arbor Day' has proved successful in arousing interest in the planting and preservation of trees, and it is urged that Bird Day would diffuse knowledge concerning our native birds and arouse a more general interest in bird protection. It is suggested that if it is deemed unwise to establish another holiday, or if it seem too much to devote one day in the year to a study of birds, the exercises of Bird Day might be combined with those of Arbor Day.

The experiments on the visibility of the Röntgen rays by Dr. Gustav Brandes, briefly noticed in this Journal, seem, according to the account in the *Sitzungsberichte der Berlin Akademie*, to have been carried out with much care and to demonstrate that the rays call up a definite sensation of light. Dr. Brandes thinks it probable that the rays do not immediately effect the retinal cells, but probably cause fluorescence of the pigment.

It is further reported from Berlin that Prof. Grunmach has been able to use the X-rays to determine calcifications resulting from pulmonary consumption. MM. Lortet and Genoud have reported to the Paris Academy that tuberculosis induced experimentally has been attenuated by exposure to the X-rays.

After a very complete and painstaking investigation of the morphological characteristics of a series of double sulfates containing potassium, rubidium and cesium, Alfred E. Tutton, of Oxford, reaches the conclusion that there is no chemical union between the molecular constituents of double salts, but that there is merely aggregation in accordance with such a particular type of homogeneous structure as ensures that the constituents are always present in the same proportion.

During the year 1895 there were published in France 10,115 new books, of which 153 were in philosophy; 473 in political and social sciences; 1,141 in medicine; 267 in geography and anthropology; 76 in mathematics and 251 in natural science.

Garden and Forest states that the United States Consul at Havre, France, recently sent home some samples of new textile fabrics which were exhibited at the State Department in Washington. They were woven from the fibres of peat, which, as they proved, can be bleached to whiteness and will then take any dye. These fabrics are said to be especially advantageous from the fact that they have antiseptic qualities which will prevent them from harboring disease germs.

The Hawaiian Congress recently passed an act by which every taxpayer in the island was compelled to register himself at the tax office, and, in addition to the usual entries according to the Bertillon system of identification, to leave in the registrar's book the imprint of his right thumb, in accordance with the recommendations of Mr. Francis Galton. The method of identification was, however, regarded by many as an indignity fit only for criminals, and the law has been repealed.

UNIVERSITY AND EDUCATIONAL NEWS.

The Archæological Museum of the University of Pennsylvania has received a gift of $10,000 from Mr. B. N. Farren.

A fire occurred last week in the Boylston Chemical Laboratory of Harvard University. No series damage was done to the building, but as the fire occurred in the storage room through self combustion of chemicals its cause should be carefully investigated in order that similar accidents may be avoided.

The nineteenth session of the Martha's Vineyard Summer Institute was opened on July 13th, with an attendance of nearly 800 teachers and other pupils.

At a meeting of the executive committee of the board of trustees of Cornell University in Ithaca, on June 15th, the chair of the principles and practice of veterinary surgery, zootomy, obstetrics and jurisprudence in the New York State Veterinary College was filled by the election of Walter Williams, D. V. S., professor of veterinary science and physiology in the Montana College of Agriculture and Mechanic Arts, and veterinarian to the Montana Agricultural Experiment Station.

Dr. v. Buchka, professor of chemistry at the University of Halle, has resigned to take a position in the Imperial Patent Office. Dr. Karl Müller has been appointed professor of botany in the Technical High School, Berlin. Dr. J. v. Gerlach, professor of anatomy in the University of Erlangen, and Dr. Carl Claus, professor of zoology in the University of Vienna, have retired.

It is stated that the total number of students on the books of the 21 Italian universities in 1895–96 is 21,161, showing a slight increase as compared with the previous year. Adding to these the students, male and female, of the institutes of higher education, a total of 23,962 is reached. Of these 6,786 are students of medicine. The most frequented university is that of Naples, which has 4,956 students, Turin coming next with 2,434; then come Rome with 1,911, Padua with 1,664, Bologna with 1,375, Pavia with 1,345, Palermo with 1,343, Genoa with 1,089, Pisa with 1,066, Catania with 890, and Messina with 551. All the others have fewer than 500, those of Urbino and Ferrara having fewer than 100.

DISCUSSION AND CORRESPONDENCE.

AN INHERITED BLUNDER.

It has been interesting to me for a number of years to notice how easily a blunder may be paraded and handed on from book to book in high honor, when a single careful thought would prove to any scientific person its absurdity.

The special case in mind is the conventional iceberg, as pictured in our school geographies and higher scientific texts. The first geography I ever saw had this physical monstrosity in it, and it is the common property of such texts up to date.

When we stop to think that an iceberg is merely a floating piece of ice, free to move in the mobile liquid water, we shall see at a glance that to be in stable equilibrium, the shortest dimension must be vertical. But notice the berg as shown in the conventional picture,

partly in diagram, as if seen through the water from the side. A berg as large as shown in some of these amusing cuts could not be kept in position by a whole fleet of great ships with grappling hooks and cables.

It is true that in some cases the artist has fitted blocks of stone into the ice near the bottom. But this has been done, very probably, to show the ice as an agent in transportation, and not in any case has he put ballast enough there to hold the berg down.

Here are some recent geography texts perpetuating this blunder. Appleton's Physical, p. 85, 1887; Butler's Physical, p. 79, 1887;

Frye's Complete, p. 9, 1895; Potter's Advanced, p. 12, 1891; Monteith's New Physical, p. 78, and Tarr's Physical, p. 316, 1896. In the last case it has ceased being a picture and has become wholly a diagram. But Prof. Tarr could tell a better fact and save two square inches of space by drawing a proper 'diagram.'

But the school texts have no monopoly on this comical berg. In the 'Story of Our Planet,' by T. G. Bonney, 1893, there are three of them, not so unstable as the others, but still ready to 'flop.' And in 'Man and the Glacial Period,' by G. Frederick Wright, p. 18, 1892, and by the same author, the more pretentious work, 'The Ice Age in North America,' 1889, p. 107, this physical impossibility is held in high esteem. In the latter work the author is not content to leave it in the text, but it glares at you in gilt from the back of the book, every time you pass it in its place on the shelf.

It is truly a relief after looking through this list to pick up A. Geikie's Text-book of Geology, and J. Geikie's 'Great Ice Age,' and find real rational icebergs.

J. Paul Goode.

SCIENTIFIC LITERATURE.

The Royal Natural History: Mammals. By Richard Lydekker. London and New York, Frederick Warne & Co. New York. 1893–95.

The mammal part of Lydekker's Royal Natural History is now completed, and most of the bird parts are out also.

The attempt of the author and publisher to produce a popular 'Natural History,' entertaining to the general reader and at the same time scientifically accurate, has met with more than the usual measure of success. The work is handsomely gotten up and profusely illustrated.

It was hoped that some of the errors and omissions of the original edition would be corrected in the American reprint, but no changes whatever have been made. In fact, there is in reality only one edition for both issues are printed from the same type and on the same paper. The only difference is in the outside covers, which in the American issue bear later dates. This should be borne in mind in quoting the work, as it is important to give the correct date. The last part came out in England before the middle of last year (1895).

The mammal part covers about 1,500 pages, royal octavo size, and, in spite of numerous inaccuracies, affords the naturalist, student and sportsman the best and most reliable general account yet published of the highest class of the animal kingdom. Since the English edition was reviewed at some length in this journal (Science, April 5, 1895, pp. 387–389, and July 5, 1895, pp. 18–21) it is unnecessary to say anything further about the American issue. If the publishers would get out an American supplement, bringing the matter down to date from the American standpoint, the work would long remain a standard of reference on the Mammalia.

C. H. M.

THE PALPI OF BUTTERFLIES.

Ueber die Palpen der Rhopaloceren. Ein Beitrag zur Erkenntnis des verwandtschaftlichen Beziehungen unter der Tagfaltern. Von Enzio Reuter. Acta Soc. Scient. Fennicæ. T. xxii. No. 1. Helsingfors, 1896, 4°.

In this work, one of the most important recent contributions to our knowledge of the structure and classification of butterflies, the author expands fully the discovery announced by him a few years ago of an area of peculiar character on the inner side of the basal joint of the palpi of these insects, varying greatly in extent and nature in different groups and affording, as he believes, perhaps too confidently, an important test of relationship. That he has not reached his conclusions on any cursory study or meagre material will be evident from this volume of nearly six hundred pages, its accompanying plates, and the statement that he has examined 3,557 palpi of 670 species belonging to 302 genera, appertaining to all the principal groups except the Hesperidæ, which he neglects.

The structure and clothing of the palpi are given in detail for each genus, with a specification of the species examined and the number of individuals of each. The characteristics of the scaleless region called the *basalfleck* are a rippled, pitted surface, covered with conical dermal appendages, and the variations in their extent and character are brought out by this study, which occupies the first part of the work, entitled *Untersuchungen.* The second and larger part, termed *Schlussfolgerungen*, is devoted to an application of this study to the classification of butterflies, group by group in great detail, in which is included a consideration of other parts of the structure and notably of the neuration of the wings in the perfect insect, but very little of the early stages, even where, as not infrequently, these would have given support to the special position maintained.

Reuter separates the Hesperidæ as a distinct suborder from the other butterflies, which last he divides into six gentes, in ascending order as follows: Papiliones (with the families Papilionidæ and Pierididæ), Lycaenæ (with the families Lycaenidæ and Erycinidæ), Libytheæ, Danaidæ, Satyri and Nymphales (each with a single family). His subfamilies are eighteen in number, his next subdivision called stirpes scarcely more numerous, while the tribes number sixty. A genealogical tree, far more detailed than any yet attempted, explains pictorially his views of the phylogeny of the group, that is, the precise origin and partings of each of these gentes, families, subfamilies, stirpes, tribes, and even in a few cases groups of genera. The union of the Grypocěra (Hesperidæ) and Rhopalocera is not shown, but the six gentes are all made to diverge simultaneously from the rhopaloceran trunk. It is a scholarly investigation and we commend it heartily to all naturalists.

A Dictionary of the Names of Minerals including their History and Etymology. By ALBERT HUNTINGTON CHESTER, E. M., Ph. D., Sc. D. New York, John Wiley & Sons.

It is significant of an implanted tendency towards system, or else it is the evidence of an essentially vital relation to external nature, that men crave names for objects. The child ministering to its first curiosities, as it meets new things asks for a name, and afterwards for an explanation of the creature or machine or specimen which it sees. The amateur collector feels a new sense of possession when he labels his miscellaneous cabinet of rocks and minerals and shells, and the delight with which he welcomes an addition to his stock of treasures takes on a keener sense when he can give a name to the late arrivals. A name circumscribes and delineates an object, and makes it more self-existent, as it were, feeding in us the premonition of a further inquiry as to its exact nature. To apply a speculation developed in Prof. Lloyd Morgan's 'Comparative Psychology,' names render objects 'focal' in consciousness, rather than 'marginal' and bring the roving eye of observation intently upon their outlines and characteristics.

The history of the nomenclature of science is full of entertainment and instruction; it is its structural history, the story of its growth, for it reflects in every stage of its development, the changing and widening knowledge, which, like an increasing stream, spreads with curving accessions over broader and broader tracts, and leaves, in names, the beach lines of its various extensions and deflections.

Names in mineralogy might be collectively grouped into four periods, that of the ancients from Theophrastus to Pliny, that of mediæval charlatanism and the alchemists, from Marbodeus to Albertus Magnus and Robert Boyle, the formative period from Steno to Werner, Haüy, Brewster, Romé de Lisle, etc., until 1820 or 1840, and the modern period. To trace the analogues, replacements, dislocations and corrections of names over this long stretch of years, intermitttently marked by activity in separate centers or individuals, until we reach the zonal glow of enthusiasm in mineralogy as a science, with the erection of a rational chemical philosophy, would form a treatise of great value. Prof. Chester possessed of great erudition in the archæology of mineral terminology, and ardent in his devotion to a science in which he has won distinction, might be fitly selected for such an exhaustive research. The present work over his name might be regarded as a preliminary contribution to such a study. This work encloses between its covers four thousand six hundred and twenty-seven names, arranged in alphabetical order, with usually a brief paragraph of explanation assigned to each, except where a name is a misprint, variant or synonym.

Prof. Chester has accomplished in the preparation of this dictionary a very useful work, and has undertaken a great amount of discriminating toil. That 'dead work' which Prof. Leslie so vigorously declared was one of the most essential tasks of the laborers in Science's behalf is here prominently shown. Names which are erroneous in spelling or obsolete, or synonomous, or applied doubtfully, or misapplied, are here recorded, and the student, the lay-reader, the collector, and man of science, can at once determine the status and significance of mineralogical names as currently used. Prof. Chester, in his preface, says: "In this work the endeavor is made to give complete information, as outlined above, concerning all the names that have ever been introduced into the nomenclature of mineralogy. Nearly all published works on this subject have been searched to prepare a complete list of such names, and all available sources of information have been consulted. Many facts have been received in private communications from correspondents at home and abroad, a list of whose names is appended. But a number of blanks still remain, after years of research, and the author greatly desires information on any of the points lacking."

The author gives some general and particular notes on names, as to the attempt of Moh and Dana to introduce binomial methods, and reveals the great difficulty, in some instances, in determining the real origin of a designation. He illustrates this in the case of the well-known mineral *Datolite*. It appeared very early under the spelling *datholite*, which was a corruption of the original name *datolith* of Esmark, from *δᾶτέομαι*, to divide, in reference to its granular structure, and *λιθος*, a stone. Werner inserted the h, and this led to its erroneous interpretation as coming from *δαθος* or turbid, which was succeeded by the criticism that there was no such Greek word, and its origin is from *δα-θολλος*, meaning very turbid, because it is never found in transparent crystals. The correct derivation was detected by Prof. Dana in 1868. Many other instances give a forcible impression of the care and learning required for a correct diagnosis of the elements of a mineralogical name.

The work is compendious and very useful, but it seems regrettable that Prof. Chester had not written a more extended treatise, by way of introduction, reviewing the stages of change which have finally given us the present series of names. The expressed regret that all mineral names should end in *ite* does not seem warranted. Haüy's names, in so many instances, pleasingly vary, to the ear, this monotonous termination, that we wish there were more judicious exceptions to its almost universal predominance. No mineralogist should be without this dictionary, and to a large public, outside of this specific designation, it will be valuable as a guide to the derivation, proper orthography and meaning of mineralogical names. Its typography seems faultless.

L. P. GRATACAP.

Laboratory Experiments in General Chemistry. By CHARLES R. SANGER. St. Louis, 1896. Published by the Author. Pp. 59.

Experiments in General Chemistry and Notes on Qualitative Analysis. By CHARLES R. SANGER. St. Louis, 1896. Published by the Author. Pp. 49.

The first of these pamphlets contains directions for 108 laboratory experiments upon the preparation and properties of the elements and compounds. They have been arranged for the use of students who are taking a course of lectures upon descriptive chemistry. The experiments are all well known ones, and the order of management is the one already adopted in laboratory manuals.

The second pamphlet contains directions for 39 of the experiments given in the first pamphlet, and in addition has 28 pages devoted to a description of the methods used in making qualitative analysis of unknown substances. This course has been arranged for medical students. Neither of these laboratory guides differ in any essential feature from the well known laboratory manuals on elementary chemistry and qualitative analysis. E. H. K.

SCIENTIFIC JOURNALS.

JOURNAL OF GEOLOGY, MAY–JUNE, 1896.

Classification of the Marine Trias: By JAMES PERRIN SMITH. As might be expected the names given to the Triassic beds of the Germanic basin, which was shut off from the open sea, have proved to be of little use as applied to marine beds of the Trias. Such are known in the Alps, Himalayas, Salt Range of India, Siberia and western North America. Quite recently the Vienna geologists, Drs. Mojsisovics, Waagen and Diener have proposed a classification of the Marine Trias. Four series are recognized, the Scythic, Dinaric, Tirolic and Bajuvaric. These are divided into stages, substages and zones. In the present paper the author attempts to show the relations of American marine strata to those of Europe and Asia on the basis of the above classification. He concludes that the Alps cannot longer be said to furnish the typical region even for marine Trias, but that each region of the earth has some open sea development of a stage lacking elsewhere. Hence studies in faunal geography must be combined with those in phylogeny.

The Geology of the Little Rocky Mountains: By WALTER HARVEY WEED and LOUIS V. PIRSSON. The Little Rocky Mountains of northern Montana are far removed from the Rocky Mt. Cordillera. They are formed by a dome-shaped uplift exposing Archean and Paleozoic rocks in a region of horizontal Cretaceous strata. They represent on a smaller scale the kind of phenomena we have in the Black Hills uplift as described by Russel in a former number of the *Journal.* The nucleal core is of crystalline schists, but the structure has been modified by the intrusion of a great laccolitic mass of granite porphyry. The schists are thought by the authors to be Archean. Above these are shown beds of Cambrian, Silurian, Devonian, Jurassic and Cretaceous. Petrographic study of the prophyry shows it to belong to the alkali granite-syenite series. It is very poor in lime magnesia and iron. The magmas resemble those of the other detached mountain groups of Montana. Ores bearing both gold and silver are found associated with flourite in the altered porphyry. The occurrence of telluride ores is much the same as at Cripple Creek. In most of the ores free gold is found in spongy masses of dark copper color. The Goldbug mine is the only property which shows much development, and this is being prospected now.

Schistosity and Slaty Cleavage: By GEORGE F. BECKER. The idea developed in the paper is that the deformation of a solid, homogeneous, viscous, isotropic, not infinitely brittle mass will develop structures in it on not less than one surface, nor on more than four surfaces simultaneously. These structure surfaces will in general stand at acute angles to the direction of the pressure to which they are due, and the flattening of the strain ellipsoids will not be normal to the pressure save in a limiting case. The common theory of slaty cleavage is well known.

The author presents evidence that solid flow does produce cleavage which is parallel to the lines of relative tangential motion or gliding and that this need not be accompanied by rupture, however microscopic. He thinks that no closer approach to slaty cleavage can be gotten by flattening of the particles even in a weak matrix than is gotten in natural sandstones, for in these there is approximate parallelism of the grains of quartz and mica scales with the bedding.

Deformation of Rocks, III.: By C. R. VAN HISE. In this paper schistosity and cleavage are discussed mainly. After defining the terms and referring to the literature of the subject the author lays down and supports the following propositions. (1) Rock cleavage is due to the arrangement of mineral particles with their long axes or readiest cleavage in a common direction and that this is caused by parallel development of new minerals, by flattening and parallel rotation of old and new mineral particles and by flattening and parallel rotation of random original particles. (2) The secondary structure of a rock deformed by plastic flow develops in the plane normal to the greatest pressure and is true cleavage. (3) In heterogeneous rocks having cleavage, in a soft layer the cleavage more nearly accords with bedding than it does in a hard layer. (4) Upon opposite sides of an anticline cleavage usually diverges downward, while on opposite sides of a syncline it usually converges downward. (5) In regions of overturned monoclinal folds the cleavage may be rotated in the same direction throughout, and hence be monoclinal. (6) Fissility developed in the shearing planes is usually secondary to cleavage developed in the normal planes.

Large Scale Maps as Geographical Illustrations: By W. M. Davis. The value of maps in geographic study has long been recognized, but it has not always been so well stated as in the present paper. Prof. Davis maintains that their study endows the observer with a power that could not even be gained by field work without their aid, except by spending a long time on the ground, and that work based on good maps is as truly scientific as Loomis's famous studies. He proceeds to describe a number of foreign maps which are better than the average American maps, and have proved to be of especial help in his own teaching. He also gives information where these maps can be bought, the price and the results of experience as to the best way to display and use them. D. P. N.

THE MONIST.—JULY.

In an article on *Terminology*, Prof. Rudolf Eucken, of Jena, broadly sketches the characteristic biographical features and vicissitudes of scientific and philosophical terms, giving concrete examples in enforcement of his views, and pointing out the immense advantages to be derived from the systematic prosecution of this study. In his plan of a colossal and exhaustive thesaurus of scientific and philosophical terms he characterizes the realization of the same as a task eminently worthy of American scholarship, wealth and enterprise.

Prof. Fr. Jodl, recently called to a chair of philosophy in Vienna, critically examines, in his article on *Causality*, the views of David Hume, which he regards as having dominated all modern inquiry on this subject, including Kant and the Kantians and the majority of professional scientists. He then discovers the origin of the notion of causality in our feeling of personal effort and of our personal action upon the external world, and considers it to have found its rigorous justification in the modern view of the transformation of energy and matter. His article contains much psychological analysis.

The second part of the series on *Science and Faith* is by Dr. Paul Topinard, entitled *Introduction to Man as a Member of Society.* Dr. Topinard discusses his subject under two heads: (I.) Preliminary Biological Data; and (II.) The Animal Family; which are to be followed by another article on Animal Societies. He follows here the origin and course of development of the solidarity of the organism and of its representative ego, as also the origin and development, in all its aspects, of the *animal family*, which he regards as the outward terminal phase of the process of the reproduction of the species—a result which has been shaped to this end by the exigencies of evolution. The rise of the social instincts is also considered in this paper, which is exhaustive and contains the results of new inquiries by Topinard.

The *Holiness of Instinct*, the title of the leading article, by Dr. Woods Hutchinson, is a plea for the reinstatement of our natural instincts as unerring criteria of conduct, and also a literary apotheosis of the beauty of life.

The article by the editor, Dr. Paul Carus, on *The Problem of Good and Evil*, opposes the idea of a merely subjective existence of evil, which he regards as a positive, objective aspect of life, and concludes with a discussion of the God idea and with a sketch of the significance of the devil in history.

The number concludes with the usual Literary Correspondence. Among the Book Reviews are critical notices of Ostwald's pamphlet on *Scientific Materialism*, Helmholtz's *Researches in Mathematics and Mechanics*, Grassman's *Ausdehnungslehre*, and Henry Clarke Warren's *Buddhism.*

NEW BOOKS.

U. S. Geological Survey; Fifteenth Annual Report, 1893–94. J. W. Powell. Pp. xiv+755. *Sixteenth Annual Report*, Part II. Papers of an Economic Character, Pp. 598, Part III. Mineral Resources of the United States Metallic Products, Pp. 646, Part IV. Mineral Resources of the United States, Non-Metallic Products, Pp. 735. Charles D. Walcott. Washington, Government Printing Office. 1895.

The Scenery of Switzerland. Sir John Lubbock. New York and London, The Macmillan Co. Pp. xxix+371. $1.50.

Home and School Atlas. Alex. Everett Frye. Boston and London, Ginn & Co. 1896. Plates X. Pp. 48.

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

*SCIENCE AND CULTURE.**

It is with peculiar pleasure that I stand before this new department of Natural Science Instruction, and I deem it a great honor that you have asked me to preside over its deliberations. It is an important sign of the times that such a department as this should have been organized by the scientific men of the country. It is significant of a broader view of the work of scientific men that we find so many here to-day to take part in the first meeting of a department which has for its object the discussion of questions pertaining to the teaching of science. I am assured that the movement which culminates in our gathering today is timely, and that it is but the visible expression of the feeling which has been steadily growing among scientific workers that the time is near at hand for a restatement as to the place of science in the education of a man. I congratulate you that you are among those who are to take part in this movement, and I trust that great good will result from your efforts.

With your permission, I wish now to bring before you, at the opening of this department, a few suggestions which may serve to give direction to your work.

It is not so long ago but that many of us have personal knowledge of the insignifi-

* Delivered before the Dept. Nat. Sci. Instruction N. E. A., Buffalo, July 10, 1896, by the President, Charles E. Bessey.

cant place accorded to natural science in the schools from the primary grades to the college. Afterwards there came a period of conflict between the advocates of science, on the one hand, and of the old culture-studies, on the other. In the controversy much was said which should have remained unsaid, and many arguments were brought forward which have long since been abandoned by both sides.

Thus, in urging the introduction of science into the schools, much was said regarding its usefulness, as in farming, in manufacturing and in commerce. The usefulness of science in everyday life was brought forward as one of the strongest arguments for its introduction in the course of study in school and college. This was so emphasized as to lead some to hold forth the money-getting value of science as contrasted with the culture-value of the older studies. Thus there arose in the popular mind the notion that while science is more 'practical,' and while it may fit a man to earn a livelihood, it is lacking in culture-value. The notion has been fostered by the fact that in the building of technical schools science has been given a large place. In fact, these schools are very commonly called scientific schools and colleges. When the educational world, during the latter half of the present century, saw the rise of engineering and mechanical schools, in which chemistry and physics were given great prominence; of agricultural colleges, in which botany, zoology and chemistry occupied the greater part of the student's time; of schools of horticulture, schools of dairying, sugar schools, etc., in all of which one or more of the great modern sciences occupy prominent place, what wonder that science seemed to be merely a servant to minister to man's material interests! What wonder, too, that some men, dazzled and bewildered by the splendid achievements of science in many fields of human industry, became materialistic and set up science as their educational goddess! In this period we heard much of the 'new education,' and too often by this term was meant little more than is included in mere trade schools. The 'new education,' while ostensibly an education in which science replaced the language and literature of the older curriculum, very commonly included merely such sciences as were of immediate use in a particular industry, and too often only those portions of these selected sciences which were most directly 'practical.' To make the matter worse, the graduates of schools with such a curriculum were called Bachelors of Science. What wonder that some men looked askance at scientific courses of study! What wonder that college men, who had been accustomed to think of the culture-value rather than the money-value of the studies in the college curriculum should hold aloof from close association with such science!

Against such merely utilitarian views as to the place of science there have been strong protests during all this period of educational unrest, but these have been little heeded. Gradually, however, with the increased introduction of science-study in the schools and colleges, doubts have arisen as to the soundness of the utilitarian view. The question is often asked whether science is 'useful' merely in the lower sense of contributing to man's material advancement. Our thoughtful students and teachers are asking whether science may not be pursued with profit by those who will not 'apply' it in some industrial pursuit. May a man profitably give prolonged attention to chemistry who does not propose to be a manufacturing chemist, an assayer or a maker of drugs? Is it a profitable use of the time of the college student to give years of study to the lower forms of vegetation, unless he hopes to become the botanist of some experiment station, or expert bacteriologist of a cheese factory or brewery? In other words is there a culture-value in these studies? May a man profitably pursue science for its culture-value, as one pursues the classics, literature, history and mathematics? Is a man made a better man, not merely a more efficient money-making machine, by the study of science? These questions are now being asked by teachers and students, and it is to help answer these that this department has been organized.

The making of a man to-day is a complex undertaking. Life is too short and knowledge too vast for us to think of furnishing a man with mere knowledge. No man can hope to master all knowledge. No man can hope to master all the details involved in the life of the community in which he lives, much less those of the civilized world. In the making of a man in primitive communities, little more was necessary than skill in hunting and fighting, with a few arts, all of which could be easily acquired by a few years of practice under the guidance of his elders. To-day in the making of a man we must develop the almost primitive child, with his limited horizon of knowledge and philosophy, into an alert, quick, accurate being, able to comprehend and classify the multitudes of facts, and to grasp and solve the many problems with which modern life is filled. We realize to-day that in making a man we must train him. We can no longer hope to acquaint him with all facts, but we may prepare him to classify and arrange them. And here perhaps is the best test of good training, of what we call culture; it is the ability to accurately classify. That culture is best which so prepares a man that whatever fact presents itself to him he will be able to arrange it accurately with reference to others. This ability to classify facts is of far more importance than the mere acquaintance with facts, however extended the latter may be.

May science help in such training as this? Can it contribute to culture? Must we still rely for culture upon the old studies only, or may we look to science for help? The answer to these inquiries should not be hard to give. In spite of the fact that science has been so badly treated, in spite of the fact that for so long its culture-value has been little esteemed, I venture to say that when properly presented it will stand second to no other subject.

In the first place, it must be clearly understood that nothing here said implies the substitution of the culture given by science-study for that given by the classics, literature, history, mathematics, etc. We cannot spare that culture from modern life. But we need in addition the special culture given by science. The culture given by science must be supplementary to, and not substituted for, the culture with which we have long been familiar.

Let the teacher of science make use of it as a means of culture for students. Let teachers set forth the culture-value of science study. Let us hear less in the schools of the practical value of science. Let us emphasize its vastly greater importance in the making of men. We are already familiar with some of the direct culture results; thus we know that through science-study quickness and accuracy of observation are developed, and both eye and hand are trained to be the ready servants of the alert mind. In the pursuit of the higher lines of science, the mind is trained to accurate generalization from secure data and to an indefinite suspension of judgment in the absence of sufficient evidence. The proper pursuit of science should develop a judicial state of mind toward all problems.

Indirectly the pursuit of science leads to a higher appreciation of Nature. As a man understands the meaning of the natural world his appreciation of its beauty and grandeur is increased. He is then led to entertain broader views of Nature and to see more clearly the relations of part to part. Finally he is led to a proper appreciation of his place in nature; possibly he is humbled by the certainty of his individual insignificance in the vast organism, but he is strengthened by the equal certainty that in his race he is the inheritor of all that makes for progress and advancement.

Men of this department of Natural Science Instruction, shall we not make of science a help to higher culture, rather than an aid to more material success? Let us give it wings, so that it may carry our pupils above mere earthly things, and not doom it to do no more than turn our spindles, haul our goods and coin our money. While we rejoice in these material achievements of science, let us bear in mind that these are not of supreme importance. When we stand by the mighty Niagara we realize that it has an infinitely higher significance for man than the mere turning of wheels. Just as the solemn flood of water speaks to and stirs man's deeper thoughts, and makes him forget the wheel-turning power of the rushing torrent, so the profound contemplation of nature through enlightened and untrammeled science leads him away from sordid things up to the higher planes of thought and experience.

Chas. E. Bessey.

THE HUMANISTIC ELEMENT IN SCIENCE.*

The time has happily passed when the rival supporters of literary studies on the one hand and of scientific studies on the other slept on their arms or engaged in open combat. Both sides were intent on victory, with no disposition to give quarter or to concede that the truth might not all be on one side. But when opponents have come to know each other better they not infrequently abide by at least a tacit agreement to live as friends. We have now arrived at such a stage in educational history and practice. An occasional note of discord still comes from the few who refuse to be reconstructed; but the prominent figures in the old conflict are fast passing over to the majority, and the new generation is born with a more pacific spirit. The pursuits of peace are more liberalizing than the devastations of war. Hence the origin at first of a spirit of toleration, and then of equality and fraternity. It is now time to inquire about a common ancestry and community of aims and interests. The spirit of the times does not sanction narrow bigotry or unseemly dissension. Educational intolerance is now as much an anachronism as religious intolerance or martyrdom for conscience. It has come to be recognized that no one system of theology contains all the truth, and no one branch of human learning is the sole instrument of culture, nor does it possess the exclusive capacity of imparting power.

At the time of the revival of learning in the Middle Ages the apostles of the Renaissance, who introduced the study of classical literature, were called humanists. Hence humanism has often been called 'the culture derived from classical training.' But more broadly, humanism is a system of thought in which the human element or interest predominates. The humanities therefore include much more than classical language and literature. They stand for philology, poetry, rhetoric, grammar and archæology, as well as for the Greek and Roman classics. Philological studies, says G. P. Marsh, "were called *literæ humaniores*, the humanities, by way of opposition to the *literæ divinæ*, or divinity, the two studies, philology and theology, then completing the circle of scholastic knowledge, which, at the period of the introduction of the phrase, scarcely included any branch of

*Read at the Buffalo Meeting of the N. E. A., July 9, 1896.

physical science." The humanities were not so named because of their peculiar value in producing culture, nor because of the human interests which they fostered, but because they were human or secular in their nature, as contrasted with the theological or divine.

Ever since the revival of learning, philology and polite literature have been justly held in high esteem as instruments of culture and as 'the literature of power.' Generation after generation of English scholars and statesmen have received their intellectual training largely by means of mathematics and the classical languages. In modern times there have been added to these, subsequent to University residence, the acquisition of modern tongues and extensive foreign travel. In America the classics have furnished the major part of a liberal training to many successive classes of students. It is only within the past twenty-five years that science has come to form any considerable part of the curriculum of American colleges. It is not my purpose to detract in any way from the utility and value of literature, philology, and philosophy as important components of a liberal education, but rather to show what the study of science has in common with the humanities as liberally interpreted by the broadest scholars. A high estimate has rightly been put upon the study of the humanities by the most prominent educators, and it is not necessary to undervalue their judgment for the purpose of advancing the cause of science. Whatever antipathy or opposition science has encountered has had its origin either in prejudice or in a lack of understanding of the aims, the nature and the content of any connected body of science. It is perhaps folly to try to remove the former, but a more refreshing task to point out what human interests are involved in the pursuit of science, and to what higher ministry to man's intellectual and ethical needs it has been applied.

It may be well at the outset to clear away a misconception relating to the objects in view in scientific study and investigation. It is a gross libel on scientific men to assert that the chief end aimed at in the pursuit of science and the claims most strongly urged in advocacy of its cultivation are narrowly utilitarian or intensely practical. If worldly success were the only reward awaiting the scientific investigator, but few branches of science would be fortunate enough to find their votaries. The taste for scientific research is a passion which finds its gratification in the truth it seeks. It can never be satisfied to con over the lessons of the past alone, but it restlessly pushes on into new chapters. The true scientific man recognizes the immense value of literary and linguistic study; he is also aware of the fact that the human intellect is many-sided and has numerous aptitudes. To be broadly developed, to have liberal sympathies, and to acquire the power to be master of circumtances, the educated man of to-day must know not only language and literature and history and philosophy; but he must have knowledge of his environment, of the physical laws under which he lives, of the varied life about him, of the earth which he inhabits, and of the heavens spread out in magnificent panorama above him.

Languages are considered to be the humanistic studies *par excellence* because they are the product of human endeavor, the outgrowth of human thought, the chief exponent and index of evolution in the human mind. All language is therefore entitled to be included in the humanities. But all languages are not of equal interest and value. They are not all equally developed products, not all equally differentiated flowers of the human intellect. The greatest interest attaches to the language of those people who have attained to the highest civilization; whose art, architecture, industries, literature and learning have reached the highest development; whose works, in short, possess the highest finish as the expression of human thought.

An important distinction may be made among the subjects belonging in the narrower sense to the humanities. Language in its structure may be regarded as the involuntary product of human activity, the result of the unconscious struggle of the mind, its reaction against the environment, with the result of a definite attainment not aimed at. The results are not fortuitous, because all activity is under law. Whether the effort is conscious or unconscious, the result anticipated or unexpected, it must issue in accordance with the laws controlling human action. On the other hand, art, architecture and poetry are the conscious products of thought. They are the results of struggles after definite and well conceived ends. They are the issue of an inner impulsion toward an ideal attainment. They are not so much the finality of collective effort as the offspring of individual genius. The written language, the canvas and colors, the quarried marble and granite, are the materials with which art works and out of which it constructs a poem, a painting, a statue, or a temple. They are compelled by poetic and artistic genius to shadow forth the ideals existing in the mind of the poet and the artist. The pigments and the marble are not art. It is the artistic use of language, of canvas and of marble that require the skill of the master. Then too the pen of the poet, the brush of the painter, and the chisel of the sculptor touch their highest point when they delineate that which is truest in life and nature, softened with ideality and ennobled by aspiration.

Now what characteristics has science that ally it to literature and art? What have they in common which entitles science to be treated as one of the humanities?

In the first place the materials which science uses are her own. It is this fact which differentiates science from other branches of learning. But given the materials, the operations of the human mind in working on them are kindred in character and similar in result to those of the same order of intellect elsewhere. It is an unworthy conception of science that makes it consist in the collection of facts about the material world or even the higher animal life. These materials, it is true, must be collected, just as the pigments must be ground and the marble and granite must be quarried. But he who stops with the collection of facts is doing the lowest order of work in science. He contributes to the final result, but it requires genius to clear away the rubbish and to construct the temple of science out of the scattered materials. Or better still, the genius in science does not merely hew and shape and color, but he brings together the *disjuncta membra* formed by the hand of the Almighty, and reconstructs a beautiful body fit for the Creator to look upon. The most important element in science is the human element, that which vivifies the dead facts, fuses them with the fire of imagination, beautifies with the fine finish of ideality, and constructs an articulated system which must conform to the truth. Science is then in a very large sense a product of human thought, the result of human endeavor. A body of correlated scientific truth can hardly be studied apart from the personality of the names inseparably linked with it. It is scarcely less a human interest which draws us to it than that which attaches to language as the instrument of human expression. Indeed the former has the added attraction of distinct personalities. It is the personality of a few master minds working with creative ability, impressing their own thought upon science, and marshalling facts in great divisions which embody their ideas of the order and dependencies of nature.

It is no new thought that scientific study makes a draft upon the imagination. This aspect of science allies it to art and literature. Music and mathematics have not infrequently been congeners in the same gifted genius, and mathematics is becoming an indispensable adjunct to every branch of science. Maxwell, perhaps the greatest modern physicist, often indulged in poetic composition, and his poetry was of no mean order. It may be readily granted that the scientific imagination is cultivated and strengthened by exercise in the related realm of poetry. The intricate and fascinating subject of electricity is greatly indebted to the imaginative faculty of the great discoverers in this field. It is an unfruitful science that has not been enriched by the scientific imagination.

In another respect science fosters human and ethical interests. It compels the restless struggle after ideals. It holds up an ideal condition which is the goal of its ambition, the one thing which it must attain before it can rest content. Hence the scientific worker studies sources of error and seeks to eliminate them. By repeated attacks he approaches nearer and nearer to the citadel which he tries to capture. And after all is done he recognizes that the object of his endeavor has not been fully attained. It is much like the chase after the foot of the rainbow, which ever moves onward as it is pursued. Says Huxley: "Men are said to be partial judges of themselves. * * * Life seems terribly foreshortened as they look back, and the mountain they set themselves to climb in youth turns out to be a mere spur of immeasurably higher ranges when with failing breath they reach the top." But it is infinitely better to have reached the top of a spur even than never to have begun the ascent. The whole world has been called to a broader outlook and a grander vision by those who have reached the spurs and higher ranges. Their effort after ideals ennobles and humbles. It chastens while it subdues.

In some respects science is more humanistic than the humanities. Here and there ancient literature enforces the conception of the reign of law. It presents the human captive vainly prolonging the struggle to escape it. Tantalus-like, the unattainable ever eludes the seeker. Prometheus bound is a fit symbol of circumscribed humanity. The same thought, which has always impressed itself upon the race and worn itself deep into human experience, is enforced in Holy Writ: "If I take the wings of the morning, and dwell in the uttermost parts of the sea; even there shall thy hand lead and thy right hand hold me."

Now science illustrates and emphasizes the reign of law. It has cleared away the mystical, the fortuitous, the anthropological, and has given us instead the orderly and progressive sequences of natural phenomena. It has in no way weakened the necessity felt for a First Cause, but it presents the activity of that Cause under a new and more rational aspect. It presents a Creator who sees the end from the beginning, who does not need to hold the world in leash or drive it with a goad, but who endowed matter with certain capabilities and infused into it divine energy, so that it can run its ceaseless changes down the grooves of time. Science has replaced a world of humanistic divinities by a world of energy and law. Instead of the caprice of classical gods and goddesses, it has supplied a physical organism devised and elaborated by infinite wisdom. Man has therefore learned to order his physical life so as to conform to the laws of the physical world, or if he elects to transgress those laws he does not expect the interposition of humanistic divinities to effect his escape. So impressed is the human mind by the reign of law in the physical world that it has carried this conception over into the spiritual. 'Natural law in the spiritual world' is an obvious sequence of natural law in the physical world. It is therefore an intensely human interest that impels to the study of the reign of law.

Every great branch of learning has been adorned with the names of eminent scholars and discoverers. When we bear in mind that the arts and sciences are the product of directed, conscious human effort, and that it is the lot of but few to be endowed with the intellectual insight, the native sagacity, the penetrating perception to push far beyond their fellows, we are not surprised at the smallness of the number of luminous names that shine on the rolls of honor, or that go down to succeeding generations as the great discoverers. The human interest in these names, differentiated from all others by their powers and their contributions to the progress of the world, is equally intense whether they belong to art or architecture, to literature or science. To these men it has been given to delight the soul with beauty, to penetrate the unknown, to enlarge the boundaries of human knowledge, and to gather up the tangled threads of thought and weave them into a tapestry of beautiful design. Each department of creative art or of learning is justly proud of the distinguished names associated with it. They all inspire the same human interest and are characterized by the same passionate devotion. Galileo, persecuted and condemned for his scientific writings, is still a vivid figure, a living personage in history; and we look with reverence upon the old bronze lamp or candelabra, swinging on its long suspending rope in the Duomo at Pisa, as it swung centuries ago when Galileo watched it and discovered the isochronism of its pendular motions. Old Copernicus, turning over with death-stricken hands the first copy of his book on the solar system, which he dared not publish sooner, is a figure to excite at the same time sympathy and indignation. The genius of Michael Angelo still presides over the art and architecture of Rome, and Raphael will forever stand beside the glowing canvas of the Sistine Madonna, which burns itself into the soul of every beholder. One almost expects to see Scott standing within the deep shadows of Melrose Abbey by moonlight, or strolling with his faithful hounds in the woods about Abbotsford. Alloway Kirk and the Brig o'Doon are still visited by the strange creations of the busy brain of Burns. How sweetly the chimes of Holy Trinity Church ring out over the hills about Stratford-on-Avon on a quiet evening! Green are the fields and quiet the cottagers along the cleanly lanes and alleys where the great poet was born. In the spacious chimney corner of the Hathaway cottage linger the shades of Ann Hathaway and William Shakespeare. It is hard to believe that for 300 years the ashes of Shakespeare have reposed beneath the slab in Holy Trinity, guarded by the famous couplet,

> "Blest be the man that spares these stones
> And curst be he that moves my bones."

The scientific traveller in London turns his steps toward the Royal Institution in Albermarle street, where the noble Faraday worked and achieved immortal renown. There are the coils and magnets and other appliances which his own hands fashioned; and Faraday himself is everywhere present there. How powerful still is the memory of our own Joseph Henry at Princeton and Washington! Though he be dead, his works do follow him.

Prof. Butler said in his address at Denver: "We must enlarge our conception of the humanities, for humanity is broader and deeper than we have hitherto suspected.

It touches the universe at many more points than one; and, properly interpreted, the study of nature may be classed among the humanities as truly as the study of language itself. This conclusion, which would welcome science with open arms into the school and utilize its opportunities and advantages at every stage of education, does not mean that all studies are of equal educational value or that they are naturally and indifferently interchangeable, as are the parts of some machines. It means rather that the study of nature is entitled to recognition on grounds similar to those put forward for the study of literature of art, and of history." This position concedes the claim which I am now urging. It is an ancient chapter in educational history that places the humanities in one grand division and the sciences in another, without mutual relations or common aims and interests. The relative value of these subjects as educational material I am not now disposed to discuss, passing it with the remark that the order of excellence laid down will depend upon the standard of values assumed and the point of view of the writer.

It will not be inappropriate to make special reference to the study of physics in connection with the subject of this address. No one of the sciences is associated with a longer list of splendid names; none appeals more strongly to that characteristic of the human mind which searches into the causes of phenomena; none is more capable of serving directly human needs and of advancing the material interests of society.

It is almost the universal judgment that physics is a fundamental subject, and more than any other is essential to the pursuit of other branches of science. In its historical development it is no less ancient and honorable than chemistry, while in recent times the proof that it has lost none of its vigor lies in the splendid discoveries that are almost unrivaled in any other department of scientific investigation.

It is therefore justifiable to urge that physics be made an essential part of every course of study in secondary schools, and that the place and time devoted to it correspond to its importance. It is not enough that physics be admitted to all secondary schools, but that it should not be there in a secondary place. It should be placed on an equal footing with the most favored subjects. It seeks no preferences, but is strenuous that no special bounties be extended to other branches. Whether it be considered from the point of view of its educational value, of its splendid achievements and its service to civilization, or of the interest that it awakens in the unfolding mind of the inquiring student, it should form as essential a part of every course of study as mathematics or history or language. First of all, a student should know his own language; it does not admit of question that he should also know the historical development of his own country; he should in addition be familiar with the fundamental physical principles and concepts which are as closely interwoven with his life and well-being as are his language and the history of the land in which he lives.

If now the pursuit of this noble science is to serve the human and ethical interests which we are contemplating, it is essential that its serious study be entered upon at the right period in the education of the pupil. It is very properly pointed out by Mr. Gage in the report of the Conference of Ten on Physics and Chemistry that "Physics requires the largest knowledge of mathematics that the secondary school affords, and the difficulty of this study demands the greatest maturity of mind." What interest can be served by placing it in the first year of the high school, except its subordination to more favored branches, it is quite impossible to understand. The Conference of Ten recommended "That physics be pursued the last year of the high school course." That recommendation meets the enthusiastic approval of every physics teacher whose experience is worth considering. The exigencies of the school programme sometimes require that physics be crowded down into the third year, but the instructor in this subject should never cease to protest against any further lowering of the standard by its relegation to the second year. When only a single year is sought for a subject of such transcendent importance, the studies that are crowded to the front for from three to six years should be compelled, in all fairness and reason, to give way, if necessary, at the point where the physics properly belongs. The pupil will then be provided with the requisite knowledge of geometry so essential to the intelligent study of physics, and may be presumed to have that maturity of mind which will enable him to profit by the study.

The limits of this paper do not permit me to enlarge on the method to be pursued in teaching physics. It must suffice to say that the student in the elements needs a text-book of principles for the purpose of securing accuracy and to enable him to dwell long enough on any portion to comprehend it. To the didactic work of the class room should be added the method of the laboratory. Practical work acts like a mordant to fix the color which may otherwise be evanescent. It is the testing machine to determine the strength and toughness of intellectual fibre. It furnishes a scale by which to evaluate acquisitions. It is the method of original investigation applied to the student; he will not discover any new laws of nature, but he will discover his own ignorance and limitations.

Henry S. Carhart.

*THE TEACHING OF BEGINNING CHEMISTRY.**

The momentous changes which have been brought about in chemical science within the past two decades are too often lost sight of in teaching the elements of the subject. It is easier to go in the old way, the habit of descriptive chemistry, founded primarily on the atomic hypothesis, is too well established to be suddenly uprooted, and, as a consequence, in America we can see but little progress toward a more rational and scientific means of beginning the study. The reason for this unsatisfactory condition is most probably to be found in the history of the development of science during the present century. Gay-Lussac, Dalton, Berzelius, Davy, Faraday, and the other lesser lights who appeared upon the chemical firmament between the years of 1800 and 1826, were completely engrossed with the discovery of new elements, the determination of chemical equivalents and the relationships between these latter quantities and the atomic weights. It was then that our system of chemical notation originated, and for this, even if his name were not inseparably connected with other lines of advance, we owe a lasting debt of gratitude to Berzelius. Naturally at this time, methods of analysis in inorganic chemistry, both qualitative and quantitative, assumed the greatest importance, for where the composition of so many new minerals remained to be ascertained, and when in each a possible new element might be discovered, such work must necessarily claim the attention of the foremost investigators. Scarcely an appeal was made to turn the science into broader channels, the material side was uppermost, the statics of chemistry was being investigated, and there was no time to think of the nature of chemical changes from any standpoint other than that of the transposition of matter. The

* Delivered before the Dept. Nat. Sci. Instruction, N. E. A., Buffalo, July 10, 1896.

voice of the great Berthollet was, it is true, raised in a demand for the study of the physical aspect of chemical change, while Avogadro explained the meaning of Gay-Lussac's and Dalton's discoveries of the simple relationships between combining gas volumes, but both were unheeded, for the chemical field was not ripe for such development. During the latter part of the life of Berzelius we find such investigators as Wöhler, Liebig and Dumas busily engaged in building a new edifice of structural organic chemistry, and at the same time the tendency showed itself to unduly emphasize the importance of chemical symbols, for the theory of compound radicles with its numerous variations, held most men in its grasp. Chemical bodies were classified according to arbitrarily constructed formulæ, regardless oftentimes of obvious family relationships; theory began to outrank exact observation; and, even with so careful an experimenter as Berzelius, chemical formulation began to distort and replace ascertained facts. This chaos, produced by the clashing of minds, all equally qualified to dictate in the chemical field, was further heightened by the lack of any reliable scientific basis for the determination of atomic weights; there were almost as many systems as there were chemists. It was only after 1850, when Cannizzaro successfully revised Avogadro's hypothesis, when the laws of thermodynamics were established and when the impulse toward a logical system of atomic weights was given, that some advance toward order was made. From this time on, owing to the labors of Kolbe, Williamson, Strecker, Gerhardt, Laurent and finally Kekule, our present views of valence and structural chemistry began to take the place of former confusion. With the advent of the definite theory of quadrivalence of carbon, at first advanced by Kekule simply as a means of classification, a basis for united action was given which was eagerly seized on by all of the workers in the chemical field. Never before had so simple a theory been adopted, and never before had one appeared which so heartily met with the approval of most men. So easily comprehended, indeed, were these views that, as a logical consequence, chemists were carried too far in their enthusiasm; if the tetravalence of carbon was established, why was not a constant valence true of all other elements? Acting on the impulse, the classification into monads, diads and triads, etc., was made, often in utter disregard of easily observed facts. Theories were once more confused with the facts from which they were deduced, and an arbitrary method of chemical teaching, far removed from the basis on which physics rested, was inaugurated. The chemical symbol and chemical equation were given a rank and place far above their merits; and, as a consequence, the scientific axiom that all theoretical deductions must be founded upon carefully observed facts was too frequently lost sight of. Even Mendelejeff and Lothar Meyer, in their Development of Newland's Periodic System, were often tempted to force dogmatic classification upon the chemical world. This tendency in chemical teaching has continued to the present day, and along with it we still have the undue emphasis laid upon analytical chemistry, a remnant of Berzelius's time, although the chemical field has been so widened that many other branches of the science have far outgrown the latter in relative importance.

Taking heed of the errors of the past, it is time to bring the teaching of chemistry to a purely scientific basis of experimental observation, to omit theoretical deductions, especially the atomic theory, until such a time as the pupil has at his disposal sufficient material to give it a definite basis to rest upon.

There are two laws which are fundamental throughout chemistry, the law of definite and the law of multiple proportions. No matter whether or not we hold to the atomic theory, these would remain unalterable and by their existence would inevitably force the science to be a quantitative one. By leaving this basis, or ignoring it, while still keeping the atomic hypothesis in sight, even great chemists have been led to adopt the most impossible theories and to distort the most carefully established facts, as the history of Prout's hypothesis abundantly demonstrates. But, if the foundations of chemistry are quantitative, why not begin the study of it in such a way that this aspect is thoroughly and permanently brought out to the attention of the student? The difficulties in the way are not great; the necessary equipment for the work does not add a large outlay to those expenditures which all properly provided laboratories already have to meet, and in the majority of cases experiments for beginners can be altered from the qualitative to the quantitative ones by the simple graduation of a glass tube. The quantitative neutralization of acids by bases and *vice versa*, easily carried out with accurate results, is especially useful, combining, as it does, both the laws of definite and multiple proportions and the most striking chemical characteristics of two important classes of compounds.

The study of the combining volumes of gases is also simple and necessary as leading up to subsequent important theoretical considerations; only by following a course of accurate work can a proper basis be secured for future generalizations.

The atomic theory has no place in the beginning of the study of chemistry. The reactions which students encounter during the first period are as easily understood without it as with it. Its early use is confusing and pernicious, giving, as it does, a visionary and immaterial basis for the science, which is too apt to cling to the pupil throughout his subsequent course. Our belief in this theory has been brought about by the convergence of a number of lines of investigation which have made use of facts discovered both in physics and in chemistry, and it should be dealt with in this way. If we use it in any other we are bringing ourselves back to the scientific standpoint of Aristotle, whose deductions were subjective and not objective.

Chemical formulæ are, of course, in their present meaning, founded on the atomic theory, and therefore are to be excluded until after the proper work has brought about their logical development. It is not, however, inexpedient to introduce a few symbols which represent not atoms, but equivalent weights which are so related as to be referred to one gram of hydrogen as a unit, for by this means an advantageous conciseness of expression can be obtained. So, to use a concrete example, it can readily be demonstrated that, by the action of certain metals on acids, a definite quantity of hydrogen is substituted by a given weight of each metal, and, if in such an experiment we select the unit weight of hydrogen as a basis of calculation, we have a means at hand of ascertaining the reacting quantities of the substances in question. These relationships are further exemplified by the experiments on neutralization, so that, finally, a few of the simple reactions can be expressed by a system of notation which is founded only on observed facts. In this way a basis is obtained for further enlargement and explanation when the time comes to introduce theoretical deductions, and thus the pupil can be brought to understand the scientific means by which our present system has been brought about. It is too often the case that students who have even had a somewhat extended chemical instruction are only able to present their knowledge in a language of symbols, of the fundamental meaning of which they have no conception. They are chemically helpless if they cannot have pencil and paper and are not allowed to express themselves in the form of chemical equations. It must be confessed that the teachers are more responsible for this state of affairs than the pupils, because in many text-books and laboratory manuals we find, possibly for the sake of a mistaken idea of saving printer's ink and paper, directions, paragraph and chapter headings given in the shape of chemical formulæ to a beginner in the science. The current language was constructed for chemists as well as for other mortals, and I see no reason why we should not express ourselves in its terms. The pupil should be able to tell us what he knows, and he should not be wedded to his writing materials.

One phase of chemical investigation has made such enormous strides of late years that it can no longer be ignored even by beginners in the science. I refer to so-called physical chemistry. From the start the teacher and pupil must recognize that there are two enduring things in the universe—matter and energy—and that but half of the tale has been told, when in studying a chemical change, only the former has been considered. Of course, it is not possible in all cases to consider the latter; none of us are as yet able to do that, no matter how great our experience or how much we have worked in this line; but in the simple reactions which are encountered at the beginning of the course the question of energy changes can be dwelt upon as clearly as the others. Such a line of work requires a certain knowledge of physics, and "as chemistry is a branch of the study of the relations of matter and energy it should be preceded by the more general aspect of this subject which is undertaken by physics. Obviously, owing to the close connection between chemistry and physics it will frequently be required to more clearly outline physical topics in chemical work, and to enable the teacher to make such outlines, a preliminary general knowledge of physics is necessary."* Another topic in physics which must necessarily be introduced before the atomic hypothesis is taken up, is the kinetic gas theory, for a comprehension of which some knowledge of elementary energetics is necessary. It is very easy to make the pupil learn the dogmatic statement that 'in equal volumes of gases, under like conditions of temperature and pressure, there are equal numbers of molecules,' but to make him understand why this fundamental theory is accepted by the scientific world, and what is its bearing on our present system of atomic weights, requires careful reasoning and conscientious teaching, without which the dogma becomes as useless as any other empirical utterance. In short, I would have the pupil's preliminary work, both physical and chemical, so centered around observed facts that he will approach his theoretical conclusions with a mind free from bias, and so logically trained in the successive steps that he may enter upon his more difficult task in a condition to comprehend its full meaning and significance. It is desirable that he should feel the need of some such theory as the atomic theory, before the teacher shows him the way for its development.

Double decomposition and phenomena attendant upon it have lately come to be among the most important topics in physical chemistry. This subject must be introduced in an elementary course, but the present state of the science forbids that it shall be treated from an empirical standpoint in which the most important fact is the obtaining of a precipitate which can be made to serve the purpose of identifying

*Extract from a report made by a committee consisting of Messrs. Noyes, A. Smith and Freer at the conference of chemists of the Northwest at Chicago, January 2, 1896.

some chemical individual. These chemical separations are simply particular cases incidental to certain conditions obtainable in a series of general phenomena, and as such they should be treated. An elementary knowledge of chemical equilibrium, of dissociation in solution, of the separation of ions by the electric current and of the modern views of neutralization, is now as essential to the beginning of chemistry as any of the descriptive portions. Armed with such a knowledge, the pupil can approach many subsequent facts, which were formerly simply memorized, from a reasoning standpoint.

To render such a course of study as I have outlined successful, it is necessary only to take up but a few of the more common elements and compounds, doing the work thoroughly and conscientiously. Important chemical deductions are as well illustrated by a few widely distributed and simple substances, as by many. The time for the study of all of the elements and of their relations in the periodic system is not in the beginning. Such work can only be undertaken in a systematic spirit when the pupil has been taught to reason in the terms of the science. A mass of descriptive detail, no matter how well it is memorized, is not chemical science; the time is passed for that; we are not longer in the age of Berzelius. For the same reason I would leave the subject of valence for a later period. The reasons for its acceptance are many and complicated; they are the result of painstaking work, of much bitter strife and heartburnings, and are too intricate for the beginner. I have much more faith in the pupil who has been trained to accurate observation, who can logically connect what he has seen and who can tell what he knows, than in the one who, by a system of arbitrary instruction, can write down any number of chemical formulæ and equations, founded on a dogmatic and too early discussion of the theories of valence. Are not even the most brilliant investigators in the science in doubt as to its present position and as to its future development?

In conclusion I would like to answer the argument that I know will be brought against me. It will be said that while the outlined course is well adapted for those who wish to make a life study of chemistry, it can scarcely be applied to pupils who will never take any more chemical work than that given in an elementary course. It is absurd to suppose that an elementary course is intended to produce a chemist. The most that can be done is to give the beginner some knowledge of the fundamental principles of the science. Such being the case, how can we best give the pupil the mental discipline incidental to the scientific habit of thought, and at the same time put him in a position to go on with his work in chemistry, should he so elect? Surely not by taking incidental facts from the entire field, by introducing him to theories which he can not comprehend, and by burdening his memory with a mass of material which disgusts him with the science and leaves him helpless for future advancement. We must always take pains, in teaching beginners, to pick out that which is absolutely essential to their comprehension of the science as such, and even if we use only such materials we shall find that the allotted time is more than filled. We must not depart from our ideal of scientific truth to meet a demand which we recognize as not in the interests of the science. By failing to teach the pupil the true elements of chemistry, and by attempting to make the course, as it is termed, 'practical,' we are in reality doing the most impractical thing imaginable, not at all teaching the real science of chemistry, besides stunting the pupil's future scientific growth.

Above all, we should compel our students to observe accurately and never to put their conclusions in their note books, until they can base such conclusions on what they have seen. I have known of teachers who require their students to balance large numbers of equations, outside of the laboratory and according to set rules, and thus entirely subvert the purpose of chemical notation, which is, at its best, but a short means of expressing observed chemical facts, and as such should only be used in the laboratory as a means of describing what the student has actually seen. The former course leads the beginner to the conclusion that chemical reactions must actually take place exactly as the equation demands; the latter teaches him to observe accurately and to express his observations in the terms of the science. Finally, I regard such work as this fitted only for advanced students; the chemical equation has but a small place in the beginning study of chemistry.

PAUL C. FREER.

CURRENT NOTES ON ANTHROPOLOGY.

MYTHS OF THE NORTHWEST COAST.

FOR some years Dr. Franz Boas has been collecting and publishing the myths and stories of the tribes of the northwest coast. In the last number of the *Zeitschrift für Ethnologie* for 1895 he sums up his theories of their development and extension. His conclusions are that the tribes there located not only borrowed from all parts of America, but drew largely for their material from the Old World also.

This conclusion from such an eminent authority will give considerable satisfaction to those who are on the hunt for traces of Asiatic culture in America. Dr. Boas reaches it by counting the number of 'elements' or incidents in a story, and then ascertaining how many of them reappear in a similar story told at a more or less distant point. If the coincidences are many, he considers it proof of borrowing.

There are various objections to this rough and ready method, notably one, to wit: that all 'elements' are not equally valuable for comparison, to which obvious fact he does not appear to attach much weight.

It is curious to note in the same number of the *Zeitschrift* that Frobenius, in discussing the prevalence of vase worship, quite positively condemns the hypothesis which is at the base of Dr. Boas' arguments. Evidently the subject is still an open question.

THE STORY OF 'NUMBER NIP.'

THE story of 'Number Nip,' the tricky wood and mountain sprite, is not unknown to English folklore, but is not prominent in it, and was introduced at a rather recent date from Germany. There, under the name Rübezahl, he figures, especially in the Riesengebirge, as a prominent personage in the tales and superstitions of the population. He has been made the subject of a singularly learned monograph lately by Dr. A. Lincke, of Dresden, who, in an octavo of fifty pages, brings together pretty much everything, at least references to it, that has been written about him.

The general conclusion appears to be that Rübezahl is no more at home in the Giant Mountains than he is in England; that perhaps he is of Slavonic origin, and that his name is a Slavonic word rendered into a German equivalent by that process of popular language which some linguists call 'otosis;' and that in this change of place and name, like many a human analogue, he left his good character behind him. Originally he was probably a divinity of the fields and crops, or vegetation and growth. Or he is a rain and thunder god of the old Germans, to which Dr. Lincke inclines; in either case, once a highly respectable god, and no mere Kobold. The title of Dr. Lincke's paper is 'Die Neuesten Rübezahlforschungen. Ein Blick in die

Werkstatt der mythologischen Wissenschaft.'

D. G. Brinton.

University of Pennsylvania.

CURRENT NOTES ON METEOROLOGY.

AUSTRALIAN METEOROLOGY.

Three valuable contributions to the meteorology of Australia have recently been published together in one volume by Hon. Ralph Abercromby, under the title *Australian Weather.* All of these papers have been previously published elsewhere, but they are now brought together and issued in book form for convenient reference. The first paper, by H. C. Russell, the Government Astronomer of New South Wales and Director of the Sydney Observatory, on *Moving Anticyclones in the Southern Hemisphere* (originally published in Quart. Journ. Roy. Met. Soc., Jan., 1893), gives a general account of the anticyclones which control Australian weather south of latitude 20° S. The average number of anticyclones which pass over the country every year is 42; they are most numerous in summer, and their average velocity is 400 miles a day. The author holds out the hope of possible long range forecasts for a month in advance, or even for longer periods.

The second paper, on *Southerly Bursters,* by H. A. Hunt, of the Sydney Observatory (originally published in Journ. Roy. Soc., N. S. W., xxviii, 1894), was awarded a prize of £25 offered by Hon. Ralph Abercromby for the best essay on southerly 'bursters.' The 'burster,' formally called the 'brick-fielder' because it was heralded by a cloud of reddish dust from the neighboring brick-fields, is a strong southerly wind associated with a V-depression, and bearing some resemblance to the 'pampero' of Brazil and the 'norther' of Texas. This is an exhaustive study of this interesting phenomenon. The last paper, also by Hunt, on *Types of Austrliana Weather,* is a clear and useful account of the typical atmospheric conditions controlling Australian weather, and is illustrated by numerous maps.

INTERNATIONAL CLOUD ATLAS.

The *International Cloud Atlas,* already referred to in these notes, may be purchased of MM. Gauthier-Villars et Fils, 55, Quai des Grands-Augustins, Paris, for 14 francs a copy. The *Atlas,* which contains 28 views, is now the official cloud atlas of the world, and the illustrations in it are the types to which all cloud forms must hereafter be referred. It is the work of the International Cloud Committee, appointed by the International Meteorological Conference held at Munich in 1891, and the standard types now adopted were selected from over 300 photographs collected from all parts of the world. The Cloud Committee is composed as follows: Hann, Hildebrandsson, Mohn, Riggenbach, Rotch and Teisserenc de Bort, and the sub-committee in charge of the publication of the *Atlas* comprises Hildebrandsson, Riggenbach and de Bort.

METEOROLOGICAL WORK AT BATAVIA.

From the 17th volume (for 1894) of the *Observations made at the Magnetical and Meteorological Observatory at Batavia,* we learn that the sub-director of the Observatory, Dr. S. Figee, is conducting an elaborate inquiry into the influence of the moon upon the magnetic elements at Batavia, some of the results of which study appear in the present volume. A large number of cloud photographs have also been taken at the Observatory, with satisfactory results, as a preparation for the work of the International Cloud Year. It is disappointing to note that it is feared the cloud observations by means of theodolites will prove to be too trying for the eyes of the observers at Batavia, and may have to be given up.

WEATHER MAP OF THE ST. LOUIS TORNADO.

THE Weather Bureau has issued what it calls a 'souvenir' weather map of the St. Louis tornado of May 27th. The sheet is of small size (8 in. by 10 in.). On one side there is a map showing the weather conditions over the United States on the evening of May 27th, with the tornado districts indicated by red crosses, and with brief descriptive text beneath. On the reverse side is an explanation of the wind, weather and temperature signals of the Bureau.

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NOTES UPON AGRICULTURE AND HORTICULTURE, VIII.

POTATO CULTURE.

WITHIN the past month no less than six bulletins have been issued by as many Stations upon potato culture or some phase of it.

HASTENING MATURITY OF POTATOES.

'HASTENING maturity' is the sub-title of bulletin No. 36 from the Rhode Island Station. Three methods of bringing about an earlier crop are considered and one in detail, as it has been tested at the Station. Director Flagg and Mr. Tucker write: "Maturity may be hastened in three ways. (a) By planting sets in pots in a greenhouse and transplanting to open ground; (b) by sprouting, that is planting sets thickly in a cold frame, and when ready to break ground transplanting them to the field, and (c) by building." For the latter small potatoes the size of hen's eggs are given heat and light for six weeks or so before planting time, thus causing a strong bud to develop and roots to form. The budded potatoes are placed in the field with the care given to onion sets, etc. A gain of 32 bushels per acre was obtained by this method over the ordinary way of planting.

CRIMSON CLOVER GOOD FOR POTATOES.

IN Bulletin No. 38 of the Maryland Station, Director Miller and Mr. Brinkley find that crimson clover plowed under increased the yield in 1894 thirty-six and in 1895 fifty per cent. Ridge and level culture have given the same results, and also deep and shallow cultivation proved of equal value. Spraying four times with Bordeaux mixture to prevent blight doubled the crop.

POTASH FOR POTATOES.

AT the Kentucky Station (Bulletin No. 61) Director Scovell found that potash was the most profitable commercial fertilizer to use, while the nitrates and phosphates were sometimes used at a financial loss. Several tests were made to check the scab; but here is an instance in which it is a misfortune for the enemy to fail to appear anywhere in the field and the results are postponed thereby.

SCAB AND INTERNAL BROWN ROT.

PROFESSOR GREEN in Minnesota Station Bulletin No. 45 reports that the subsoiling of heavy clay land increases somewhat the yield of potatoes. Considerable space is given, with engravings, to the report upon treatment for scab. The germ theory, or fungous nature of the disease is recognized in full, for it is stated that: "Perfectly clean seed planted on land which is free from scab fungus will always and in any season produce a crop of smooth clean potatoes, no matter what the character of the land. * * * Land infected by the germs of this disease will produce a more or less scabby crop, no matter how clean and smooth the seed is." It is recommended to dig scabby potatoes as soon as ripe, because the scab continues to grow so long as the potatoes are in the ground.

The internal brown rot works at the center of the potato, and all thus infested should be discarded as seed. The cause of this trouble is not given.

EARLY AND LATE POTATO BLIGHTS.

Bulletin 113 of the Cornell, N. Y., Station treats only of the diseases of the potato, giving several illustrations of these troubles and one coloritype plate of blight. Two leaves are shown in this, one of the 'early Blight' and the other of the 'late blight." The former is due to the fungus *Macrosporium Solani*, E. & M., and the latter to *Phytophthora infestans*, DeBy, a downy mildew which, when affecting the tubers, produces the potato rot, an old enemy in Europe, where it has caused famines, as in Ireland in 1846. Prof. Lodeman draws largely upon the literature of this blight, mentioning its rapid growth in and destruction of the attacked vines and the disagreeable odor of the ruined potatoes. The germ tube from the spore secretes a ferment that dissolves the cell wall of the host, and permits the parasite to pass through. The term 'late blight' came from the fact that the Phytophthora does not usually appear before August. The early blight comes sooner in the season, and usually the fungus follows after some injury, frequently the work of flea beetles. The earlier plantings of the same variety are the more affected by this blight.

Bordeaux is a satisfactory remedy for the late blight and a promising one for the early blight.

The cause of the scab is considered and the corrosive sublimate both highly recommended with the precaution that it be not used so strong as to injure the seed.

VARIETY TESTING OF POTATOES.

Bulletin 65 Ohio Station is devoted to the comparison of varieties of potatoes and experiments with fertilizers, by Profs. Green and McFadden. They maintain that variety trials are of much value only when the sorts are tested under several sets of conditions. It is the summing up of sets of trials that brings results of practical importance. Thus the three varieties that have averaged highest at the central and both sub-stations in Ohio are American Wonder, Columbus and Irish Daisy. Varieties that are the least influenced by variations of soil, climate, etc., they claim are the most valuable.

GOVERNMENT FARMERS' BULLETIN UPON POTATOES.

In addition to the above station bulletin the United States Department of Agriculture has issued a farmers' bulletin (No. 35) upon Potato Culture, by Mr. Duggar with the following sub-heads: Soil and rotation, manuring, varieties, planting, change of seed, side of seed pieces, distance in the row, mulching, storing, with a lengthy summary. This is a remarkably comprehensive, condensed and clear exposition of potato culture.

The impression at least is gained from the above notes that the potato is fully recognized by experimenters as a leading crop in the country and likewise a subject that is many sided and as yet far too little understood. Byron D. Halsted.

SCIENTIFIC NOTES AND NEWS.

SIR JOSEPH PRESTWICH.

At the meeting of the Geological Society of London, on June 24th, the President, Dr. Henry Hicks, said: It is with deep regret that I have to announce to you the death of our dear and much-beloved friend, Sir Joseph Prestwich. He was elected into the Society in the year 1833, and we had come to look upon him as the father of our Society. He served it as Treasurer and President and was one of its Wollaston Medallists, and we feel that by his death our Society loses one of its truest friends. He always gave us of his best, and delighted to communicate his knowledge to his fellow workers. He was in every respect a typical representative of our Society and its objects, for he passionately loved the science, fearlessly maintained what he believed to be the truth, and had that open mind and craving for knowledge which has ever characterized the best and noblest of its members. This is not the time to refer specially to his labors; but we may feel assured that such sterling work as he accomplished will ever hold an honored place in the annals of British geology. The Council at their sitting this afternoon passed the following resolutions, which I feel no doubt all the Fellows present will cordially endorse:

(1) That the President, Council and Fellows of the Geological Society of London desire to convey to Lady Prestwich the assurance of their heartfelt sympathy with her in the sad and irreparable loss that she has sustained, and at the same time to place on record their high appreciation of the lifelong geological work achieved by Sir Joseph Prestwich, who for sixty-three years was a member of their body, alike respected and beloved.

(2) That this Resolution be placed upon the Minutes, and a copy of it be communicated to Lady Prestwich.

The above resolutions were then passed unanimously.

'A NEW FACTOR IN EVOLUTION.'

UNDER this title Prof. J. Mark Baldwin has contributed an article to *The American Naturalist* (June and July) enlarging upon the views published by him in this JOURNAL (Aug. 23, 1895, Mar. 20, Apr. 10, 1896). Prof. Baldwin thus sums up the factors in evolution which he designates 'organic selection' and 'social heredity.'

"*Organic Selection.*—The process of ontogenetic adaptation considered as keeping single organisms alive and so securing determinate lines of variation in subsequent generations. Organic selection is, therefore, a general principle of development which is a direct substitute for the Lamarkian factor in most, if not in all instances. If it is really a new factor, then it deserves a new name, however contracted its sphere of application may finally turn out to be. The use of the word 'organic' in the phrase was suggested from the fact that the organism itself cooperates in the formation of the adaptations which are effected, and also from the fact that, in the results, the organism is itself selected; since those organisms which do not secure the adaptations fall by the principle of natural selection. And the word 'selection' used in the phrase is appropriate for just the same two reasons.

"*Social Heredity.*—The acquisition of functions from the social environment, also considered as a method of determining phylogenetic variations. It is a form of organic selection, but it deserves a special name because of its special way of operation. It is really heredity, since it influences the direction of phylogenetic variation by keeping socially adaptive creatures alive, while others which do not adapt themselves in this way are cut off. It is also heredity since it is a continuous influence from generation to generation. Animals may be kept alive, let us say, in a given environment by social cooperation only; these transmit this social type of variation to posterity; *thus social adaptation sets the direction of physical phylogeny and physical heredity is determined in part by this factor.* Furthermore, the process is all the while, from generation to generation, aided by the continuous chain of extra-organic or purely social transmissions. Here are adequate reasons for marking off this influence with a name."

GENERAL.

THE Astronomer Royal, Mr. Christie, has been unanimously elected corresponding member of the Paris Academy of Sciences in the place of the late Mr. Hind.

ADVICES from Japan state that the two American expeditions to observe the solar eclipse under the charge of Professors Todd and Schæberle, respectively, have reached Yokohama.

THE sum of $5,000 has been subscribed for the purpose of erecting a statue as a memorial to the late Wilhelm Mayer, of Copenhagen, the discoverer of adenoid vegetation of the pharynx. It appears that the largest sum has been subscribed in America (about $1,500), Great Britain and Denmark each having subscribed in the neighborhood of $1,200 and Germany $500.

MRS. HUXLEY, widow of Prof. T. H. Huxley, has been granted a Civil List pension of £200 a year.

AT the celebration of the centennial of the founding of the city of Cleveland, it was announced that Mr. John D. Rockefeller would give the city for a park 276 acres of land valued at more than $600,000.

THE *Hauer Medaille*, of the Vienna Geographical Society, and the gold *Kirchenpauer Medaille*, of the Geographical Society of Hanover, have been awarded to Prof. Neumayer, of Hamburg.

THE Ashmolean Museum, Oxford, was struck by lightning on July 7th. The fire was extinguished before damage was done to the valuable contents of the museum. There are four lightning conductors on the building, but the electric current struck a gable on which there was no conductor and traveled along a lead gutter and down a standpipe to the earth.

THE completed building of the Indian Institute at Oxford was declared open on July 1st by Lord George Hamilton, the Secretary of State for India. The building contains an oriental library and museum.

MR. PERCIVAL LOWELL, of Boston, has left for Flagstaff, Arizona, to continue observations on the planet Mars. He is accompanied by Mr. Alvan G. Clark, who will mount the new 24-inch telescope. Dr. T. J. J. See, of the University of Chicago, also accompanies the expedition in order to continue his observations on double stars.

PROF. G. D. HARRIS, of Cornell University, is spending the summer in Alabama, making paleontological collections for the University.

THE death is announced of Prof. A. G. Stoletow, professor of physics in the University of Moscow.

A LIFE of Fridtjof Nansen by W. C. Brögger and Nordhal Rolfsen has been published in Scandinavia.

PROF. HUGH C. MCLAUGHLIN died on July 20th at the age of 85. He had recently been a professor of classical languages and had formerly been Superintendent of the Bureau of Statistics.

THE daily papers state that Mr. William R. Brooks, director of Smith Observatory, while observing the moon recently with the large telescope, made a most interesting and unique discovery. A dark round object was seen to pass rather slowly across the moon in a horizontal direction. Mr. Brooks believes that it was the passage of a dark meteor between the earth and the moon, far beyond the earth's atmosphere, so that it remained non-luminous.

A NEW entomological journal, *Illustrierte Wochenschrift für Entomologie*, will hereafter be published by Neumann in Neudamm. It proposes to treat rather the biological relations of insects than systematic entomology.

THE *Scientific African*, a journal founded at the beginning of the present year in South Africa, has been compelled to suspend publication.

THE discontinuance of the publication *Climate and Health* is announced to take effect with the end of the present fiscal year, June 30, 1896. Vol. II., No. 3 (four weeks ended March 28, 1896), will be the last issue. It has been deemed necessary to take this action in view of a doubt having arisen as to whether the publication of *Climate and Health* was authorized by the act making appropriation for the Department of Agriculture for the fiscal year ending June 30, 1897. It is the intention of the Chief of the Bureau to have prosecuted during the coming fiscal year a number of special climatologic studies, and it is expected that the statistics collected during the present fiscal year will be of much value in this connection. The results of these special researches will, if their importance justifies it, be published in the form of special bulletins, at such times and in such shapes as the circumstances may warrant.

WE have received the first number of *The Laryngoscope*, a new monthly journal devoted to diseases of the nose, throat and ear, edited by Drs. F. M. Rumbold and M. A. Goldstein. The number opens with an article by Dr. S. Montbleyer on the Photo-Fluoroscope, describing applications of the X-Rays in laryngology.

PSYCHICAL research has assumed such dimensions that Mr. W. H. Myers finds it desirable to compile a glossary in the June number of the *Proceedings of the Society*. Many of the terms given are those commonly used in psychology and medicine, but we owe to Mr. Myers the invention, or at least wide application, of the words 'telepathy' and 'subliminal,' and we find here a number of other words suggested by him—'cosmopathic,' 'hyperpromethia,' 'methectic,' 'telergy,' etc., which we may not only soon find in the Century Dictionary, but may also hear on the street corners some day.

DR. LÉON BERTRAND, of Antwerp, describes in the *Medical Record* a fluoroscope in which double fluoride of uranyl and ammonium was used as the fluorescent substance. This is said to be fully as good as other substances, such as tungstate of calcium and to be much cheaper.

ON July 4th the Royal Societies' Club gave a complimentary dinner and reception to the newly elected Fellows of the Royal Society and the newly elected Royal Academicians and Academicians-elect. Speeches were made by Sir Clements Markham, Sir Robert Ball, Prof. Ray Lankester and others.

The Railway Review describes a foul-air indicator exhibited at the Industrial Exposition at Zurich, Switzerland, which is designed to show whether and in what degree the air in a workshop or other inhabited room is contaminated. The apparatus is described as consisting of an air-tight closed glass vessel filled with a red fluid. Through a glass tube that dips into the liquid and is bent at the top a drop falls every 100 seconds on a cord that hangs beneath and that is somewhat stretched by a weight. The fluid from which the drop comes has the property of changing its color by the action of carbonic acid. The more carbonic acid there is in the air the quicker this change in color takes place. If the air is very foul the drop becomes white at the upper end of the cord, while the change of color corresponding to a slight proportion of carbonic acid does not take place till the drop has run further along the cord. The exact condition of the air can be ascertained by observing a scale that is placed alongside the cord and divided into convenient parts, bearing the designations, 'extremely bad,' 'very bad,' 'passable,' 'pure.'

MM. BEAUREGARD and Dupuy have reported to the Paris Academy, experiments on electrical variation in the acoustic nerve when excited by a sound with one electrode placed on the tympanum and one on the nerve it was possible to note the variation of the current with the pitch of the sound which gives a method for determining the range of audibility for pitch in the lower animals.

UNIVERSITY AND EDUCATIONAL NEWS.

THE FUTURE OF AMERICAN COLLEGES AND UNIVERSITIES.

IN the *Atlantic Monthly* for August President Gilman takes the appearance of the memoirs of Barnard and McCosh as an occasion to review the progress and outlook of universities in America. President Gilman's article is of special interest, as he not only writes from wide knowledge, but also with the power to carry into effect the ideas that he advocates. He says: "Barnard came very near the right expression when he claimed that the university must be 'a school of all learning that the necessities of the age demand.' Whatever may be the best definition of a university, its functions are clearly to be discovered. It must above all things be a seat of learning, where the most cultivated scholars reside, where libraries, laboratories, and scientific collections are liberally kept up, and where the spirit of inquiry and investigation is perpetually manifested. It must be a shrine to which the outside world will resort for instruction and guidance upon the problems of the day, scientific, literary, educational, political. It must be a place from which are sent forth important contributions to science—theses, memoirs, books. Here every form of scientific investigation should be promoted. Researches too costly for ordinary purses should be prosecuted at the expense of the general chest. Expeditions should be sent forth from time to time to engage in investigations on the seashore or on the mountains. Physical and astronomical instruments of the most improved forms should be devised, procured and frequently renewed. The literatures of all nations, ancient and modern, should have their devotees. Every school of philosophy should be interpreted. Historical and political inquiry should be diligently promoted. The problems of modern society, economical, industrial, financial, administrative, philanthropic, demand the most careful examination. All these researches should go forward in an atmosphere of repose and leisure, very different from that of business and professional engagements.''

GENERAL.

THE *Ithaca Daily Journal* states that there are 179 students enrolled in the Cornell University summer school, exclusive of 40 students in the school of law. A large part of the students—58 per cent.—come from states other than New York.

DURING the last ten years the department of entomology of Cornell University has deferred the regular winter term's work until summer. These summer terms have been largely attended, and by many who are now holding professorships in other colleges or at experiment stations. The present summer term is attended by 18 students, 6 of whom are graduates, and a part of the graduates are professors of entomology in other colleges. Certainly, if insect life and the economic side of entomology are to receive due consideration, this plan of a summer instead of a winter term commends itself. There is also the advantage of not being disturbed by the demands of other subjects. It also makes more advanced work possible.

DR. THADDEUS L. BOLTON, of the faculty of the State Normal School at Worcester, has resigned to accept a position in the State Normal School at San José, Cal., at the head of the department of psychology, pedagogy and training of teachers.

DR. VAUGHAN HARLEY has been appointed to a newly established professorship of pathological chemistry in University College, London.

PROF. PAUL JACOBSON has been called to Berlin to fill the position of General Secretary of the German Chemical Society.

DRS. JOSSE and Kämmerer have been appointed full professors of engineering in the Technical High School of Berlin, and Prof. Schmidt, of Stuttgart, has been made director of the Weather Bureau at Würtemburg in the place of Prof. Mack, who has retired.

Garden and Forest states that the first horticultural school for women in Germany was opened at Friedenau, near Berlin, in the autumn of 1894, and it will graduate its first class of seven members next fall. One of the graduates will then assume the position of teacher in a similar school recently established at Riga, in Livonia. On the first of October next still another institution of the kind will be opened on the estate of Baroness Barth-Harmating, near Plauen, in Saxony. The courses of study extend over two or three years, and include not only the various branches of horticulture, but also fundamental scientific instruction and such knowledge of business methods as is needed for the successful prosecution of commercial gardening. Emphasis is laid upon the fact that the new work thus made possible for women is suitable for those of the cultivated classes, and not for uneducated or semi-educated rustics.

THE Duke of Devonshire has introduced in the House of Lords a bill, somewhat similar to that introduced by Lord Playfair in the last Parliament, consolidating the educational institutions of London with a view to the establishment of a great university. The report of the Cowper Commission has thus the support of the two English parties, but it is not likely that any progress will be made during the present session of Parliament.

THE issue of *Nature* for July 9th contains an extended article discussing the position of science at Oxford, which takes a somewhat discouraged view of the place of science in the University. It attributes the comparatively small number of students in the school of natural science in part to the lack of scientific instruction in the public schools, which is in turn due to the nature of the examinations required for entrance to the University, and in part to the fact that there are only three science tutors in all the colleges, while the course chosen by the student depends largely on the advice of his tutor.

DISCUSSION AND CORRESPONDENCE.

THE TEACHING OF ANATOMY.

TO THE EDITOR OF SCIENCE: It seems to me proper to take some exception to Prof. Mall's paper on this subject, which you quote from in the issue of July 10th, for there are many points connected with this question of great practical interest. I assume that Prof. Mall is speaking of teaching anatomy to medical students. If I am mistaken as to this, I have nothing but praise for his methods; but if he is speaking of medical education it seems to me that he puts himself out of court at once. He says: "The object of the laboratory is to teach students, to train investigators and to investigate. Although the first mentioned requires the greater portion of the instructor's time; its importance is by no means as great as the second and third." I submit that the first and most important duty of a professor in a medical school is to teach the students his branch in the manner best fitted to their future needs as practitioners of medicine. He must find time for scientific research when he can, and it must be subordinate to his teaching, and to his teaching for a practical purpose. Prof. Mall is very severe on the lecture system. He mentions that several professors, 'even' of anatomy, declare that they learned nothing that way. I wish my name to be added to the list; but I conceive the reason to be that I had no lectures worth listening to. It seems to me that there is a fallacy in calling the method stupid because none of us would choose it for himself were he a student. Of course, we would choose to be the private students of some distinguished anatomist; but this is impossible for all the members of a large class. Moreover, as implied above, we professors of anatomy are hardly fair representatives of the rank and file of medical students, who are studying anatomy as a means and not as an end. Again, I am not sure precisely what is meant by 'lectures,' as Prof. Mall admits that 'lectures with demonstrations are certainly valuable—more valuable than the lectures with text-books alone.' But who does lecture with a text-book? It is true that I have heard of a professor of anatomy who gave his class a certain number of pages of Gray learned by heart; but what competent man does not illustrate his lectures to the best of his ability? It is his duty to emphasize certain parts of his subject and to go lightly over others, to point out the practical deductions, to show what facts are for, what against, prevailing theories. If lectures are to be abolished the professor might be abolished too were it not necessary for him to lay out the course and to see it carried out. In a large school the teaching or guiding of small groups must of necessity be left to assistants of varying learning and of varying power of imparting it, and were there no lectures the professor's influence would be lost. There must be students of all grades, and to my mind those who learn the most from the lectures are the best ones. The worst are hopeless anyway; probably a little more so in the laboratory course that they neither understand nor appreciate.

But, though I firmly believe in the anatomical lecture, I believe in personal study, in demonstration to small classes, and in close supervision. I am developing these at Harvard as fast as I can. Prof. Mall's plan strikes me as most admirable for the training of scientists; I do not believe in it even for good medical students; certainly I do not want to have it implied that those who differ are behind the times in matters of medical education.

THOMAS DWIGHT.

HARVARD MEDICAL SCHOOL.

IS NOT THIS COUNTRY RIPE ENOUGH TO ADOPT THE METRIC SYSTEM?

ON reading in your issue of July 17, Prof. Slosson's clear and cogent exhibition of the present condition of Decimal Numeration in the United States, I am impressed by the rapidity with which a great change in the habits of thought of our people has been brought about. The paramount influence of the custom of reckoning in dollars and cents is palpable; it first became universal on the disappearance from circulation of the Spanish fractional coins which were common during the first half of this century. But beside that it is evident that the change of usage from 'common' fractions to decimals has been due in some measure to the improved general character of the school arithmetics, faulty enough though many of these books may still be. The change bears emphatic witness to the efficacy of scientific methods of teaching and to the good results which must necessarily follow from the action and reaction of scientific methods in the class room upon the affairs of every-day life. Barring the risk of some vicious compromise, it should be a hopeful sign for the speedy adoption of the metric system that the American people are now so thoroughly imbued with the decimal method of notation and have become impatient of other forms of reckoning.

As bearing on the difficulties felt to-day by several eminent Englishmen, I can testify that thirty years ago when serving in a great manufacturing establishment under a man of more than ordinary ability and intelligence, who had been thoroughly drilled in the intricacies of the older arithmetics, it was a matter of surprise to us youngsters that on presenting any decimal computation to our chief he invariably converted the decimals into vulgar fractions, not at all for the sake of the double verification of our work, but that he might comprehend clearly the matter in hand. We respected the thoroughness with which the old schooling had taken possession of the man, though we could not but marvel that the number of his fingers and toes had so little influenced the workings of his mind. I have reason to believe that many elderly merchants and manufacturers in this vicinity were at that time of the same habit and opinion as my friend; in fact, their training had been similar to his. But it would probably be difficult to find many such men in the country to-day.

It may seem incredible to most of your readers, as it does to myself, that the per cent. mark (%), now in universal use, is in this country a modern innovation. In the year 1858, on the occasion of printing a 'Dictionary of Solubilities,' I found that the charater % was unknown to the printers and type founders of Boston and Cambridge, and was not to be had in the market. At my instigation, and at my own expense, the leading type founder in Boston prepared at that time a punch and matrix and cast types of the character in question. It is of interest to remark, by the way, that the procuring of this type was the result of French influence. In my capacity of American *collaborateur* of the old *Répertoire de Chimie Appliquée,* I had become familiar with the economy and convenience of the per cent. mark.

As regards the inconvenience of changing from the present to the metric system, it seems to me that it would be felt more keenly in measurements relating to buildings than in the matter of weights or of measures of capacity. Most existing constructions have been made in terms of feet and inches. 'Dimension work' and 'dimension lumber,' all joists and beams, whether of wood or iron, bricks, boards, castings and moulds for castings, are measured by feet and inches. Plans and specifications have been drawn, stated and acted upon in these terms. Feet and inches have full possession of the bodies and souls of masons, carpenters and other mechanics, and it would doubtless be highly inconvenient in many instances, especially in the case of repairs and reconstructions, to make the inch and the centimeter lie down together harmoniously.

Here is an impediment which must be faced, and the public needs to be taught how much more rational it would be to accept the metric system in its entirety than to acquiesce in the gradual subdivision of our common measures into tenths, for the sake of a simplification which would be incomplete at the best. The practical experience of the French and other nations has shown emphatically that the difficulty just now mentioned is in no sense insuperable. Every instructed person knows that the inconveniences incidental to the adoption of the system have been met and overcome by most of the civilized nations. That some small hitches may have occurred in respect to nonessential details does not in the least detract from the great gain which has everywhere resulted from the adoption of the metric system. For example, it is simply amusing to hear the hawkers in the streets of Paris offer their *haricots verts* at so many *sous* the *demi*-kilo. The habit shows merely how, in the final shadings, strict verbal and logical accuracy must give way to a combination of inherited instinct or sentiment and practical convenience. There is no sense anyway or anywhere in stickling too strongly for *le pied de la lettre,* though for the sake of preventing fraud it was, perhaps, well enough for the French authorities to have accepted the term demi-kilogram rather than to have encouraged the perpetuation of the old word, *livre*. In respect to this country, however, there may be danger, as Prof. Slosson intimates, that we may after all drift into a less satisfactory system than the metric, in case the adoption of the latter should be too long delayed.

At the present moment we are really in some sort in the predicament of the boy blubbering at the street corner, who explained to the sympathetic stranger that his hands were so cold that he couldn't put on his mittens because it would 'hurt.' It would have been false and futile to have told the urchin that his hands were not cold or that the enterprise he shrank from could bring no pain, but it might have been well to convince him that he was a baby, and to have suggested ways and means of taking the leap with the least possible inconvenience.

F. H. STORER.

SCIENTIFIC LITERATURE.

Preliminary Synopsis of the American Bears. By DR. C. HART MERRIAM. Proc. Biol. Soc. Washington, X., 1896, pp. 65–83, pll. iv–vi. April 13, 1896.

Material for the comparative study of any of the larger mammals is exceedingly troublesome to bring together in satisfactory amount, owing to its bulky character and the labor and expense of its preparation and transportation. This is particularly the case with our North American bears, where the large series of specimens, skins as well as skulls, necessary for their detailed study, is especially difficult to acquire. By the expenditure of much time and labor Dr. Merriam has been able to gather for the present investigation about 200 skulls, but, owing to the lack of proper material, has been unable to treat of the external characters of the species and sub-species he believes are entitled to recognition. In fact, of several of the forms here for the first time recognized no skins exist in any of our museums. We, hence, have here merely a preliminary announcement of the results of a study of the cranial and dental characters, which is 'to be followed later by a more comprehensive treatise.' This preliminary announcement, however, is most welcome, since it has been for some time evident that the number of forms of North American bears is much greater than has been currently recognized.

As all are aware who have made a study of bears, the range of individual variation, in cranial as well as in external characters, is quite extended, in addition to which there is much variation due to age and sex. This Dr. Merriam duly concedes, and still finds, after making allowance for such differences, characters that appear to be constant, by which the species and sub-species may be recognized. In view of what is now known of the variability, with varying conditions of environment, of the smaller North American mammals, it is not surprising that Dr. Merriam has found it necessary to recognize a considerable number of new forms. Whether their status will be that of full species or in some cases that of sub-species merely, it is evidently too early to determine. Of the eleven species here formally admitted, five are described as new, and two additional sub-species are incidentally indicated as probably worthy of recognition.

Heretofore it has been customary to refer the bears of North America to three groups, consisting of the polar bear type, the grizzly bear type and the black bear type. To these Dr. Merriam adds the Sitka bear type and the Kadiak bear type. The polar bear was long since separated from the land bears as *Tholarctos maritimus* (Linn.), and remains thus far a monotypic group. The black bears were also some time since distinguished as a separate sub-genus (*Euarctos* Gray) of the genus *Ursus*, in which latter genus all the other North American bears are still retained.

Dr. Merriam considers that "the black bears may be separated into at least four species, having more or less circumscribed geographic ranges." He recognized of the grizzly bear group also four more or less marked forms. As distinct from the grizzlies, Dr. Merriam distinguishes, as already said, two other types of large bears, one of which consists of two species and the other of one, the *Ursus middendorffi*, 'the largest of living bears,' and 'differing markedly from the other American species.'

The species and sub-species recognized in this important paper are the following:

1. Polar Bear, *Thalarctos maritimus* Linn.

2. Kadiak Bear, *Ursus middendorffi* Merriam, of Kadiak and the Alaskan Peninsula.

3. Yakutat Bear *Ursus dalli* Merriam, from Yakutat Bay, Alaska.

4. Sitka Bear, *Ursus sitkensis* Merriam, from Sitka.

5. Grizzly Bear, *Ursus horribilis* Ord.

6. Alaska Grizzly, *Ursus horribilis alascensis* Merriam (nom. prob.).

7. Sonora Grizzly, *Ursus horribilis horriæus* Baird.

8. California Grizzly, *Ursus horribilis californicus* Merriam (nom. prob.).

9. Barren Ground Bear, *Ursus richardsoni* Reid.

10. Black Bear, *Ursus* (*Euarctos*) *americanus* Pallas.

11. Louisiana Bear, *Ursus* (*Euarctos*) *luteolus* Griffith.

12. Everglade Bear, *Ursus* (*Euarctos*) *floridanus* Merriam.

13. Glacier Bear *Ursus* (*Euarctos*) *emmonsi* Dall, St. Elias Alps, Alaska.

The paper is very fully illustrated, having seventeen cuts in the text and three plates, illustrating the dental and cranial characters of the forms recognized. Many of the figures of the skulls are reproductions from photographs.

J. A. A.

Elementarcurs der Zootomie in fünfzehn Vorlesungen. Von Dr. B. Hatschek und Dr. C. J. Cori. Jena, Gustav Fischer. 1896.

This new zootomy of viii. and 104 octavo pages, 18 plates and 4 text figures comes to us as a surprise after waiting so long (and apparently in vain) for the Vierte Lieferung of Hatschek's Lehrbuch der Zoologie. It devotes four lectures to Salamandra maculosa, one to Rana temporaria, two to Anodonta mutabilis, two to Helix pomatia, two to Astacus fluviatilis, two to Periplaneta orientalis, one to Lumbricus terrestris, and one to Hirudo medicinalis. Apus cancriformis and Hydrophilus piceus each constitutes an 'Anhang' to the eleventh and thirteenth lecture respectively. Of the plates four are devoted to the Salamander, one to Rana, two to Anodonta, two to Helix, three to Astacus, one to Apus, three to Periplaneta and Hydrophilus, one to Lumbricus and one to Hirudo.

The general plan of the book is to indicate first in a table or two the systematic position of the animal to be studied; then, as au introduction, give a brief account of the organization and relationship of the group to which the animal belongs, and then give an account of the external and the internal anatomy of the animal, preceding the accounts of the several systems of organs with brief laboratory directions. Practically it is a meager laboratory guide distributed in a text-book that aims to give the beginner a general survey of the animal kingdom in as short a time as possible, and with material most easily obtained at Prague.

The fish is omitted because a profitable study would require too much time, and the Coelenterata, Echinodermata and Ascidians are merely alluded to in the lectures, because laboratory work on these groups is impracticable in 'eines ganz elementaren Kurses.' When we read the lectures, the technical notes and examine the figures we exclaim what is a 'ganz elementar Kursus' at a university!

In the preface we are told this elementary course in zootomy is the outcome of a ten-years' experience at the University at Prague and that with respect to 'Form, Inhalt und Ausdehnung' it represents quite accurately the annual course of lectures and exercises given at the University. The object of the course, it is stated, is to acquaint the beginner with a mass of facts that in connection with the lectures upon theoretical zoology shall constitute a foundation for more advanced study.

All of this we are assured can be attained in fifteen two-hour periods! This will no doubt be welcome news to the lovers of the '14 weeks' courses which many of us mention with so much respect. Personally we have no time to waste upon such courses at our colleges or universities, and we even have our doubts as to their value in our high schools.

It is the unanimous verdict of careful observers that the American student in general is not a whit inferior to the German student, and yet these authors would have us believe their beginners in zoology study 'in fruchtbringender Weise' the vascular and nervous systems of Salamandra maculosa—listening to the lecture, dissecting and making sketches and notes of these systems—in two hours! And this at the beginning of the course! This same course also provides laboratory work on Apus and Hydrophilus in addition to that on two other Arthropods, but can not get time for any work on the fish or the Echinodermata or the Coelenterata. We can crowd ourselves enough to pass the Tunicata, but we can hardly comprehend how a man capable of beginning so promising a work as the 'Lehrbuch der Zoologie' can so lightly pass over these magnificent groups.

As to the figures we are bound to say that in point of distinctness most of them are inferior to those of well known standard works. The shading is often poorly done, though they are all neat and clean. Originality, however, is hardly enough to justify a new figure, particularly if it is to appear in a text-book for some good. Unless a figure is a decided improvement in some respect or other we prefer to have it remain the exclusive property of the author and his students. Some of the figures are of necessity so much like well known old ones that they have nothing to specially recommend them.

It is undoubtedly a mistake to introduce into an elementary course individual views of matters in dispute. The authors have not sinned grossly in this respect; still the 'Cladus' and 'Anhang' ideas might have been kept out without impairing the value of the book. We even get the accounts of Apus and Hydrophilus as Anhänge.

The hope of the authors that their 'Büchlein' will prove useful to others may be realized to some extent in Germany; but for the English teacher and student, excepting the descriptions and illustrations of animals not taken up so fully in other books, there is nothing in it to recommend it above any of the good books now available. HENRY F. NACHTRIEB.

SCIENTIFIC JOURNALS.

THE PHYSICAL REVIEW, JULY–AUGUST.

On the Measurement of the Expansion of Metals by the Interferential Method: By E. W. MORLEY and WM. A. ROGERS. The first part of this article by Prof. Morley is devoted to a description of the method used, which consists essentially in measuring the change in length, during the heating or cooling of a test bar, by observing the displacement of interference bands. These bands result from the interference of beams of monochromatic light reflected from mirrors which are placed at the ends of the test bar and a constant temperature bar respectively. A later article will contain the results of an actual trial of the method. As in all cases where interference phenomena are used, the method demands great care in all details and is capable of extreme accuracy. Prof. Morley discusses the sources of error and the means of avoiding them at some length and in a very practical manner. A difficulty which one would not be apt to think of arose when the sodium flame was used as a source of light; for the number of bands to be counted was so great (five or six thousand) that the slight difference in wave-length between the two sodium lines caused a great decrease in the visibility of the bands in certain regions. Thus when about 3,400 bands had been counted, the fringes were so obscure that the next hundred could hardly be observed at all.

The Viscosity of Polarized Dielectrics: By A. W. DUFF. Professor Duff finds that the viscosity of certain non-conducting liquids, such as glycerine and castor oil, is increased when the liquid is subjected to considerable electrostatic stress. The increase observed was small, being expressed in fractions of one per cent., but the fact of its existence seems to be definitely proved. The change was measured by observing the rate of descent of small spheres which were allowed to fall through the liquid between two oppositely charged plates. If, as seems probable, Prof. Duff's results are confirmed, we have here a new class of electrical phenomena, doubtless intimately connected with the electrostatic Kerr effect.

Note on the Theorem of Clausius: By EDGAR BUCKINGHAM. Prof. Buckingham's object is to give a demonstration of what we usually refer to as the 'Second Law of Thermodynamics,' for cases not considered in Clausius' original proof and usually treated very briefly by his followers. The cases considered are (1) systems whose state is defined by only one coordinate besides the temperature, but where the work done is not necessarily confined to overcoming pressure. The coordinate used to define the state may be of the most general type; *e. g.*, quantity of electricity, as used by Helmholtz. (2) Systems whose state is defined by more than two coordinates. An example of such a case would be an electrolytic cell in which the effect of pressure is not negligible. Professor Buckingham's article gives an interesting discussion of the graphical, as well as the analytical, treatment of such cases. The article is one which will do good, for the subject is one which must be presented in many different forms, as well as with great clearness, if our text-books are to be freed from the hazy and unsound treatments of Thermodynamics with which they now abound.

The Refractive Index and Reflecting Power of Water and Alcohol for Electric Waves: By A. D. Cole. In preliminary work the index of refraction for waves 260 cm. long was found to be 8.95 for water and 5.24 for alcohol. These results are in fair agreement with values obtained by other observers, as well as with the values computed according to Maxwell's theory from the dielectric constants. Using much shorter waves (5 cm.) Prof. Cole then again determined the indices, the object being to find at what wave-length dispersion begins. The absorption of both liquids was so great that a prism method could not be used, even with the delicate means at hand for detecting and measuring the waves. The method finally adopted depended upon the measurement of the *reflecting power* of the two liquids. The index was then computed by Fresnel's formula. The values obtained were 8.85 for water and 3.2 for alcohol. It thus appears that there is considerable dispersion by alcohol between the wave-lengths 260 and 5 cm.

A New Electrolytic Generator for Oxygen and Hydrogen: By W. S. Franklin.

An Apparatus for Illustrating the Laws of Falling Bodies: By H. M. Randall and W. A. Markey.

Books reviewed: Gray and Mathews, *Bessel Functions;* Groth, *Physikalische Krystallographie;* Jahn, *Grundriss der Thermochemie;* Preston, *Light.*

SOCIETIES AND ACADEMIES.

NORTH CAROLINA SECTION OF THE AMERICAN CHEMICAL SOCIETY.

The second meeting of the North Carolina Section of the American Chemical Society was held in Chapel Hill, N. C., on July 7, 1896. The Secretary reported ten new members as received since the last meeting. After the transaction of some routine business the following papers were read: 'Crystallized Aluminium,' by F. P. Venable; 'The Detection and Purification of Saccharin,' by B. W. Kilgore; 'Reduction of Sulphuric Acid,' by C. Baskerville; 'A Comparison in Digestibility of Raw and Steamed Cotton Seed,' by J. A. Bizzell and A. H. Prince; 'An Attempt to Form Some Organic Compounds of Zirconium,' by Thos. Clarke; 'The Determination of Sulphur in the Presence of Iron,' by W. A. Withers and R. G. Mewborne; 'The Action of Phosphorus Trichloride upon an Ethereal Solution of Hydrogen Dioxide,' by W. A. Withers and G. S. Fraps; 'Some Difficulties in the Way of the Periodic Law,' by F. P. Venable. The Section then adjourned to meet in Raleigh next winter. The Section has doubled its numbers in less than six months.

NEW BOOKS.

Herbart's A B C of Sense—Perception and Minor Pedagogical Works. Translated with Introduction, Notes and Commentary, by William J. Eckoff. New York, D. Appleton & Co. 1896. Pp. xviii+288. $1.50.

Grundriss einer exacten Schöpfungsgeschichte. By Hermann Habenicht. Wien, Pest, Leipzig, A. Hartleben. Pp. viii+135. Plates vii.

Tenth Report of the New York State Entomologist, for the year 1894. J. A. Lintner. Albany, University of the State of New York. 1895. Pp. 341–633.

Manual of Midwifery. W. E. Fothergill. New York and London, Macmillan & Co. 1896. Pp. xiiii+484. $2.25.

The Monetary and Banking Problem. Logan G. McPherson. New York, D. Appleton & Co. 1896. Pp. iv+135. $1.00.

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CONTENTS:

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

NATURE STUDY AND MORAL CULTURE.*

IN making a plea for nature study as a means of moral culture I do not wish to make an over-statement, nor to claim for such study any occult or exclusive power. It is not for us to say, so much nature in the schools, so much virtue in the scholars. The character of the teacher is a factor which must always be counted in. But the best teacher is the one that comes nearest to nature, the one who is most effective in developing individual wisdom. To seek knowledge is better than to have knowledge.

The essence of character building lies in action. Precepts of virtue are useless unless they are built into life. At birth or before, "the gate of gifts is closed." It is the art of life, out of variant and contradictory materials passed down to us from our ancestors, to build up a coherent and effective individual character. Character building is action, not imitation. The chief value of nature study in character building is that, like life itself, it deals with realities. The experience of living is of itself a form of nature study. One must, in life, make his own observations, frame his own inductions, and apply them in action as he goes along. The habit of finding out the best thing to do next and then doing it is the basis of character. A strong character is built up by doing, not by imitation, nor

* Presented at the National Educational Association at Buffalo, N. Y., July 10, 1896.

by feeling, nor by suggestion. Nature study if it be genuine is essentially doing. This is the basis of its effectiveness as a moral agent. To deal with truth is necessary if we are to know truth when we see it in action. To know truth precedes all sound morality. There is a great impulse to virtue in knowing something well. To know it well is to come in direct contact with its facts or laws; to feel that its qualities and forces are inevitable. To do this is the essence of natures study in all its forms.

The claim has been made that history treats of the actions of men, and that it therefore gives the student the basis of right conduct. But neither of these propositions is true. History treats of the records of the acts of men and nations. But it does not involve the action of the student himself. The men and women who act in history are not the boys and girls we are training. Their lives are developed through their own efforts, not by contemplation of the efforts of others. They work out their problem of action more surely by dissecting frogs or hatching butterflies than by what we tell them of Lycurgus or Joan of Arc. Their reason for virtuous action must lie in their own knowledge of what is right, not in the fact that Lincoln or Washington or William Tell or some other half-mythical personage would have done so and so under like conditions. The rocks and shells, the frogs and lilies, always tell the absolute truth. Association with these, under right direction, will build up a habit of truthfulness, which the lying story of the cherry tree is powerless to effect. If history is to be an agency for moral training it must become a nature study. It must be the study of original documents. When it is studied in this way it has the value of other nature studies. But it is carried on under great limitations. Its manuscripts are scarce, while every leaf on the tree is an original document. When a thousand are used or used up, the archives of nature are just as full as ever. From the intimate affinity with the problems of life, the problems of nature study derive a large part of their value. Because life deals with realities, the visible agents of the overmastering fates, it is well that our children should study the real rather than the conventional. Let them come in contact with the inevitable instead of the made-up, with laws and forces which can be traced in objects and forms actually before them rather than with those which seem arbitrary or which remain inscrutable. To use concrete illustrations, there is a greater moral value in the study of magnets than in the distinction between shall and will, in the study of birds or rocks than in that of diacritical marks or postage stamps, in the development of a frog than in the longer or the shorter catechism, in the study of things than in the study of abstractions. There is doubtless a law underlying abstractions and conventionalities, a law of catechisms, or postage stamps, or grammatical solecisms, but it does not appear to the student. Its consideration does not strengthen his impression of inevitable truth. There is the greatest moral value as well as intellectual value in the independence that comes from knowing, and knowing that one knows and why he knows. This gives a spinal column to character, which is not found in the flabby goodness of imitation or the hysteric virtue of suggestion. Knowing what is right and why it is right before doing it is the basis of greatness of character.

The nervous system of the animal or the man is essentially a device to make action effective and to keep it safe. The animal is a machine in action. Toward the end of motion all other mental processes tend. All functions of the brain, all forms of nerve impulse, are modifications of the simple reflex action, the automatic transfer of sensations derived from external objects into movements of the body.

The sensory nerves furnish the animal or man all knowledge of the external world. The brain, sitting in absolute darkness, judges these sensations, and sends out corresponding impulses to action. The sensory nerves are the brain's sole teachers; the motor nerves and through them the muscles are the brain's only servants. The untrained brain learns its lessons poorly and its commands are vacillating and ineffective. In like manner the brain which has been misused shows its defects in ill-chosen action, the action against which nature protests through her whip of misery. In this fact that nerve alteration means ineffective action, lying brain and lying nerves, rests the great argument for temperance, the great argument against all forms of nerve tampering, from the coffee habit to the 'protracted meeting.'

The senses are intensely practical in their relation to life. The processes of natural selection make and keep them so. Only those phases of reality which our ancestors could render into action are shown to us by our senses. If we can do nothing in any case, we know nothing about it. The senses tell us essential truth about rocks and trees, food and shelter, friends and enemies. They answer no problems in chemistry. They tell us nothing about atom or molecule. They give us no ultimate facts. Whatever is so small that we cannot handle it is too small to be seen. Whatever is too distant to be reached is not truthfully reported. The 'X-rays' of light we cannot see, because our ancestors could not use them. The sun and stars, the clouds and the sky, are not at all what they appear to be. The truthfulness of the senses fails as the square of the distance increases. Were it not so we should be smothered by truth. We should be overwhelmed by the multiplicity of our own sensations, and truthful response in action would become impossible. Hyperæsthesia of any or all of the senses is a source of confusion, not of strength. It is essentially a phase of disease and shows itself in ineffectiveness, not in increased power. Besides the actual sensations, the so-called realities, the brain retains also the sensations which have been and are not wholly lost. Memory pictures crowd the mind, mingling with pictures which are brought in afresh by the senses. The force of suggestion causes the mental states or conditions of one person to repeat themselves in another. Abnormal conditions of the brain itself furnish another series of feelings with which the brain must deal. Moreover the brain is charged with impulses to action, passed on from generation to generation, surviving because they are useful. With all these arises the necessity for choice as a function of the mind. The mind must neglect or suppress all sensations which it cannot weave into action. The dog sees nothing that does not belong to its little world. The man in search of mushrooms, 'tramples down oak trees in his walks.' To select the sensations that concern us is the basis of the power of attention. The suppression of undesired actions is the function of the will. To find data for choice among the possible motor responses is a function of the intellect. Intellectual persistency is the essence of individual character.

As the conditions of life become more complex it becomes necessary for action to be more carefully selected. Wisdom is the parent of virtue. Knowing what should be done logically precedes doing it. Good impulses and good intentions do not make action right or safe. In the long run action is tested, not by its motives, but by its results.

The child when he comes into the world has everything to learn. His nervous system is charged with tendencies to reaction and impulses to motion, which have their origin in survivals from ancestral experience. Exact knowledge by which his own actions can be made exact must come through his own experience. The experience of others must be expressed in terms of his own before it becomes wisdom. Wisdom is knowing what it is best to do next. Virtue is doing it. Doing right becomes habit if it is pursued long enough. It becomes a 'second nature' or a higher heredity. The formation of a higher heredity of wisdom and virtue of knowing right and doing right is the essence of character building. The moral character is based on knowing the best, choosing the best and doing the best. It cannot be built up on imitation. By imitation, suggestion and conventionality the masses are formed and controlled. To build up a man is a noble process, demanding materials and methods of a higher order. The function of individual education is to break up the masses. Only the robust man can make history. Others may adorn it, disfigure it or vulgarize it. The growth of man is the assertion of individuality.

The first relation of the child to external things is expressed in this: What can I do with it? What is its relation to me? The sensation goes over into thought, the thought into action. Thus the impression of the object is built into the little universe of his mind. The object and the action it implies are closely associated. As more objects are apprehended, more complex relations arise, but the primal condition remains. What can I do with it? Sensation, thought, action—this is the natural sequence of each completed mental process. As volition passes over into action, so does science into art, knowledge into power, wisdom into virtue.

By the study of realities wisdom is built up. In the relation of objects he can touch and move, the child comes to find the limitations of his power, the laws that govern phenomena and to which his actions must be in obedience. So long as he deals with realities these laws stand in their proper relation. "So simple, so natural, so true," says Agassiz. "This is the charm of dealing with nature herself. She brings us back to absolute truth so often as we wander."

So long as a child is led from one reality to another, never lost in words or in abstractions, so long this natural relation remains. "What can I do with it?" is the beginning of wisdom. "What is it to me?" is the basis of personal virtue.

So long as a child remains about the home of his boyhood he knows which way is north and which is east. He does not need to orient himself, because in his short trips he never loses his sense of space direction. But let him take a rapid journey in the cars or in the night and he may find himself in strange relations. The sun no longer rises in the east, the sense of reality in direction is gone, and it is a painful effort for him to join the new impressions to the old. The process of orientation is a difficult one, and if facing the sunrise in the morning were a deed of necessity in his religion this deed would not be accurately performed.

This homely illustration applies to the child. He is taken from his little world of realities, a world in which the sun rises in the east, the dogs bark, the grasshopper leaps, and the water falls, and the relations of cause and effect appear simple and natural. In these simple relations moral laws become evident. "The burnt child dreads the fire," and this dread shows itself in action. The child learns what to do next, and to some extent does it. By practice in personal responsibility in little things, he can be led to wisdom in large ones. For the power to do great things in the moral world comes from doing the right in small things. It is not often that a man who knows that there is a right does the wrong. Men who do wrong are either ignorant that there is a right or else they have failed in their orientation and look upon right as wrong. It is the clinching of good purposes with good actions that makes the man. This is the higher heredity; that is not the gift of father or mother, but is the man's own work on himself. The impression of realities is the basis of sound morals as well as of sound intellect. By adding near things to near, the child tends to grow into wisdom. 'Knowledge set in order' is science.

Nature study is the beginning of science. It is the science of the child. To the child training in methods of acquiring knowledge is more valuable than knowledge itself. In general throughout life sound methods are more important than sound information. Self-direction is more important than innocence. The fool may be innocent; only the sane and the wise can be virtuous.

It is the function of science to find out the real nature of the universe. Its purpose is to eliminate the personal equation and the human equation in statements of truth. By methods of precision of thought and instruments of precision in observation it seeks to make our knowledge of the small, the distant, the invisible, the mysterious, as accurate as our knowledge of the common things men have handled for ages. It seeks to make our knowledge of common things exact and precise that exactness and precision may be translated into action. The ultimate end of science, as well as its initial impulse, is the regulation of human conduct. To make right action possible and prevalent is the function of science. The 'world as it is' is the province of science. In proportion as our actions conform to the conditions of the world as it is do we find the world beautiful, glorious, divine. The truth of the 'world as it is' must be the ultimate inspiration of art, poetry and religion. The world, as men have agreed to say it is, is quite another matter. The less our children hear of this, the less they will have to unlearn in their future development.

When a child is taken from nature to the schools he is usually brought into an atmosphere of conventionality. Here he is not to do, but to imitate; not to see nor to handle, nor create, but to remember. He is, moreover, to remember not his own realities, but the written or spoken ideas of others. He is dragged through a wilderness of grammar with thickets of diacritical marks into the desert of metaphysics. He is taught to do right, not because right action is in the nature of things, the nature of himself and the things about him, but because he will be punished somehow if he does not.

He is brought into a medley of words without ideas. He is taught declensions and conjugations without number in his own and other tongues. He learns things easily by rote, so his teachers fill him with rote learning. Hence grammar and language have become stereotyped as education, without a thought as to whether undigested words may be intellectual poison. And as the good heart depends on the good brain, undigested ideas become moral poison as well.

In such manner the child is bound to lose his orientation as to the forces which surround him in life. If he does not recover it he will live in a world of mixed fancies and realities. Nonsense will seem half truth, and his appreciation of truth will be vitiated by its lack of clearness of definition, by its close relation to nonsense. That this is no slight defect can be shown in every community. There is no intellectual craze so absurd as not to have a following among educated men and women. There is no scheme for the renovation of the social order so silly that educated men will not invest their money in it. There is no medical fraud so shameless that educated men will not give it their certificate. There is no nonsense so unscientific that men called educated will not accept it as science. It should be a function of the schools to build up common sense. Folly should be crowded out of the schools. We have built costly lunatic asylums for its accommodation. That our schools are in a degree responsible for current follies there can be no doubt. We have among us many teachers who have never seen a truth in their lives. There are many who have never felt the impact of an idea. There are many who have lost their own orientation in their youth, and who have never since been able to point out the sunrise to others. It is no extravagance of language to say that diacritical marks lead to the cocoaine habit, nor that the ethics of metaphysics points the way to the higher foolishness. There are many links in the chain of decadence, but its finger posts all point downward.

"Three roots bear up dominion, knowledge, will, the third obedience." This statement which Lowell applies to nations belongs to the individual man as well. It is written in the structure of his brain: Knowledge, Volition, Action; and all three elements must be sound if action is to be safe or effective.

But obedience must be active, not passive. The obedience of the lower animals is automatic, and therefore in its limits measurably perfect. Lack of obedience means the extinction of the race. Only the obedient survive, and hence comes about obedience to 'sealed orders,' obedience by reflex action in which the will takes little part.

In the early stages of human development the instincts of obedience were dominant. Great among these was the instinct of conventionality by which each man follows the path others have found safe. The Church and the State, organizations of the strong, have assumed the direction of the weak. It has often resulted that the wiser this direction the greater the weakness it was called on to control. The 'sealed orders' of human institutions took the place of the automatism of instinct. Against 'sealed orders' the individual man has been in constant protest. The 'Warfare of Science' was part of this long struggle. The Reformation, the Revival of Learning, the Growth of Democracy, are all phases of this great conflict. The function of democracy is not good government. If that were all it would not deserve the efforts spent on it. Better government than any king or congress or democracy has yet given could be obtained through the automatic processes of competitive examinations. By this we could get along with one-half our number of rulers and at one-fourth the present cost. Even an ordinary intelligence office or employment bureau for statesmen would serve us better than we are served by caucus and convention. But not for long. The people who could be ruled in this way would be a people not worth saving. But this is not the point at issue. Government too good as well as too bad may have a baneful influence on men. Its character is a secondary matter. The function of self-government is to intensify individual responsibility, to promote abortive attempts at wisdom, through which true wisdom may come at last. Democracy is a nature study on a grand scale. The Republic is a huge laboratory of civics, a laboratory in which strange experiments are performed, but by which, as in other laboratories, wisdom may arise from experience, and having arisen may work itself out into virtue.

"The oldest and best endowed university in the world," Dr. Parkhurst tells us, "is life itself." "Problems tumble easily apart in the field that refuse to give up their secret in the study or even in the closet.

Reality is what educates us, and reality never comes so close to us with all its powers of discipline as when we encounter it in action. In books we find truth in black and white, but in the rush of events we see truth at work. It is only when truth is busy and we are ourselves personally mixed up in its activities that we learn of how much we are capable, or win the power by which these capabilities can be made over into effect."

Mr. Jackman has well said: "Children always start with imitation, and very few people ever get beyond it. The true moral act, however, is one performed in accordance with a known law that is just as natural as the law which determines which way a stone shall fall. The individual becomes moral in the highest sense when he chooses to obey this law by acting in accordance with it."

Conventionality is not morality and may co-exist with vice as well as with virtue; for the obedience which lasts is the product of individual knowledge and will. It is the progressive response to higher and higher laws and as the individual comes to recognize them in his own experience. The welfare of man is not primarily security from deception and evil influences. It goes with the growth of his power to recognize illusions and to base his action on realities. Obedience induced by deception cannot be permanent. Wrong information, it is true, may lead to right action, as falsehood may secure obedience to a natural law which would otherwise be violated. But in the long run, men and nations pay dearly for every illusion they cherish. For every sick man healed at Denver or Lourdes, ten well men will be made sick. Faith cure and patent medicine feed on the same victims. For every Schlatter who is worshipped as a saint, some equally harmless lunatic will be stoned as a witch. This scientific age is beset by the non-science which its altruism has made safe. The development of the common sense of the people has given security to a vast cloud of follies, which would be destroyed in the unchecked competition of life. It is the soundness of our age which has made what we call its decadence possible. It is the undercurrent of science which has given security to human life, a security which obtains for fools as well as for sages.

For protection against all these follies which so soon fall into vices or decay into insanity, we must look to the schools. A sound recognition of cause and effect in human affairs is our best safeguard. The old common sense of the 'unhighschooled man,' aided by instruments of precision and directed by logic, must be carried over into the schools. Clear thinking and clean acting, we believe, is a product of the study of nature. When men have made themselves wise, in the wisdom which may be completed in action, they have never failed to make themselves good. When men have become wise with the lore of others, the learning which ends in self and does not spend itself in action, they have been neither virtuous nor happy. "Much study is a weariness of the flesh." Thought, without action, ends in intense fatigue of soul, the disgust with all the 'sorry scheme of things entire,' which is the mark of the unwholesome and insane philosophy of pessimism. This philosophy finds its condemnation in the fact that it has never yet been translated into pure and helpful life.

With our children the study of words and abstractions alone may in its degreee produce the same results. Nature studies have long been valued as a 'means of grace' because they arouse the enthusiasm, the love of work, which belongs to open-eyed youth. The child blasé with moral precepts and irregular conjugations turns with delight to the unrolling of ferns and the song of birds. There is a moral training in clearness and tangibility. An occult impulse to vice is hidden in all vagueness and in all teachings meant to be heard, but not to be understood. Nature is never obscure, never occult, never esoteric. She must be questioned in earnest, else she will not reply. But to every serious question she returns a serious answer. 'Simple, natural and true' should make the impression of simplicity and truth. Truth and virtue are but opposite sides of the same shield. As leaves pass over into flowers and flowers into fruit, so are wisdom, virtue and happiness inseparably related.

DAVID STARR JORDAN.

OBSERVATIONS ON THE RELATION OF PHYSICAL DEVELOPMENT TO INTELLECTUAL ABILITY, MADE ON THE SCHOOL CHILDREN OF TORONTO, CANADA.

IN the spring of 1892 Dr. Franz Boas, then of Clark University, Worcester, Mass., obtained the necessary permission from the Toronto School Board to make anthropometric observations upon the school children of that city. The observations were made by the teachers of the various schools upon the children under their immediate charge. The teachers were instructed as to the method of taking the measurements by Mr. A. F. Chamberlain of Clark University, and the subsequent work was carried on under his immediate supervision. The measurements made by the teachers were stature, weight and finger reach. Besides the statistical information regarding age, sex, parentage, etc., the teachers were also requested to group the children as to their mental ability into three as nearly as possible equal divisions of 'good,' 'average' and 'poor.' They were to make their estimate, not on the mere class standing, which would be influenced by such irrelevant matters as regularity and punctuality of attendance, etc., but upon the observed natural intellectual quickness, general aptitude for assimilation of ideas and initiative. At the same time that these observations were carried on, a similar series of observations was being made in Worcester. There it was soon made manifest that any such classification of children's mental ability would be very greatly influenced by the mental calibre of the teacher making such classification, and in all cases it rested almost exclusively upon the markings of the class book. There was a further fact which was brought

very sharply to my notice, and that was that in most class rooms there were *no poor scholars*. The teachers were perfectly willing to classify the scholars as of 'good' and 'average' intelligence, but any intimation of the presence of 'poor' or stupid scholars was taken as a personal reflection upon the teacher of the class in question. The result was that what was primarily intended for a classification upon the lines of excellence, mediocrity and stupidity became a classification upon the basis of the two first qualities only. What occurred in Worcester was evidently the key to what occurred in Toronto. There also the 'poor' students were no more than a mere handful and had to be disregarded in making up the material from the point of view of the groups 'good,' 'average,' 'poor,' though not with regard to the general average of the city. Between the other two classes the material was quite evenly distributed.

The stature was taken, the child standing erect, heels together and shoes removed, by means of a straight rod marked in centimeters against which the child stood, an arm at right angles to the upright being brought in contact with the top of its head and the scale read at the nearest centimeter. For finger reach the child was required to stand straight, place the middle finger of one hand against the wall and stretch with both arms at their greatest extent along the rod mentioned before, held horizontally at the height of its arm, the arm of the rod being brought in touch with the middle finger of its other hand and the scale read as before at the nearest centimeter. The weight was taken on the ordinary weighing scales in ordinary indoor costume and was recorded in pounds.

The material has been arranged according to sex and age, the children being grouped according to age within the full year, *i. e.*, children between five and six are classed as five years of age. Thus the children are on an average a half year older than the tables represent. The separation into annual groups being made, the various measurements were then tabulated and the average found. This was done by taking the sum of the observations of one kind within the year and dividing the result by the total number of cases for the same year.

In working up this material it was necessary first to form the general average for each series of observations for the whole school population and then the averages of the two classes of 'good' and 'poor' students. The averages of these two classes were then compared with the general averages.

We have, therefore, in our tables six groups, three for boys and three for girls. Examining the tables we find that the general rule is that the 'poor' children are more fully developed than the 'good' children, though in each series of measurements there are one or two cases where the 'good' children show a higher average than the 'poor.' These cases are generally near the latter end of the series. In the case of girls' stature this is so at fourteen years, of boys' weight at thirteen years, while for girls' weight it is at ten years. In the case of boys' and girls' finger reach, the preponderance of the 'good' is seen at thirteen and fourteen. Again, in boys' weight the 'good' are the heavier from five to seven, inclusive, and the finger reach at six and seven. The most striking difference between the two groups is in the case of stature for both sexes. The 'poor' are the better developed throughout, except, as before noticed, in the case of girls of fourteen and possibly boys of thirteen. There is generally about half an inch difference in the averages of the two groups in favor of the 'poor' students. In the case of weight this difference is not so marked.

The reason for these differences is probably the following: As I have said, the children of 'good' ability were probably so designated from their class standing, and their class standing was undoubtedly in many cases due to a greater amount of 'pushing' on the part of their parents. This would naturally mean a diminution in the amount of exercise, resulting in decreased rate of growth, while, on the other hand, their more sedentary life would result in a greater relative girth and consequent weight. The weight depending on the stature as well as on the girth, we have the reason for the less marked difference in weight between these two classes than between the same classes in respect to stature. The difference in stature is fairly constant; the difference in weight fluctuates considerably. We see here, from both points of view, the relative effects of insufficient and of proper exercise. On comparing the difference between the two pairs of groups of the girls and the corresponding groups of the boys we find that there is less contrast in the case of the former than in that of the latter. The diagram illustrating the girls' stature is fairly regular in both groups and the difference fairly constant and comparable with that of boys. But when we examine the weight groups we find the girls' diagrams to be much more irregular and the differences much more marked. It is difficult to estimate the cause of this difference, unless it be that the difference in exercise taken by the two groups of girls is more than that taken by the two groups of boys, though the reverse would seem to be most probable. The meaning of the remarkable irregularity of the curves of finger reach is not apparent. The differences in favor of the 'poor' children is due to the fact that the finger reach bears a fairly constant, though not exact, ratio to the stature. This is seen in the general trend of the curves of stature and of finger reach.

On the whole, we may from these observations consider it safe to say that precocity bears an inverse ratio to bodily development. In making this statement, however, we are directly contradicting the result set forth by Dr. W. Townsend Porter, in his paper on 'The physical basis of precocity and dullness' (Transactions of the Academy of Science of St. Louis, Vol. VI., No. 7). A short discussion will perhaps show the reason for this discrepancy. In the first place, we find that Dr. Porter has grouped his material in two ways; first as to age, and next within the age, as to school grades. In this way he has made the school grade of the pupil the criterion of his mental powers. The policy of this arrangement will be appreciated at once when it is remembered that the school grade of the child depends partly upon the age at which he entered school, *e. g.*, a child who enters the I. grade at nine years of age will naturally not be so far advanced in his studies as a child who enters that grade at six years of age, and who at nine years would naturally be in the IV. grade. Again, it would be necessary to ascertain whether the pupil has been able to attend regularly. The reason of the two children's entrance at the respective ages mentioned might depend upon a variety of causes irrelevant to the question of their mental caliber, as means, health, and, in the case of a large heterogeneous population, knowledge of the language. Any or all of these would serve to determine the child's grade irrespective of its ability. In the material obtained from Toronto this error has been avoided by considering the two questions of school standing in the class and the measurement, and these only. We thus avoid the question of the age at which the child first entered school, and the question whether its attendance has been continuous. Dr. Porter ignores these and evidently proceeds on the hypothesis that all children enter school at the same age and pursue their studies uninteruptedly thereafter, both of which are assuredly far from being the case. Again, while in arranging his material, he has grouped all children as of the same age who have, *e. g.*, passed their ninth birthday and not yet reached their tenth; he has again ignored the fact that the majority of children enter school at the beginning of the year and not during the term, thus in this way still further throwing out his calculation.

G. M. West.

A TWO-HEADED TORTOISE.

Inquiries from various quarters have been made so repeatedly for the sequel to the brief story of a young two-headed tortoise, *Chrysemys picta*, published in the *American Journal of Science* for October, 1888, that the author is led to believe that a public account thereof will serve more useful ends than many private ones. In order that the sequel may be more intelligible to all, a brief resumé of the first paper will be given.

The young tortoise, hatched but a day or so, was found in the marshes bordering West River, New Haven, Conn. The carapace, which was somewhat broader than long and slightly distorted, bore the customary legs and tail, but there were two perfectly developed heads and necks.

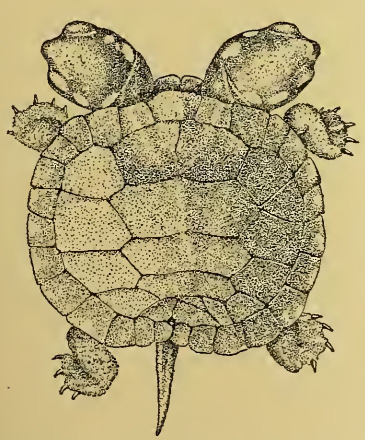

Fig. 1. Dorsal view of the two-headed tortoise *Chrysemys picta.*

The author visited and studied this little monstrosity almost daily for weeks. It lived and thrived and grew appreciably during that time. Its charm was in the very perfection of its imperfection. Such a oneness of two with individuality preserved is not to be found. In one carapace there were two alimentary systems, two nervous systems, two respiratory and circulatory systems, two muscular and bony systems. Each was double in part at least. There were two wills, for the heads fought continually for the rights of their common shell and for their food.

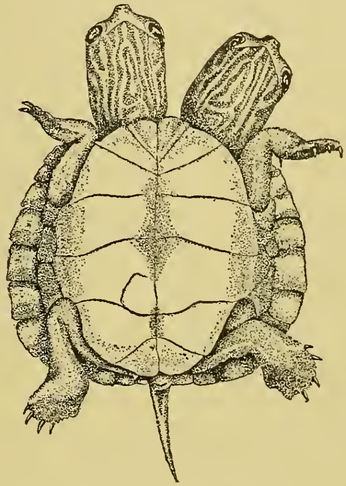

Fig. 2. Ventral view of the same.

There were two dispositions; the one quicker, more timid and more irascible; the other stolid. Each head could hear, see, eat, drink and breathe independently. Though afterwards acquired, there was originally no concerted action between the right side and the left. However, with surprising frequency, the two did act in unison, and simultaneously, as if there were correlation by a common nervous system.

They might, or they might not, each drink, sleep or swim, as each willed. When one side with its organs and appendages slept, or was inert, the other with this dead weight as a center could but describe a circle—a course which it found endless. Here then arose a beautiful example of adaptability. It learned to drag itself sideways, wherever it would—over the whole yard. This was the right half (never the left) which has been spoken of as having a timid, quick and irascible temperament. They swam together well, but walked together awkwardly. As they walked, the fore legs acted simultaneously, so in turn the hind legs, leaving alternately the front and back of the shell without support. Thus by a slow teetering, or rocking gait, they could go where they would. In starting they almost invariably pulled persistently in opposite directions, which drew them laboriously backward three or four feet. Resting a moment, they would start together, as described above, and make the circuit of the yard.

With fate against them, they adapted themselves to their condition so admirably, and excited the admiration of so many that a false and exaggerated value was put upon them. Showmen offered sums out of all proportion to the actual value, which were rejected by the owners.

If so highly prized then it should in all consistency have been more zealously guarded. But while at large with other similar pets, a prowling cat singled out this one and pounced upon it. It was secured at once, but not before it had tumbled down the stone steps leading to the cellar.

It was returned to its aquarium, where the right head came out from its protecting shell at once; likewise the left head a half hour later. The next day it was itself again. It ate, walked and swam as usual, save the left head refused food, which was not unusual. The second day it was itself still, though the left head would take no food. On the third day it drooped. Though rallying at times and hurrying about as usual, the left one was soon dead, as were also the left legs. The cat's claw had pierced the neck close to the shell. The distress and uneasiness of the surviving half was very apparent. All its energies and activities were redoubled, yet it died in two and one-half hours later. Up to this time its only sign of weakness was an occasional gaping as if for more air.

This little monstrosity's short life continued from the first of June to the middle of September.

Erwin Hinckley Barbour.
The University of Nebraska.

SOME DIFFICULTIES IN THE PRESENTATION OF THE PERIODIC LAW.

The Periodic Law contains so much that is true, and promises so much further revelation as to the connection between the elements and the relations of their atomic weights, valence and other properties, that its permanent position in the science is assured. It truly deserves the name of the Natural System, first given it by Mendeléeff, but abandoned because it had been used some twenty years before by Odling for a very different sort of arrangement. It stands before us to-day as the statement of a natural law, though as yet undeveloped and imperfectly understood. There can, therefore, be no question as to the acceptance of the law of the inter-dependence of the atomic weights and other properties, and the peculiar relationship of the elements now known as the Periodic Law. This must be the basis of the science, and the proper formulation of the law will contribute to a wonderful development of it in the future.

But there may well be question as to the acceptance of any of the present statements of the law. The systematic arrangements of Mendeléeff or Meyer or Bayley are all necessarily tentative because of the serious imperfections in our knowledge. There is a probability that new elements will be discovered. The properties including the important physical constants of even the well-known elements and their compounds are quite imperfectly known. A great deal of the future work of the chemist must be devoted to the detailed and patient study of the multitudinous compounds already known, as well as to the formation of new ones.

The increased knowledge of the future will render changes and modifications necessary in any one of the present systems, or, perhaps, will set all of them aside and evolve out of them one which will perfectly present the truths of the law. Understanding the heading of this paper to refer then not to the law itself, but rather to the present arrangements of the elements under that law, let us briefly look at some of the difficulties in their way.

An impartial observer would notice first the large number of unknown elements, necessary for the completion of most of these arrangements. Mendeléeff has blank spaces for at least thirty-five new elements, or, if a hydrogen period below lithium be granted, then forty-one more elements must be discovered somewhere, or more than one-third of the total supposed number. It would almost seem unreasonable to found any system upon the imperfect knowledge of less than two-thirds of the individuals to be included in it, were it not borne in mind that the ones now known constitute all but a small fraction of the matter of which the universe is composed, and again that they fall in the system in regular consecutive order, leaving only one unoccupied space among the first fifty-two members according to Mendeléeff. Even this blank has been filled, if the recent discovery of an element in monazite having an atomic weight of approximately 100 be confirmed.

Modifications of the Mendeléeff system do not require so large a number of additional elements for their completion, eight or ten satisfying all apparent requirements. In case the Mendeléeff system is correct, where are these to come from? The close scrutiny to which all terrestrial forms of matter have been subjected by chemical and spectroscopic analysis leaves little material to be called upon as the source of these elements. Still the recent discoveries of argon and helium teach us not to be too positive in our exclusion of unknown elements because of past investigations. The so-called rare earths will unquestionably yield several new elements. It seems a great pity that this scarce and valuable material cannot be collected and placed in the hands of some patient investigators whose labors might be supported from some research fund and who could tell us then just what the science had to expect from this source. A further thought is that some of these elements may not occur in nature, but that the future may teach us some way of synthesizing them, and then the whole list can be filled out. The brilliant victory over the difficulties surrounding the chemistry of the sugars and their synthesis, filling out their system so meagerly outlined in nature, would be ground for encouragement as to possible conquests among the elements.

The anomalous position of hydrogen forms a second objection to the Periodic Law. It is not counted in any of the periods of seven or of seventeen. Its introduction into any system in which the arrangement depends upon increasing atomic weight would throw out the sequence of the elements. Placing hydrogen at the head of the system, with connecting lines to all seven of the first period, as has been done by some, is a very questionable expedient. This is simply an unjustifiable return to the Proutian hypothesis, and is a violent distortion of all the facts concerning valence, positive and negative properties etc, for which the table is supposed to stand, and lastly it does not relieve the anomaly of the position.

A second supposition that hydrogen is the initial member of a period of seven which precedes Mendeléeff's typical elements, but which are as yet unknown, is much more plausible. The discovery of helium, and perhaps another element with very low atomic weight, lends strength to this supposition. Certainly the present anomalous position of hydrogen is a serious blot upon the system.

Wurtz has pointed out two difficulties in the system, both of which bear upon the nature of periodicity. The first is the lack of regularity in the differences between successive elements, and the second is that the gradations in properties do not seem to depend upon the degree of these differences. It has been also pointed out that the use of the term periodic in the case of these variations is not a strictly mathematical one, and that these periods, in passing from negative to positive values, should pass through a transition stage of either zero or infinity. It is true that very little has been done to discover the nature or the laws of this so-called periodicity, though some of the modifications of Mendeléeff's table make some points clearer and remove some difficulties. Chemists have generally contented themselves with calling any successive increases or decreases in properties periodic, whether they exhibited any regularity or not. This is too slovenly and unsatifactory for a true science, and those who love the science must labor to remove such a reproach. The obstacles to success are first inaccurate knowledge of the properties, and in some cases the absence of any definite standard of measurement for these properties.

Minor difficulties lie in the relative position of certain elements. Some are far from satisfied with the position assigned the triad, iron, cobalt and nickel. In some respects they are out of line with some of the elements apparently closely allied to them. Perhaps when what Blanchard has called 'cross analogies' are better understood these matters will be made clearer.

In the cases of at least two sets of elements, tellurium and iodine, and cobalt and nickel, the very best determinations of their atomic weights would place them in different relative positions from those demanded by the periodic system. These determinations have been repeatedly revised in the past few years, and yet the system still seems at fault. Which is wrong, the system or the investigations of the atomic weights? So many difficulties surround these determinations, and so many chances for errors lie in their paths, that most will decide in favor of the system and call for more thorough and patient search after impurities and imperfections of methods in the previous determinations.

The discovery of argon and helium has been regarded by some as giving a most telling blow to the periodic system. Article after article has been written on their possible position in the system. Several originators of systems have claimed to have predicted these new bodies. No supposed property nor absence of property staggers these prophets. They have foreseen everything. The whole question is, however, premature. Manifestly the position of any newly discovered element cannot be fixed until two things are definitely settled: first, the elemental character; and secondly, the more salient properties, as atomic weight, valence, etc. These questions are yet to be settled for the substances named, and there are some serious difficulties in the way of those investigating them. Until these questions are answered nothing can be done, and certainly a system which has answered admirably for so many of the elements is not to be given up on the half knowledge and half guess-work which surround the two newly found bodies.

F. P. Venable.

University of North Carolina.

CURRENT NOTES ON PHYSIOGRAPHY.

HILLS AND PLAINS OF SOUTHEAST LOUISIANA.

The State Experiment Station at Baton Rouge has just issued a report on the Florida parishes of east Louisiana and the bluff, prairie and hill lands of southwest Louisiana, by W. W. Clendenin, of the State University, with a lucid account of the topography and drainage. East of Baton Rouge the 'pine hills' grade westward into the 'bluff' district toward the Mississippi, and southward into the 'pine flats' toward the sea marsh. The 'pine hills' have a mature topography, produced by pre-Columbian dissection of Lafayette strata, and now thinly veneered by the loam of Columbian submergence. The streams still occupy their pre-Columbian courses, giving typical examples of resurrected drainage. Passing towards the Mississippi the veneer of Columbia thickens; the pre-Columbian topography fades away, and at last disappears beneath the flat cover of 'bluff' or loess. Here the topography is adolescent; extensive interstream plains still standing between narrow, steep-sided valleys. The 'pine flats' are an infantile coastal plain of Columbia clays, so level that the rainfall is hardly gathered into streams; the larger water courses seeming to be the seaward extensions of the resurrected streams from the 'pine hills.'

PIMPLED PRAIRIES OF SOUTHWEST LOUISIANA.

The same report describes the coastal prairies of southwest Louisiana, upon which there are numerous mounds, especially around the sulphur district of Calcasieu parish, but extending also inland to the 'pine hills' and seaward to the coastal marsh. The mounds are roughly circular in outline, about fifty feet in diameter and up to ten feet in height; always arranged in zones or intersecting systems of lines, never solitary. They are more sandy than the argillaceous prairie, and hence are drier and support trees and a better pasture grass than that of the marshy plain. Clendenin discards Hilgard's explanation of the mounds as ant hills, and follows Hopkins in comparing them to 'mud lumps,' formed by the escape of gas from beneath; adding that the zonal and linear arrangement of the mounds may be accounted for by associating them with the radial and branching fractures that diverge from earthshock centers. According to this theory, ants, like plants, occupy the mounds but do not make them.

LUBBOCK'S SCENERY OF SWITZERLAND.

This admirable book (Macmillan, 1896) shows how thoroughly a sagacious amateur may follow, appreciate and transmit to a large circle of readers the best physiographic results gained by geologists and geographers of Switzerland. The many essays and memoirs quoted appear to have been interpreted, and indeed verified on the ground, during the authors' vacations during the past thirty years. Beginning with geological structure, chapters follow on glaciers present and past, rivers, valleys, lakes, influence of strata on form, the Jura, the central plain, the outer Alps and the central massives; then come ten other chapters on districts of particular interest, such as Lake Geneva, Mont Blanc, the Rhine, the Reuss. etc., closing with a general summary. There is no book in English in which so compact and accurate an account of the physiography of Switzerland is to be found. It is on every account to be most warmly welcomed and commended to students, travelling or at home. The contests and exchanges between the several branches of the upper Rhine are well presented, after Heim; but the processes by which a river may come to follow an anticlinal axis, and the many ways in which rivers may come to cross mountain ridges, are not fully appreciated. The delta-like origin of the Rigi conglomerates, now overturned; the 'dead valleys' of the plain, once occupied by larger streams; the warping of valleys to produce lakes—these and many other topics are most acceptably treated.

REPORT OF THE LONDON GEOGRAPHICAL CONGRESS.

A volume of almost a thousand pages, edited by Dr. Mill, now presents in full and in the original language the papers read at the Sixth International Geographical Congress in London last summer (Murray, 1896). The volume is so large, and so much mention was made of the proceedings of the Congress in current journals, that an abstract of the Report is now neither possible nor necessary. The account by Levasseur of the status of geographical instruction in France is of much value as illustrative of a highly formulated system. Penck presents his geomorphological nomenclature, in which he introduces the idea of stage of development, but hardly extends it as far as seems desirable to many, some of his fundamental forms being the products of erosion. On the whole, physiographical problems attracted little attention alongside of subjects of greater popular interest, such as polar exploration, or the habitability of Africa by the white race. Lallemand, director of general levellings in France, makes the following surprising statement, displacing a view supposed to be orthodox: The inequality of level between the Mediterranean and the Atlantic, determined by former French and Spanish levels, and explained by the different densities in the two bodies, does not exist; the illusory results being due to systematic errors of early observations, and to the superficial character of the observations made on the salinity of sea water. Whether the density currents at the Strait of Gibraltar must also be given up is not told. W. M. Davis.

Harvard University.

CURRENT NOTES ON METEOROLOGY.

RELATIVE HUMIDITY OF NEW ENGLAND.

Bulletin No. 19 of the Weather Bureau is a *Report on the Relative Humidity of Southern New England and other Localities*, by A. J. Henry. The investigation, the results of which are now published, was undertaken in order to ascertain how the humidity conditions of the South compare with those of New England and other places where cotton is manufactured, cotton manufacture, as is well known, being to a considerable extent dependent on the humidity of the atmosphere. It appears that hitherto in the development of the cotton manufacturing industry but little account has been taken of climatic conditions as affecting the quantity or quality of the output, and that the control of temperature and humidity by artificial means is the final solution of the problem when the establishment of mills in a relatively dry section is contemplated.

PROTECTION FROM FROST.

The Weather Bureau has issued a short pamphlet entitled *Injury from Frost and Methods of Protection* (Weather Bureau No. 86,) by Hammon. The formation of frosts; the best locations for orchards or gardens to avoid injury by frost; the methods of protection and times when protection is needed, are considered.

TORNADOES IN TEXAS, MAY 12 AND 15.

During the spring a number of destructive tornadoes were recorded in our Southern and Western States. The local tornadoes which occurred in northern Texas on May 12 and 15 are described by Cline in Special Bulletin No. 8 of the Texas Climate and Crop Service. On May 12 two distinct tornadoes occurred, and on May 15 four were noted. The usual phenomena accompanied the disturbances.

R. De C. Ward.

Harvard University.

CURRENT NOTES ON ANTHROPOLOGY.

NATIVE AMERICAN TEXTILE ART.

A monograph of much beauty and interest has lately appeared from the pen of Prof. W. H. Holmes, of the Field Columbian Museum. Its subject is the 'Prehistoric Textile Art of the Eastern United States,' and it a portion of the 13th Annual Report of the Bureau of American Ethnology. The topics taken up are the basketry, matting, cloths, nets, featherwork, embroidery and wattling of the Indians in the region designated, as these arts existed before the arrival of the white man. The primitive methods of spinning and weaving are explained, and the various knots and stitches illustrated by numerous engravings. Incidentally, the styles of clothing in former use are touched upon.

A chapter is added on 'fossil fabrics,' by which is meant those exhumed from caves, mounds, shelters and other deposits supposed by some to be the relics of a pre-Indian population. The result of the investigation here is noteworthy and adds to the evidence that it seems impossible to get away from the Red Indian in the Eastern United States. "Charred cloths from the great mounds are identical in material, combination of parts and texture with the fabrics of the simple savage." Nothing in them indicates a higher development of the art than was possessed by Algonkins and Iroquois.

THE 'SECOND COLUMN' OF THE ACHEMENIDEAN INSCRIPTION.

The famous inscription in cuneiform characters of the Achemenides is, as most readers are aware, in three columns, each a different language. The first is Old Persian; the third is the Assyrian dialect of the Semitic; but the second has been a standing puzzle. Some claimed it as Dravidian, others as a remote Aryan tongue, but most scholars, following Norris, Rawlinson and Max Müller, looked upon it as 'Turanian,' by which is meant Ural-Altaic. It has been called Susian or Medic, and some have thought it related to the Sumerian or Acadian, of Babylonia.

The first thoroughly satisfactory analysis of its forms which has ever appeared has just been published at Breslau, from the pen of the profound Ural-Altaic scholar, Dr. Heinrich Winkler. He had already announced that this Susic was certainly not Ural-Altaic, nor was the Sumerian. In the present brochure of sixty-five quarto pages he proves that the verb of the Susic is a true verbal, whereas in the Ural-Altaic, like many American languages, it is a noun form; that the relative in the Susic is one that is real and not a mere connective; that the formation of the case relations is wholly distinct; and a number of other vital points.

As the second column is certainly not Altaic, what is it? To this Dr. Winkler replies by assigning a number of cogent reasons for believing it a member of the Caucasic group of related tongues.

His valuable essay, like that which he wrote on the relationship of the Japanese to the Ural-Altaic, has extremely important bearings on the ethnography of Asia. The full title is: 'Die Sprache der Zweiten Columne der Dreisprächigen Inschriften und das Altaische.'

D. G. Brinton.

University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS.

ELECTRICAL CONDUCTION AT LOW TEMPERATURES.

In a Friday evening discourse at the Royal Institution, Prof. J. A. Flemming, F.R.S., recently gave an account of the very interesting researches into the magnetic and electric properties of metals at low temperatures, which have been carried out, during the last four years, in the laboratories of the Royal Institution, by him in conjunction with Prof. Dewar.

According to the report in the London

Times, the lecturer showed that the conductivity of a pure iron wire, at ordinary temperatures only about one-sixth of that possessed by a copper wire of equal size, was increased nine or ten times under the influence of the cold of liquid air. But while pure metals had their conductivity immensely increased by intense cold it was shown that alloys, such as brass or German silver, experienced in the same circumstances a comparatively small increase in conducting power, not more than about ten per cent. By carefully examining with a suitable form of resistance coil the variations in the electric resistance of a large number of chemically pure metals cooled to about 190 degrees, Profs. Dewar and Fleming have established that every pure metal would in all probability have no electrical resistance at the zero of absolute temperature, or, in other words, would become a perfect conductor of electricity. In this condition the passage of an electric current would generate no heat in it. Another consequence would be that a pure metal at the absolute zero would form an absolutely opaque screen to electro-magnetic radiation. These experiments furnished an additional proof that the process by which an electric current was conveyed from place to place was primarily dependent on actions going on outside that which we usually spoke of as a conductor. At the absolute zero any electric power, however large, could be transmitted along metallic wires, however small, without loss of energy, the wire becoming then a mere boundary and the energy-conveying processes being all effected in the nonconductor outside of it. Diagrams were shown illustrating the great increase in the conductivity of mercury on freezing. At its freezing point its conductivity rose fourfold, and beyond that point increased in such a way as to show that at the absolute zero its conductivity would be perfect. The peculiar differences in the resistance of pure and slightly impure bismuth were described, and proof was adduced that the result of taking the electric resistance of a wire of any metal in liquid air afforded a conclusive test of its chemical purity. It was found that the remarkable property possessed by bismuth of undergoing a great increase in electrical resistance when placed in a magnetic field was increased several hundred per cent. by the cold of liquid air. In contrast with metals, carbon and non-metallic bodies increased in electric resistance as their temperature was reduced, this increase continuing to take place as far as the lowest temperature reached. In conclusion, Prof. Fleming laid stress on the value of the knowledge gained about the electrical resistance of metals at low temperatures as a means of testing the purity of a metal almost rivalling the spectroscope in delicacy, and said that the facts collected would prove of importance in judging the validity of existing hypotheses of electric and magnetic action, while at the same time they opened out a wide field for fascinating research in a region hitherto but little explored.

THE DIMINUTION OF CONSUMPTION.

Dr. Arthur Ransome contributes to the *Lancet* (July 11) an article on 'Tuberculosis and Leprosy,' in which he draws a parellel between the two diseases, (1) in their specific causation and in their morphology; (2) in their pathology; (3) in their distribution; (4) in their general history and the conditions favorable or otherwise to their existence; and (5) in their infectiveness and hereditary transmission.

There are many points of similarity between them, and the author states that many authorities are inclined to believe from a study of their morphology that they are identical in character and that their bacilli are modifications of one species altered only by their environment. Dr. Ransome does not, however, regard the diseases as absolutely identical, but believes that they are at least so far alike as to make it permissible from a study of the decline of one complaint and its causes to attempt to glean some idea of the most hopeful means of diminishing the other; and that it is possible to go further and prophesy that as one disease, leprosy, has disappeared from our midst, so the other, tubercle, may also be made to vanish, and that from the recognition of its predisposing causes we may learn in what way it may best be attacked and finally driven from amongst civilized nations.

Leprosy was banished mainly through general sanitary measures and was scarcely affected by direct efforts at preventing contagion. The author considers it, therefore, only necessary to press forward the general sanitary measures on which he dwells in the article, in order that "we may regard as no Utopian dream the forecast that after only a few more years we may see the total extinction of tubercle in our land."

A chart is appended showing the phthisis rate per 10,000 of the population during the last fifty-eight years. In the year 1838 it stood at the enormous figure of over 38, and in 1894, little more than half a century later, it was only 13.8—little more than one-third of its former prevalence. A straight line drawn from its highest to its lowest points shows also that its decline has been remarkably steady and generally regular. If phthisis were to continue to diminish in prevalence at the same increasing rate of decline for another thirty years it would then have entirely disappeared.

GENERAL.

In connection with the proposed railway to the summit of the Jungfrau, it is proposed to establish a series of meteorological stations at which it will be possible to study at various altitudes the relations of temperature, atmospheric pressure, precipitation, etc. The observatory at the summit will cost $20,000.

According to *Nature* Dr. N. Busch, of Dorpat, has undertaken, at the request of the University of Dorpat and the Russian Geographical Society of Petersburg, a botanical investigation of the Caucasus. He proposes to visit the hitherto unexplored sources of the rivers Teberda and Maruch in northern Caucasus.

An expedition under the direction of Lieutenant Werther, accompanied by two geologists, is about to leave Berlin to spend a year or more in exploring Northeast Africa.

Die Natur states that the Austrian deep-sea expedition under the charge of the ichthyologist Dr. Franz Steindachner, the Director of the Royal Vienna Museum, has now returned. The expedition has for seven months been engaged in explorations of the Red Sea on the warship *Pola.*

The Société Scientifique Antonio Alzate, of Mexico, elected the following honorary members at the recent general meeting: M. Cuenot, professor in the Faculty of Nancy; MM. Fizeau and Lippman, of the Institute of France; M. Ch. Richet, of the Faculty of Medicine, Paris; Dr. G. Brown Goode and Prof. F. H. Bigelow, of Washington; Prof. Röntgen, of Wurtzburg; Lord Rayleigh and Prof. William Ramsay, of London.

There will be held, at Sables d' Olonne, from the 3rd to the 7th of September of the present year, an International Congress of Fisheries.

Two new year books are announced from Paris, one *Annuaire des Musées scientifiques et archéologiques des Départements,* the other *L'Année biologique,* edited under the direction of M. Y. Delage.

Sir William MacCormac, of St. Thomas' Hospital, has been elected President of the Royal College of Surgeons of England.

The Macmillan Co. announce for early publication a translation of Dr. von Zittel's elaborate Paleontology, by Dr. Charles R. Eastman, of the Museum of Comparative Zoology at Harvard University.

At the sixty-fourth annual meeting of the British Medical Association, which was held at Carlisle on July 28, 29, 30 and 31, the address in medicine was to be delivered by Sir Dyce Duckworth, lecturer on medicine, St. Bartholomew's Hospital, and that in surgery by Dr. Roderick Maclaren, senior surgeon to the Cumberland Infirmary. The scientific business of the meeting was conducted in nine sections.

The Millennial Congress of Hygiene and Medicine will be held at Buda-Pesth, September 13th to 16th, under the Presidency of Profs. Koranyi and Ketli. Among the subjects proposed for discussion are the organization of medical aid for the poor, pension and sick funds for medical men, medical councils, etc.

The third *Congrès Français de Médecine* meets at Nancy on August 6th to 9th. The subjects announced for discussion are The Application of Blood Serums to the Treatment of Diseases, Intravascular Coagulation of Blood and Prognosis of Albuminuria.

If certain conditions are fulfilled by the City of Chicago the Field Columbian Museum is to receive $2,000,000 as an endowment fund from Marshall Field, the founder of the institute.

The London Goldsmiths' Company have contributed £1,000 for the extension and better equipment of the scientific laboratories at the Imperial Institute. A research fellowship of the value of £150 annually has been established by the Salters' Company, in connection with the scientific department, for the investigation of new or little known natural products.

It is stated that Mr. T. Ruddiman Johnston, a Fellow of the Royal Geographical Society, will erect in London a terrestrial globe, showing the earth's surface on a scale of about eighty miles to the inch. Every geographical feature of importance will be shown and named, as well as every city and town having 500 inhabitants or more. The globe will take nearly two years to construct, and Mr. Johnston hopes to have the assistance of all those having a special knowledge of any portion of the earth's surface. The globe will revolve slowly, and will be observed from the upper end of a spiral gallery to be erected for this purpose.

The Tokyo Botanical Society is doing excellent work in making known studies of the native flora carried on by its members. The last number of the journal of the Society, *The Botanical Magazine*, contains the following articles: Notes on the Plants collected in Suruga, Totomi, Yamato and Kii, by M. Shirai; On the Smut of Japanese Cereals, by S. Hori; Salix of Hokkaido, by Y. Tokubuchi; Plants employed in Medicine in the Japanese Pharmacopoeia, by K. Sawarda; Contribution to Knowledge of the Marine Algae of Japan, by K. Okamura; Phanerogams of Shonai, by T. Kawakami. The first four articles are in Japanese.

The first part of the 9th volume of the Proceedings and Transactions of the Nova Scotia Institute of Science contains an account of the work of the session of 1894–95. The papers are of interest, as they contain chiefly observations regarding the local geology, antiquities, flora, etc., of the region. The address of the President, the late Prof. George Lawson, reviewed the history of the Institute, which was founded in 1862, with special reference to the work of the preceding session.

M. William Vogt has prepared a biography of his father, Carl Vogt, which has been published by Reinwald under the title *La vie d'un homme—Carl Vogt.*

It has been decided to erect a statue of Jenner in Tokyo; 1000 yen have been subscribed by the private Sanitary Association, and it is estimated that 2,500 yen will remain after the expenses of the recent centennial have been defrayed, which will be devoted to the purpose. The statue is to be ordered from London.

We quote the following from *Nature:* "Dr. Brown Goode makes the following comparison in a report of the U. S. National Museum, lately issued: 'There is not a department of the British government to which a citizen has a right to apply for information upon a scientific question. This seems hard to believe, for I cannot think of any scientific subject regarding which a letter, if addressed to the scientific bureaus in Washington, would not receive a full and practical reply. It is estimated that not less than 20,000 such letters are received each year. The Smithsonian Institution and National Museum alone receive about 6,000, and the proportion of these from the new States and Territories, which have not yet developed institutions of learning of their own, is the largest. An intelligent question from a farmer of the frontier receives as much attention as a communication from a Royal Academy of Sciences, and often takes more time for the preparation of the reply.' It is little to the credit of the British government that Dr. Goode's comparison should be so much to our disadvantage."

Last year Mr. George W. Breckenridge, of San Antonio, presented to the University of Texas 'The Singley Collection of Texas Mollusca.' This unique gathering of shells was the work of Mr. J. A. Singley, who devoted much time and energy to its production. It is unrivaled, we believe, in the world, embracing 309 species, represented by 6143 specimens from 977 localities. This year the same generous donor has added to his previous gift the remainder of the 'Singley Collection,' consisting of shells from all parts of the world: Marine shells, 750 species and varieties, represented by 2350 specimens; land shells, 1101 species and varieties, represented by 3839 specimens; fresh water shells, 702 species and varieties, represented by 1947 specimens. In this collection there are, it will be seen, over 2500 species and varieties. It is safe to say that the University of Texas has now the largest and finest collection of recent mollusca in the South or West.

THE 'Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for 1892 and 1893,' by F. B. Weeks, has been issued as Bulletin No. 130, of the U. S. Geological Survey. This Bulletin is a continuation of the annual publication heretofore known as the 'Record of North American Geology' (Bulletins Nos. 44, 75, 91, 99). The extended scope of the work necessitated a change in its arrangement. It is divided into two parts, a bibliography and a subject index. The bibliography is arranged alphabetically by authors' names. The index comprises geographic, geologic mineralogic, paleontologic and petrologic subdivisions, arranged alphabetically; and lists of economic products, minerals, rocks and fossils described in the various papers listed in the bibliography are given. A similar bibliography and index for the year 1894, and another for the year 1895 (Bulletins Nos. 135 and 149, respectively), are in press and will be delivered soon.

THE deficiency of rainfall in Great Britain is this year even greater than last, being so far 4.69 inches. The East London Water Works Company has been compelled to shut off the supply of water during the night, and lack of sufficient water in the east end of London is apt to be followed by an increased mortality.

THE *Lancet* states that an important Royal Commission has just been appointed. Its object is to enquire into the administrative procedure available for controlling danger to man through the use as food of the meat or milk of tuberculous animals. The Commission will further consider what should be the proper action of the responsible authorities in condemning for the purposes of food supplies, animal carcasses or meat exhibiting any stage of tuberculosis. The Commissioners are as follows: Sir Herbert Maxwell, Dr. Thorne Thorne, C. B., Mr. G. T. Brown, C. B., Mr. H. E. Claver, Mr. Shirley F. Murphy, Mr. John Speir and Mr. T. C. Trench. Dr. T. M. Legge will act as Secretary to the Commission, the work of which, from a sanitary point of view, should be of the highest possible value to the community.

ACCORDING to *Nature* General M. Rykatchef has been appointed Director of the Central Physical Observatory, St. Petersburg, in the place of Dr. H. Wild, resigned. For many years General Rykatchef has had charge of the maritime meteorological branch of the Observatory.

UNIVERSITY AND EDUCATIONAL NEWS.

FOREIGN STUDENTS IN THE FRENCH UNIVERSITIES.

OFFICIAL information has been received in Washington by the Franco-American Committee, organized for the purpose of securing fuller privileges for American students in the educational institutions of France, that in all probability the faculties of letters will soon be open to Americans as freely as the other faculties that have already been opened. The Compagnie Transatlantique offers a reduction of 30 per cent. in its rates to duly certified American students who intend to study in France.

There are already fifty or more American students enrolled in the French faculties. Since the promulgation of the decree of January last, changing the regulations in the faculties of science, the number of German students in the French faculties has increased from fifty-two to one hundred and twelve, of whom only sixteen are students of medicine.

The admission of foreign students to the medical schools gave rise to a serious debate in a recent session of the Chamber of Deputies, it being claimed that French students were exposed to undue competition on account of the influx of foreigners, who, by reason of graduation, became entitled to practice medicine in France, and this without being subjected to military duty. It is probable that the regulations will be modified so that foreigners will not be hereafter entitled to the privilege of practice, although the facilities for study and the obtaining of degrees will be as good or better than heretofore.

GENERAL.

DISPATCHES to the daily papers from Lansing, Mich., state that the Supreme Court decided on July 28th that the State Legislature has no right to interfere with or dictate the management of the University of Michigan. The Legislature passed an act at its last session directing the regents to establish the homeopathic department of the University in Detroit. The regents refused to comply on the ground that the act was unconstitutional, and a mandamus was asked for to compel them to establish the department in Detroit. The Court holds that the regents have the sole control of the University and that the act of the Legislature is invalid.

Ground has been broken for the new science hall at Lake Erie Seminary, O. Of the $20,000 required for the completion of the building, $14,000 has already been raised. In addition $10,000 has been subscribed for equipment.

Dr. H. T. Lukens, of Clark University, has been appointed professor of education at Bryn Mawr College, and Dr. Colin A. Scott to the chair of experimental psychology and child study at the Chicago Normal School.

Mr. Ben F. Hill, B. S., has been appointed Fellow in Geology at the University of Texas. He will assist in the laboratory instruction in paleontology and mineralogy under the direction of Dr. F. W. Simonds.

Mrs. Arthur Jackson has contributed to the Sheffield Medical School the sum of £5,000 towards the endowment of a chair of anatomy, to be called the Arthur Jackson Chair of Anatomy. Mr. Jackson, who died recently, was much interested in the success of the Medical School, and had served it in the capacity of Secretary and Lecturer.

Dr. J. Norman Collie, F.R.S., has been appointed professor of chemistry in the Pharmaceutical Society's School of Pharmacy. Dr. Collie has been for some time associated with Professor Ramsay in the teaching of chemistry at University College, London. The Council of Bedford College for Women, London, has appointed Dr. Thomas Morison Legge, to the professorship of hygiene.

Among recent foreign appointments we note the following: Professor Valentiner, of Carlsruhe, has been called to the chair of astronomy in the University of Heidelberg. Professor A. B. Tichamerow has been appointed director of the Zoological Museum at Moscow. Professor Gutermuth, of Aachen, has been made professor of engineering in the technical high school at Darmstadt. Dr. Von Rümker, professor of agriculture in the University of Breslau, has been called to Leipzig. Dr. Henking, of the University of Göttingen, has been promoted to a professorship of zoology, and Dr. H. Biltz, of the University of Greifswald, to a professorship of chemistry. Dr. Schenk, of the University of Bonn, has been elected full professor of botany and director of the botanical gardens at the Technical High School at Darmstadt. Dr. Pauly, docent in the University at Munich, has been promoted to an assistant professorship of applied geometry, and Dr. W. Semmler, of the University of Greifswald, has been made professor of chemistry. Dr. Wachsmuth has been appointed docent in physics in the University of Göttingen, and Dr. Emil Knoblauch docent in botany in the University of Giessen.

Dr. Ernst Beyrich, professor of geology and paleontology, died at Berlin on July 9th at the age of 81 years.

Dr. Franz Reuleaux, for forty years professor of engineering in the Technical High School at Charlottenburg, has resigned.

DISCUSSION AND CORRESPONDENCE.

THE PERSONAL EQUATION.

In the admirable heliometric triangulation of the cluster in Coma Berenices, by Dr. F. L. Chase, lately published by the Yale Observatory, the author has not noticed that the cluster is one which was photographed by Mr. Rutherfurd in 1870 and several years since; hence, material is already on record for the proper motions of the group. The cluster will furnish an unusual number of stars which can be observed for personal equation between bright and faint ones, a problem which is not without psychological as well as astronomical interest at the present time. It will be remembered that among very early studies in experimental psychology were those experiments conducted by

Wundt in 1861, which resulted in his important discovery of the Zeitverschiebung, which takes place when the observer connects clock beats heard with the seen positions of a star in apparent motion through the field of the telescope. As this Zeitverschiebung may be either positive or negative, it offers an explanation of the abnormal personal equations (more than a second of time) which Bessel found to take place in his own case, as compared with Argelander and Wilhelm Struve. The variations of personal equation depending on the magnitudes of the stars can most readily be studied by the help of heliometric or photographic relative right ascensions such as are now in progress of publication. The Pleiades, Præsepe and Coma Berenices, as well as the clusters in other parts of the sky which have been photographed by Rutherfurd, deserve careful study by transit observers. The delay in reaction caused by the faintness of the stars is now pretty well recognized by astronomers when the chronograph is used, but there are indications of a similar delay in apperception when the eye and ear method is still retained. Astronomers need to pay especial attention to those magnitudes of stars which are near the point where the observation of transits begins to become difficult.

T. H. SAFFORD.

CINNABAR AND RUTILE IN MONTANA.

TO THE EDITOR OF SCIENCE: I wish to call the attention of your readers to a new locality for cinnabar and rutile. Specimens were sent me from the placer works in the vicinity of Philipsburg, Montana, with the idea that they were hematite and emery. The cinnabar is in small rolled grains, quite pure, and the rutile in small prisms. Neither of these minerals are known to have been found in Montana before. I hope to obtain more definite information concerning the occurrence of these minerals later.

M. E. WADSWORTH.

MICHIGAN MINING SCHOOL,
HOUGHTON, MICH.

PYGMY VILLAGES DISCOVERED IN THE INTERIOR OF SURINAM, GUIANA.

TO THE EDITOR OF SCIENCE: Yesterday I received a letter from an American commercial explorer of Guiana, who had recently met there with villages of typical pygmies, who are not over 4 feet 8 inches in height, and have a 'brilliant reddish-yellow complexion.' They seem to have come from the head waters of the Orinoco, and to be numerous enough to finally settle the problem as to the existence of dwarf races in America. Humboldt heard rumors as to them, but was unduly skeptical. I hope to be able, at the approaching meeting of the American Association at Buffalo, to submit a full description by the explorer, of his interesting discovery.

R. G. HALIBURTON.

BOSTON, MASS., July 29, 1896.

SCIENTIFIC LITERATURE.

Sporozoenkunde. VAN WASIELEWSKI. Ein Leitfaden für Aerzte, Tierärzte und Zoologen. Mit 111 Abbildungen im Text. Jena (Verlag von Gustav Fischer). 1896. Pp. 162. M. 4.

The specialist in parasitology is frequently asked by general zoologists and by physicians for a short comprehensive book, which, while not too technical and detailed, will serve as a general guide to a brief study of the Sporozoa. As a rule he recommends Balbiani's Les Sporozoaires (1884) and Bütschli's Protozoa, I. Bd., II. Abth. (1882), both of which are now rather old; Blanchard's Traité de Zool. méd., I., p. 32–68, Railliet's Traité de Zool. méd. et. agric., I., p. 122–160 (1893), and Braun's Die tierischen Parasiten des Menschen., pp. 47–106 (1895), which though excellent, do not cover the entire field; or possibly Pfeiffer's Die Protozoen als Krankheitserreger (1891)—a book which is very difficult to comprehend, and in which the line between fact and supposition is not always clearly drawn.

To this list of general works we can now add von Wasielewski's *Sporozoenkunde* which forms, in some respects, a very excellent compilation on these parasitic protozoa.

In a general introduction to the Sporozoa the author discusses their (1) distribution, (2) habitat, (3) form, (4) food and motion, (5) reproduction, (6) development, and (7) classification. Each group is then discussed in turn, and brief diagnoses of the more common genera and species are given. Next follows a valuable tabular list of the parasites, arranged according to their hosts, and finally brief remarks on technique and a short bibliography.

The author recognizes the orders *Gregarinæ*, *Hæmosporidia*, *Coccidia*, *Acystosporidia*, and *Myxosporidia*, while the *Sarcosporidia*, *Amœbosporidia* and *Serosporidia* are given in an 'Anhang.'

In discussing the *Gragarinæ* Léger's classification is adopted. The chapter on *Hæmosporidia* is based almost entirely upon Labbé's writings; in this order the author recognizes only one family the *Drepanididæ*. In the classification of the *Coccidia*, A. Schneider is followed. Labbé's (1894) order *Gymnosporidia* appears as the *Acystosporidia*, and in it are placed the malarial parasites, the parasite of Texas fever and allied forms. In the chapter on the *Myxosporidia* Thélohan is followed.

While the general discussion of the groups is interesting, and the numerous illustrations give the reader unacquainted with these forms a very good idea of the Sporozoa, it is necessary to exercise considerable care in accepting the nomenclature adopted by the author, and further, not to assume that the numerous species mentioned by him in his compendium represent a complete list of the known forms. The reader should, therefore, be warned that this work is more fitted for use in obtaining a knowledge of the morphology and biology than of the classification of the *Sporozoa*. The generic and specific names adopted in many cases, and the authorities to which the binomials have been attributed, do not seem to have been determined by any particular principle. *Pyrosoma* Smith, for instance, is rejected as name of the parasite of Texas fever, on the grounds that it is preoccupied, while *Apiosoma* Wandolleck, (which is also preoccupied) is adopted, and the name *Piroplasma* is overlooked. The parasite of malaria is given as *Hæmamœba laverani*, although neither this generic nor this specific name can stand. *Balbiania gigantea* is quietly included in *Sarcocystis tenella*, notwithstanding the lack of grounds for so doing, while quite a number of other Sarcosporidia which have been described and named as belonging to three different genera are mentioned as '*Sarcocystis spec. inc.*'

It is possibly unfair to criticise these details adversely, yet, as the author includes the zoologists among the persons for whom his work is written, he should have had more regard for zoological customs. On the whole, von Wasielewski's Sporozoenkunde will be a welcome guide to those who desire to study this group, but who are unable to consult the original papers. CH. WARDELL STILES.

Report of the Government Entomologist for the Year 1895, Cape of Good Hope, Department of Agriculture. By C. P. LOUNSBURY.

This little volume illustrates three interesting points: First, that the Government of Cape Colony is an enterprising one, and will not allow itself to fall behind other governments in matters which affect the welfare of the agricultural community; second, that in appointing an entomologist it was considered to be for the best interests of the Colony that an American, trained in recent American methods in the warfare against insects, should be chosen; and third, that this American has in so short a time familiarized himself with the needs of the Colony in his own special line of work, and has presented as his first report a most excellent account of the species which are attracting particular attention at the present time in that country. The report is largely general and much attention is paid to the subject of the importation of injurious insects and of the desirability of legislation to check importation and spread. The species especially considered are certain scale insects, the peach maggot, codling moth, pear slug, the apple and quince borer and the so-called American blight, which is the name generally used in English colonies for the wooly root-louse of the apple, Schizoneura lanigera. The Government of Cape Colony is to be congratulated upon its appointment.

L. O. H.

Tenth Annual Report of the New York State Entomologist. By J. A. LINTNER, PH.D.

It is always a pleasure to receive a new report from Dr. Lintner. The full and careful articles which the reports of this writer always contain are models in style and treatment for the younger generation of economic entomologists. The present report, although smaller than some of its predecessors, contains the usual array of important articles, the most interesting of which are the account of *Phora agaraci*, a little fly which damages mushrooms, and which is largely the cause of the impracticability of mushroom cultivation during the summer months; an account of the 1894 occurrence of the seventeen-year locust in New York State, and of the grasshopper plague in western New York. The present report contains a valuable appendix in the shape of an article on scorpion flies, by Dr. Lintner's assistant, Dr. E. P. Felt, who describes the heretofore unknown larvæ of *Panorpa rufescens*. The report also contains an elaborate index to Reports I. to X., which renders at once available nearly all of the results of Dr. Lintner's able work since he has held the position of State Entomologist of New York. This general index means more than appears at first glance, on account of the custom which Dr. Lintner has followed of late of publishing full bibliographies of the insects treated. Thus it becomes an easy matter for a person possessing the ten reports to familiarize himself to a very considerable degree with the literature of a very large number of species.

L. O. H.

La psychologie des sentiments. By Th. Ribot. Paris, Alcan. Pp. xi+443.

The indefatigable Th. Ribot has given us in his last work, *La Psychologie des Sentiments*, a clear, forcible and succinct summary, professedly from the James-Lange point of view. However, this interpretation is not adhered to very rigorously, and sometimes, indeed, seems directly contradicted (see p. 383 and compare pp. 108 and 187). Yet M. Ribot's main position undoubtedly is that all feeling is a reflex, or, as he would prefer to state it, an aspect of organic changes. But this constant reference to the nature and constitution of the nervous system, or otherwise set forth as tendency, instinct, need, impulse, seems to us highly unsatisfactory explanation. To explain mental forms as knowing and egoism by intuitive fixed tendencies thereto (*e. g.*, p. 192 ff.) appears to us quite on a par with the old intuitive psychology, and not far removed from the much derided metaphysics that explains lion by leoninity. It appears to us that the word 'tendency', whether interpreted physiologically or psychically, is like the word 'chance' in physics and biology, a mere expression to cover ignorance. And it does not better things to assume that physiological and mental are only modes of an unknown something. To explain the known by the unknown may be good metaphysics, but it is certainly bad science. Further, when M. Ribot endorses Spinoza's *dictum* that desire and appetite are the bases of all emotion, we must ask what is desire but an emotion, and what is appetite but pure pain mingled with a feeling toward an unrecognized objectivity?

However, we fully recognize the value of a physiology of feeling, and of a physics and chemistry as well, and we wish that M. Ribot had adhered rigidly to this interpretation, but he often encroaches on psychology where his descriptions are only of the most general and obvious sort and his analyses (*e. g.*, jealousy, p. 264) are greatly lacking in accuracy and thoroughness.

M. Ribot regards fear, anger and sympathy as the universal primitive emotions, closely followed by the self-feeling and sexual feeling, which five are basal, all other emotions being derived by evolution, by arrest of development and by composition. We do not think that the author has here made clear how hate is arrested anger, or how platonic love is arrest of sexual. As to the latter, indeed, he at one place (p. 18) assigns it a rank as culmination of sexual evolution. But, however, this may be, it certainly seems contrary to the first principle of evolution, that any high and late form can be explained as arrest of development of an early form. The whole treatment of this and other principles is far too slight.

M. Ribot touches upon the curious pleasurable pain and painful pleasure, but the treatment is rather unsatisfactory. The taking a pleasure in a pain or *vice versa* is, we think, not uncommon, and merely shows that emotion can develop upon any subject. The child in taking a certain pleasure in picking its own sores has a relief from *ennui* and an emotion of effective activity. The desire to feel, to do, to know, help explain this pleasure. Alphonse Daudet is said to take great pleasure in his fear experiences, but this may be a case of mere reaction from over-refined emotion, or it may be artistic emotion. The whole subject demands a large and detailed treatment.

This volume adds little to our knowledge. M. Ribot refers the very highest emotions to the James-Lange theory, but only in a very general way. Chapter XI. is an original study of affective memory and contains some interesting matter. I incline to believe that the memory of feeling is a far more general fact than M. Ribot makes it, and that, since the interesting is the rememberable, it is the core of all memory. All living in the past is filled with resuscitated feelings, both recalled and recurrent, and both associated with images and with correlated feelings. The difficulty in the study of affective memory is to discriminate between the new and the old, between the anger resuscitated with the thought of the insult and the anger provoked by the thought.

Æsthetic feeling is, as usual, referred to superfluity of energy. However, this theory must explain why great artists and poets are so often starvelings. The truth is, superfluity expends itself in the easiest channel for the individual, which for most men is apt to be hunting or fishing, or fighting. Superfluity may be one condition of rise and progress of æsthetic, just as there must be a certain fund of available energy for the rise of any higher emotion, but it cannot in itself explain æstheticism.

On the whole, while we can commend M. Ribot's work as a useful summary, we can not speak highly of its originality, its thoroughness or its fairness of tone. It is often narrow and dogmatic, and though the author is sufficiently eclectic in his field it is an eclecticism little vindicated. Hiram M. Stanley.

SCIENTIFIC JOURNALS.

AMERICAN CHEMICAL JOURNAL, JULY.

Oxidation of Sodium Sulphide and Hydrosulphide to the Sulphate by Electrolysis: By F. W. Durkee. Sodium sulphide and hydrosulphide are completely oxidized to sulphate when a current is passed through the solution. When carbon or copper electrodes were used, no oxidation took place; but when platinum ones were substituted, the formation of sulphate was quite rapid. When the current is first passed through, considerable hydrogen is set free at the negative electrode; but very little oxygen escapes at the positive electrode. The oxygen is used up in oxidizing some of the sulphide to thiosulphate, and this in turn to sulphate, setting sulphur free. This free sulphur, which separates as a white cloud, is partly dissolved in the sulphides forming polysulphides, which color the solution yellow. These polysulphides are in turn oxidized, and so it continues until all has been oxidized to sulphate, which point is reached when no further separation of sulphur takes place. The presence of these different products was shown by quantitative determinations of the substances present at different stages of the oxidation. Both direct and alternating currents were used, but the former were found more suitable for the purpose.

A Method for Obtaining Crystalline Silicon: By G. De Chalmot. By heating a mixture of silica, carbon and oxides of metals in an electric furnace, crystals of silicon can be obtained. These can be obtained in almost pure condition by treating the product with hydrochloric and hydrofluoric acids. When oxide of manganese is used, a manganese silicide having the composition $MnSi_2$ is formed.

On Some Mercury Salts of the Anilides: By H. L. Wheeler and B. W. McFarland. So little attention had been given to the methods of formation and reactions of these compounds that no conclusions could be drawn as to their structure. In this paper the authors give the results of their work and conclude that the metal is joined to the nitrogen and not to the oxygen, as has been suggested. When formanilide is treated with mercuric bromide, a mercuric formanilide is formed; and when this is treated with benzoyl chloride, halogen mercury compounds are formed, which are undoubtedly nitrogen derivatives. Nitrogen substituted anilides, whose reactions can only be explained on the supposition that the metal is joined to nitrogen, are also formed.

On the use of Antimony Trichloride in the Synthesis of Aromatic Ketones: By W. J. Comstock. In some cases antimony trichloride is preferable, as a condensing agent, to aluminium chloride, on account of its cheapness and the fact that it is more stable and can be easily recovered again. It cannot be used, however, with low-boiling chlorides, and also fails in some cases where aluminium chloride can be used, as in the formation of triphenylmethane from chloroform and benzene. Several examples are given of the different classes of compounds with which it can be used and the yields as compared with the other method.

The Action of Sodium on Aldehyde: By P. C. Freer. On account of the great instability of the compound formed by the action of sodium on aldehyde, the latter is mixed with benzoyl chloride and then added to the sodium in ether. The compound formed can be isolated in pure condition and obtained as white crystals. Determinations of its composition, molecular weight and decomposition show it to be aldehydoaldol benzoate. The authors consider the product first formed by the action of sodium on adelhyde to be sodium aldehyde or sodium vinyl alcohol $CH_2 : CHONa$. In this compound the metal is joined to the oxygen.

On the Constitution of Some Derivatives of Formic Acid: By P. C. Freer and P. L. Sherman, Jr. Attention is called to the fact that formic acid, although classed with the acetic acid series, does not exhibit physical properties in conformity with the rest of the series. It is stated by some authors that this acid acts both as acid and aldehyde, but the evidence in favor of the latter is very slight. A study of sodium formylphenylhydrazine seems to show that there is neither a hydroxyl nor aldehyde group in it, while in the salts of formanilide there is evidence of the presence of a hydroxyl grouping. Different groups seem to have different influences and the evidence is not yet sufficient to draw any positive conclusions.

Notes on New Apparatus: By G. O. Higley, B. J. Howard and P. C. Freer. Improvements are suggested in the old Hofmann apparatus for showing the electrolysis of hydrochloric acid, and in the Hofmann apparatus for demonstrating the volumes of oxygen and hydrogen which unite to form water vapor. A simple form of apparatus for distillation in a vacuum is also given.

The Action of Metals on Nitric Acid: By G. O. Higley and W. E. Davis. In the present paper the authors give the results of the action of nitric acid on silver. In this case nitric oxide and nitrogen peroxide are formed and no nitrous oxide as with copper.

On the Esterification of Halogen Substituted Acetic Acids: By D. M. Lichty. The author has continued his investigation of the esterification, using lower temperatures, and finds that the results depend on the mass-action of water and alcohol and also on the specific nature of the acid. Starting with acetic acid and introducing one, two, and three atoms of chlorine, he finds that the increase in chlorine influences the rate to a greater extent than it does the limit.

The Constitution of the Acid Amides: By A. Lachman. Some doubt has recently been thrown on the generally accepted structure of the amides, and while there seems to be evidence in some cases pointing to the occurrence of the normal amide structure in some compounds, in others it is in favor of the imido hydroxy structure. The author finds that the attempts made so far to test these ideas have failed on account of the great indifference of amides to all the reactions he tried.

Chromic Hydroxide in Precipitation: By H. E. Patten. Many hydroxides when precipitated carry down other substances with them and in some cases even decompose them. The present work is a study of the action of potassium hydroxide on chromium chloride in the presence of potassium sulphate. In all cases the precipitation was complete and no sulphate was carried down. Magnesium, calcium and ammonium sulphates behave in the same way; but chlorides and nitrates do not cause precipitation. When the sulphates are not present the hydroxide of cromium dissolves in the excess of alkali. He conceives of two reactions taking place, first a breaking up of the sulphate by the chromium hydroxide and the formation of a compound of sulphur trioxide and chromium sesquioxide, and second, a decomposition of this compound by water.

An Empirical Relation Between Melting-point and Critical Temperature: By F. W. Clarke. The author draws attention to the ratio between the melting point and critical temperature of a number of compounds, and shows how this ratio is constant for certain ones; but these belong to such widely different classes of compounds and the facts at hand are so slight that no generalizations can be drawn.

Aluminium Alcoholates: By H. W. Hillyer. When attempts were made to preserve some amalgamated aluminium by keeping it in a solution of mercuric chloride in absolute alcohol, it was found that the aluminium acted quite violently on the alcohol forming aluminium alcoholate. A number of alcohols were found to act in the same way and the subject is now being investigated by the author.

The Conductivity of Solutions of Acetylene in Water: By H. C. Jones. The author calls attention to the fact that the results published by Jones and Allen, showing acetylene to be considerably dissociated in water, are not correct. He has repeated the work and finds that it has a very slight conductivity. He attributes the previous error to some unknown impurity. This number contains reviews of the following books:

Water Supply, W. P. Mason; *A Dictionary of Chemical Solubilities*, A. M. Comey; *Milk, Its Nature and Composition*, C. M. Aikman.

J. Elliott Gilpin.

THE AUK.

The *Auk* for July (Vol. XIII., No. 3) opens with an article by Herbert K. Job, on 'The Ducks of Plymouth County, Massachusetts,' wherein the author presents the results of many years' observations in a condensed report on the 28 species known to occur. Dr. Walter Faxon gives, with prefatory remarks, a list of nearly 200 drawings of Georgia birds made by John Abbot between 1790 and 1810. Some 160 species are represented, including several which were then unknown to science. Publication, or rather the lack of it, seems to have been Abbot's only bar to immortality as an ornithologist.

Mr. O. Widmann discourses pleasantly on 'The Peninsula of Missouri as a Winter Home for Birds,' and Mr. A. W. Anthony gives evidence of the breeding of the Black-vented Shearwater off the coast of southern California with other interesting notes on the habits of this species. In giving his 'Observations on *Histrionicus histrionicus* in Maine,' Mr. Arthur H. Norton writes of a comparatively little known species, while Mr. Ruthven Deane adds a page to the life history of the Passenger Pigeon, in which our interest increases as it 'takes its flight.' Notes from Bermuda, that refuge for feathered waifs and strays, are always of value, and in commenting on the Bermudan avifauna Dr. Prentiss tells of the recent colonization of the Mocking-bird and European Goldfinch. The latter was accidentally introduced in 1893 by escaping from a vessel at St. George's, and so favorable have the conditions proved that already it is quite common. The English sparrow, the most abundant resident species, is spoken of as 'aggressive, offensive and despised.'

Somewhat over a dozen pages are devoted to reviews of recent ornithological books and papers, and about an equal number to records of the capture of more or less rare species or brief original observations of unusual interest.

The colored plate of this issue is an excellent illustration of the handsome Ptarmigan (*Lagopus evermanni*), from Attu Island, described by Mr. D. G. Elliot in the January number.

NEW BOOKS.

Prantl's Lehrbuch der Botanik. Herausgegeben und neu bearbeitet von Dr. Ferdinand Pax. 10th edition. Leipzig, Wilhelm Engelmann. 1896. Pp. x+406. M. 4.

Grundriss der Entwicklungs geschichte des Menschen und der Säugethiere. Dr. Oscar Schultze. Leipzig, Wilhelm Engelmann. 1896. Erste hälfte Bogen 1–11. Pp. 176. M. 5.

Studien zu Methodenlehre und Erkenntnisskritik. Friedrich Dreyer. Leipzig, Wilhelm Engelmann. 1895. Pp. xiii+223. M. 4.

Psychologische Arbeiten. Herausgegeben von Emil Kraepelin. Leipzig, Wilhelm Engelmann. Hefte I., II., III. Pp. 488. M. 12.

Beiträge zur Psychologie und Philosophie. Herausgegeben von Dr. Götz Martius. Leipzig, Wilhelm Engelmann. Bd. I. Heft I. Pp. 159. M. 4.

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

PALEONTOLOGY AS A MORPHOLOGICAL DISCIPLINE.*

THE day has forever gone by when any one mind, however profound and comprehensive, can take all knowledge for its province. Increase of knowledge, like advance of civilization, necessarily brings with it a division of labor, and each of the great branches of science becomes more and more minutely divided and subdivided for the purposes of investigation. Such subdivision greatly enhances the efficiency of the individual worker, enabling him to concentrate his attention upon some definite problem of more or less limited scope, and, so far, it is advantageous. On the other hand, like most human devices, it has its drawbacks, and what is gained in one direction is apt to be lost in another. One great and growing evil is the subdivision of *knowledge* which accompanies specialization of research. The worker finds the greatest difficulty in keeping abreast of all that is being accomplished by fellow laborers in his own field; how, then, shall he find time to learn anything of the work in other fields? Not to do so involves the penalty of such a narrowness of view as will inevitably lessen the value of his own work, because deductions drawn legitimately enough from a single line of investigation often appear absurd when tested by a wider range of facts. Many a blunder might be avoided, were the worker's vision not so strictly limited by the boundaries of his own speciality.

The narrowing effects of this subdivision of knowledge result in a more or less marked loss of sympathy and mutual understanding between the representatives of the different branches of the same science. To

*A lecture given at the Marine Biological Laboratory, Wood's Holl, printed in advance of its publication in the Lectures of the Marine Biological Laboratory by permission of the Director, Prof. Whitman.

magnify one's own office is a very human infirmity, but it involves a minimizing of the offices of others. Science is not advanced by the sneers of its representatives at one another as mere 'species-makers,' or 'section-cutters,' or 'closet-naturalists,' as the case may be. One is prone to regard with instinctive distrust results which run counter to cherished convictions, or which ill harmonize with prevalent theories and call for a radical readjustment of opinion. Naturally the investigator is apt to place undue reliance upon the methods with which he is familiar and to undervalue other ways of attacking the same problem. Evidence derived from other lines of investigation means less to him and is the more readily overlooked and ignored. Perhaps the greatest danger which at present threatens the healthy growth of zoological science in all its branches is the ever-increasing tendency to ambitious speculation, founded upon the narrowest basis of fact. So much of a theoretical taint attaches to nearly all morphological work as to cause hesitation in fully accepting it, and one often feels in reading that we have gone back to the days of the transcendental anatomists. The glib use of phrases and formulæ, which hide ignorance under the guise of 'explanations' which do not explain, is an outgrowth of the same tendency. It is the fashion to measure with elastic standards, which expand and contract to meet the needs of each case. Dogmatism and narrow-mindedness have ever been closely akin.

The obvious corrective for many of these evils is to take a wider view of our subject, and for each of us to learn something of the methods and results of workers in other fields than our own. I wish to invite your attention to a branch of morphology, the bearings of which are much misapprehended by the representatives of other departments of the same science, and which, where not completely ignored, is often wofully abused, namely, the subject of paleontology. This science has too long been abandoned to the geologist, but morphologists are coming to see that they have an interest in it, and sometimes condescend to make use of such parts of its data as favor their opinions. Even yet, however, the necessary and close connection which obtains between paleontology and geology leads many to the assumption that its relation to morphology is, at best, very remote; but this assumption is quite unjustified, and proceeds from a confounding of the two quite distinct aspects and offices of paleontology. One of these offices is to determine the chronological succession of the rocks, and in this morphology is very indirectly concerned; but the other office is the study of fossils as organisms, and here Huxley's dictum thoroughly applies: "The only difference between a collection of fossils and one of recent animals is that one set has been dead somewhat longer than the other." This is a shining example of the 'true word spoken in jest.'

The great problems of morphology are the same for all workers in that science; it is the method of attacking them which differs. If I may be allowed to quote what I have elsewhere said, I would again call attention to the very instructive character of the analogies which exist between the history, aims and methods of animal morphology and those of comparative philology. "In both sciences the attempt is made to trace the development of the modern from the ancient, to demonstrate the common origin of things now widely separated and differing in all apparent characteristics, and to establish the modes in which, and the factors or causes by which, this evolution and differentiation have been affected. At the present time morphology is still far behind the science of language with regard to the solution of many of these kindred problems, and can hardly be said to have advanced beyond the stage which called forth Voltaire's famous sneer: 'L'étymologie est une science où les voyelles ne font rien et les consonnes fort peu de chose.' Of the animal pedigrees, now so frequently propounded, few have any better foundation than the guessing etymologies of the last century, and for exactly the same reason. Just as the old etymologists had no test to distinguish a true derivation from a false one, except a likeness in sound and meaning in the words compared, so the modern morphologist is yet without any sure test of the relationships of animals, except certain likenesses or unlikeness of structure. How much weight is to be allowed a given similarity, and how far this is offset by a dissimilarity which accompanies it, we have, as yet, few means of determining, and have still to discover those laws of organic change which shall render the same service to morphology as Grimm's law has done to the study of the Aryan tongues."

Philology was raised to the dignity of a true science by the laborious tracing back of modern words, step by step, to their ancient origins, through all their intermediate gradations, and sound principles of etymology could not be established until this was done. Morphology must profit by this lesson and must imitate the method of the science of language. Not until many long phylogenetic series have been recovered, can the law of change be worked out. It is just here that paleontology is fitted to render invaluable services to the common cause.

As every one is aware, the principal methods of morphological inquiry are comparative anatomy, embryology and paleontology, each of which has its great advantages, but accompanied by its own peculiar drawbacks and limitations. Lack of time will prevent any discussion of Bateson's proposed new method for the study of variation. I have elsewhere examined that at some length.

The foundation and corner stone of the whole structure of morphology must ever be comparative anatomy, an accurate knowledge of which is indispensable to successful prosecution of the other departments of inquiry. This method has, in the hands of the masters, registered many great triumphs in the solution of difficult problems of homology and of the mutual relationships of animal groups. At the present time the tendency is to give more and more weight to its determinations. On the other hand, finality cannot be reached by this method. It suffers from the very significant drawback of possessing no sure criterion by which to distinguish between those similarities of structure which result from actual genetic relationship and those which are due to parallel or convergent development, and thus to determine the taxonomic value of a given likeness or unlikeness. It is an exceedingly common fallacy to assume that, because a number of allied groups display a certain structure, their common ancestor must also have possessed it. This may have been the case, but it is almost as likely not to have been, because the structure in question may have been many times independently acquired. While the comparative method frequently enables us to discriminate between the two classes of phenomena, it generally does not do so, and it never can give entire certainty upon this point.

On comparing the humerus of the horses with that of the camels, we find in each a characteristic difference from other artiodactyls and perissodactyls and agreement with each other—a feature which may be described in brief as the duplicity of the bicipital groove and presence of a bicipital tubercle. It is *à priori* probable that such an isolated resemblance between two widely separated groups is due to convergence, and yet the comparative method can give us no assurance that this is not a primitive ungulate character retained in these two series and lost in the others. Having recovered the various extinct genera of both these phyla, we may trace out the gradual transformation of the humerus and definitely show that the resemblance has been independently acquired at a comparatively late period, and is not a case of a persistent primitive feature.

In short, the difficulty of reaching firmly fixed conclusions upon questions of homology and relationship by the exclusive use of comparative anatomy lies in the fact, that this method deals only with the modern assemblage of animals, a mere fragment of that which has existed in former times. It is like attempting to work out the etymology of a language which has no literature to register its changes.

The second method of morphological inquiry, embryology, has had a somewhat chequered career. Not many years ago it was universally regarded as the infallible test of morphological theory, and the principle that the ontogeny repeated the phylogenetic history in abbreviated form was accepted, almost without question, as a fundamental law. But this view has fallen somewhat into discredit. The admission which very early had to be made, that 'cenogenetic' features of development were imposed upon or substituted for those due to ancestral inheritance, opened the door to an unduly subjective way of dealing with embryological evidence and deprived the method of that authoritative character which had so generally been ascribed to it. Now the whole recapitulation theory is boldly called in question, and, in the admirable lecture delivered last year in this place, Prof. E. B. Wilson showed the untrustworthy nature of the embryological criterion of homology. The difficulty in this case lies in the absence of any 'canons of interpretation' (to use Bateson's phrase) by which the contradictory data of embryology may be harmonized into a consistent whole. To take a concrete illustration: The ontogenetic development of the horse's teeth would give us a very inadequate and indeed false conception of the actual steps of change, by which the modern type of dentition has been attained, nor would embryology show that the horse is descended from five-toed ancestors. Knowing, as we do from the fossils, the phyletic series, the embryological facts may be readily understood. It is an undue reliance upon such facts which has led to the concrescence theory of tooth development, now so rife in Germany and which seems so absurd when viewed in the light of paleontology.

I have no intention of belittling the splendid services which embryology has rendered to morphology, but merely to point out that this method alone cannot reach finality any better than comparative anatomy. It resembles dealing with a literature that has been vitiated by many forgeries, only the grossest and most palpable of which can be readily detected.

A third method of attacking morphological problems is that offered by paleontology. Let us begin our consideration of this method by frankly acknowledging its drawbacks and limitations. (1) In the first place there is the imperfection of the geological record. Paleontology does not profess and never can hope to reconstruct the whole history of life upon the earth, or even the greater part of that history; very many chapters are irretrievably lost, and others are so fragmentary that they teach us little or nothing. The great sedimentary deposits which contain nearly the whole recorded history of the globe were laid down under water, and for a land animal or plant to be entombed there is a lucky accident. If all we could learn of the terrestrial life of North America had to be deciphered from the fragments enclosed in the oceanic deposits along its shores, how very imperfect would our knowledge be! Although the estuarine, swamp and lake formations, which occur on such a grand scale among the rocks of the earth's crust, have preserved whole chapters in the history of terrestrial life with wonderful fullness and accuracy, they are all too few and too widely separated to form any complete record. Even in a continuous series of marine deposits, representing vast periods of time, there are sure to be gaps of greater or less importance in the record. Changes in the depth of water and the character of the bottom will drive out one set of forms from that locality and bring in another, which has no genetic connection with the former, which may perhaps return with a renewal of the old conditions. Many groups of organisms are incapable of preservation in the fossil state, except under the rarest conditions—conditions which occur so seldom, and so widely separated in space and time, as to render hopeless any attempt to reconstruct a continuous story from them.

The very circumstances under which organisms are preserved in the rocks offer another obstacle to the determination of phyletic series. On examining large collections of fossils from several successive horizons, we find that the majority of the species and even of the genera are confined to one or two formations, and that each succeeding fauna is recruited partly by migrations from other regions and partly by the rapid expansion of comparatively few adaptive and plastic types, while most of the forms which were especially well fitted for the older conditions die out under the new. The collections are, of course, largely made up from the abundant and dominant species of each horizon, which frequently are not the ancestors of those which will be dominant in the succeeding one. The sudden appearance, as it so often seems to be, of a fully differentiated group is sometimes due to that cause, sometimes to a migration from some other region. Even in phyletic series which are well-nigh complete there is a tendency for each successive genus to undergo similar cycles of specific variation, and this adds to the confusion, the very completeness of the record increasing the difficulty of its interpretation.

(2) a second drawback to the paleontological method of inquiry lies in the incomplete preservation of those organisms which are fossilized. Of plants we find, for the most part, only scattered leaves, rarely the reproductive organs, stems or roots, and often the proper association of the various parts requires the strenuous labor of years. Of animals, except under exceedingly rare circumstances, only the hard parts, teeth, bones, shells and the like, are preserved, and in the case of vertebrates how seldom is even the skeleton completely recovered! As in plants, the association of the various parts of a single skeleton may require the long continued and laborious efforts of many workers. Extraordinary blunders have sometimes been committed in this work. In the remarkable genus *Chalicotherium* the skull was at first referred to one mammalian order and the feet to another, and Forsyth-Major's suggestion that they all belonged together was received with incredulity. Of the even more curious *Agriochœrus* the head was ascribed to one order, the fore-leg to a second and the hind-foot to a third.

The utterly false notion, which nothing seems able to eradicate, that the paleontologist can readily restore an extinct type from a single bone or tooth, ought to receive its quietus from such examples, though of course it will not. It is equivalent to saying that we have nothing to learn from the fossils, and that all possible types of structure are exemplified in the living world.

On account of this incompleteness of

preservation we cannot learn much that we wish to know of the structure of extinct organisms. The nervous, vascular, muscular and alimentary systems are entirely lost and can be inferred only from indirect and often insufficient evidence. Were the pearly nautilus extinct, our notions of the anatomy of the tetrabranchiate cephalopods would be very much astray, and in the cases of several groups of fossils we are quite unable to interpret the structure from what remains.

(3) A third difficulty in the way of a truly morphological paleontology consists in the uncertainties of geological correlation, by which the relative age of formations in widely separated areas and different continents is to be determined. It may and often does make a vital difference in the construction of a phylogeny, whether a given set of rocks in North America is older or younger than one in Europe, with which it is correlated. The principles according to which such correlation is to be made are still somewhat indeterminate, and not a few geologists maintain that the problem is an insoluble one. On the other hand, it is essential to the paleontologist that it should be solved, and already a very encouraging beginning has been made.

(4) In the fourth place the apparent order of succession of organisms in the stratified rocks must not be too implicitly and uncritically accepted. Animals and plants diffuse themselves as widely as possible until stopped by some impassable barrier. During the long ages of the world's history these migrations have ever been in progress, and they greatly confuse the record when we attempt to read it in terms of evolutionary descent. A species in a newer formation, which appears to be derived from one in an older horizon of the same region, may, as a matter of fact, have had an entirely different ancestry and have migrated half around the globe to the place where it occurs. To make these distinctions theoretically is easy; to apply them very difficult.

(5) Lastly should be mentioned a practical drawback to the paleontological method, namely, its costliness. The naturalist may find much to do in other departments at small expense, which will be a source of infinite pleasure to himself and of great value to science. Every field and wood, every pond and stream, and above all the sea, offer boundless stores of material. Even the side of paleontology which bears upon stratigraphy and historical geology may be taken up to great advantage by the private worker who happens to live in a favorable locality. With paleontology as a branch of morphology, however, the case is unhappily very different. Here great collections brought together without much regard to cost, skilled workers to prepare the specimens, and great buildings in which to house them are indispensable. Distant regions must be examined and the whole world ransacked for material. Many problems connected with the North American fauna must await their explanation until Asia can be thoroughly explored, while Africa and South America have already shown what a complete geological knowledge of those continents may be expected to teach. In this country the arid parts of the West have yielded a marvelous store of wonderfully preserved fossils, but great sums have been expended in gathering them—an opportunity which falls to the lot of but few. It is to be hoped that the multiplication of museums may ere long put within the reach of all biological students something of these great stores of wealth.

It might well seem that all these limitations and drawbacks would necessarily disqualify paleontology as a morphological subject from being of the smallest real importance, but such a conclusion would be highly erroneous. Several of the limitations are but partial, not applying to particular cases, while others are difficulties that further investigation may hope to remove, not insurmountable obstacles. Every year new forms are discovered and better material of known forms. Though the White River Bad Lands have for more than half a century been classic collecting ground, hardly a season passes that several new genera are not registered from there, and, better still, types before known only from fragments are gradually made more and more complete. From the middle Eocene to the lower Miocene there is in the West an almost unbroken transition which is bringing forth a truly magnificent series of evolutionary stages.

While paleontology, as we have seen, does not profess to give an unbroken life history of the earth, yet it has certain preeminent advantages which neither comparative anatomy nor embryology possesses, and which fit it to form an invaluable supplement to those other methods of morphological investigation.

(1) In the first place, it gives us in many cases actual phyletic series in their true order of succession in time. In many groups of animals we have already recovered phyletic series so full, so complete, that no observer can hesitate to accept them as representing actually or very nearly the successive steps of evolutionary change in the order in which they occurred. Little confidence may, perhaps, be placed in these phyla by those who have not made a special study of them, and it may be imagined that fuller knowledge will require them to be completely changed. But when we find such a series as that of the horses, leading back by almost imperceptible gradations from the great monodactyl living forms to their little five-toed progenitors in the far distant Eocene times, doubt becomes well-nigh impossible. A limit of error is placed by the stratigraphical order, the geological and morphological successions coinciding beautifully. Whatever changes in the details of such a series may be needed, a radical reconstruction of it is not in the least likely to be called for. Few observers, if any, would now uphold the arrangement of the equine phylum proposed by Kowalevsky, namely, *Palœotherium*, *Anchitherium*, *Hipparion*, *Equus;* and yet it is surprising to see how the general character of this series, and the deductions as to the manner of evolution which may be drawn from it, agree with those made on the basis of the equine series as we now have it. Kowalevsky's mistake merely consisted in putting certain members of the side branches into the main line of descent, and that similar errors have been made in accepted phylogenies is not at all unlikely. The correction of such errors will, however, change the general result but little, and we may appeal with considerable confidence to the conclusions which legitimately follow from a study of these phylogenies.

Fortunately, the well-defined phyletic series which have already been made out occur in very widely separated animal groups—mammals, reptiles, cephalopods, brachiopods, echinoderms, etc.—so that the points in which they agree are apt to prove of general application and validity. The cephalopods are particularly valuable in this connection, because in them the embryonic and young stages of the shell are preserved in the adult, and thus conclusions have a distinct support from embryological considerations. To recur to the linguistic analogy, we have here at least fragments, and sometimes very extensive ones, of the various literatures which register the changes of language, and in the original documents which bear evidence of their dates and succession, and which, however incomplete, have not been falsified by forgeries and late interpolations. In this way we may establish unequivocally some, at least, of the animal pedigrees, which it is one of the great objects of morphology to construct, and thus to correct the results obtained by the other methods of inquiry.

Paleontology further enables us accurately to discriminate between resemblances which are due to genetic affinity and those which result from parallelism or convergence.

To illustrate: On grounds of comparative anatomy, Flower classified the land Carnivora in three sections: the Cynoidea, or dogs; the Arctoidea, containing the bears, raccoons and mustelines; and the Aeluroidea, including the civets, hyenas and cats. This classification has found wide favor and very general acceptance, but paleontology proves it to be untenable. The extinct phyla show that the dogs and bears are very closely akin, as are the mustelines, civets and hyenas, while the cats occupy a very isolated position and are not nearly allied to any of the other families. The anatomical characters which suggested Flower's system are, in part, examples of convergence, and in part, due to the retention of primitive characters in some groups and their loss in others.

Again, reasoning from embryological data, Röse and others have propounded the theory that the complex, multicuspidate, mammalian tooth has been formed by the coalescence of many simple teeth. The phyletic series enable us to follow the evolution of these teeth step by step, and demonstrate the incorrectness of the 'concrescence theory.' In fact, the great lesson which the study of the phyla continually brings home to the observer is that trustworthy results are to be obtained only by the laborious and minute tracing of the changes through every step of the way. Fragmentary series are not to be depended upon, and the wider the gaps between their members the more uncertain is their connection.

(2) The reconstruction of pedigrees, the solving of homologies, the determination of relationships, and the establishing of classification upon a sound and natural basis, important as these are, are yet only a part of the great task which morphology has set before itself. We wish to penetrate more deeply into the mystery of nature and learn how and why these changes have occured; or, in other words, to discover the manner in which, and the efficient causes by which, development is effected. On these subjects there is, as yet, wide divergence of view among morphologists. The postulates and assumptions upon which morphological discussions are founded are, in great measure, incapable of proof, and appeal with very different degrees of force to different minds. Modes of development which appear axiomatic to one observer are by another regarded as absurd. All are agreed that there are limits to the possibilities of change; no one attempts to derive a butterfly from a beetle, or a horse from a cow; but just how and where these limits should be drawn it is at present impossible to say. It is this uncertainty which refers the question to the individual judgment and leaves the way open for such radical differences of opinion.

To the solution of these problems of evolutionary modes paleontology offers most valuable assistance, drawn from the study of actual phyla. It might seem that this was merely arguing in a circle, because the construction of phylogenetic series involves certain presuppositions as to what changes are and what are not possible, and we then proceed to prove the presuppositions by the phyla thus constructed. But the cautious, step-by-step method, guarded by the order of appearance in time, offers a way of escape, and enables us to construct phyla in harmonious structural and stratigraphical succession, which must very nearly represent the actual stages of change. Only a beginning has been made in this work, but the results drawn from an examination of widely separated phyla, such as mammals, gasteropods and cephalopods, are so consistent and harmonious as to be full of promise for the future.

Limitations of time and space forbid an attempt to fully consider here all the deductions which have been suggested and rendered more or less probable by this method, but one or two principles which stand out with especial clearness may be mentioned.

(*a*) Evolution is ordinarily a continuous process of change by means of small gradations. The continuous character of a phylum is apt to be proportional to the relative abundance of its representatives in the strata, which is equivalent to saying that well-known series are continuous, while apparently discontinuous series are imperfectly known. This does not imply that the rate of change was always uniform—it probably was not—or that a sudden alteration of conditions may not bring about discontinuity, or *per saltum* development. It means that the usual and normal mode of advance is by continuity of change.

(*b*) Development is, in most instances, direct and unswerving. The rise of new forms, and the decadence and degeneration of old ones, are not ordinarily by zigzag and meandering paths, but by relatively straight ones; and though, of course, a path once taken may be diverged from, yet in such a case it is not regained. This applies particularly to the organism as a whole; in minor details more latitude is permissible. The evidence is not yet sufficient to show just how widely applicable this principle is.

(*c*) Parallelism and convergence of development are much more general and important modes of evolution than is commonly supposed. By parallelism is meant the independent acquisition of similar structure in forms which are themselves nearly related, and by convergence such acquisition in forms which are not closely related, and thus in one or more respects come to be more nearly alike than were their ancestors. While some observers have tacitly or explicitly denied the reality of these processes, most authorities have been compelled to admit them. What paleontology has done, and is doing, is to show the universality of these modes of development, and to point them out in directions where they had not been suspected. To give a few examples: The crescentic, or selenodont, molar has been separately acquired by no less than three groups of artiodactyls, and probably others as well. The spout-shaped odontoid process of the axis has independently developed in the horses, the tapirs, and in three artiodactyl series. The true ruminants (Pecora) of the present day are, among other characteristics, distinguished from the remaining artiodactyls by the hollow tympanic bullæ, which in the pigs, tragulines and camels are filled with cancelli, or spongy bone. In Oligocene times only the camels had acquired the cancelli; the other groups, though already differentiated as such, still had hollow and inflated tympanics. Lists of such parallelisms in single characters might be multiplied almost indefinitely, but they also occur in whole groups of structures. The camels have in teeth, skull, vertebræ and limbs many points of resemblance to the true ruminants, which demonstrably are not due to inheritance from a common ancestor. The two great series of ungulates, the artiodactyls and perissodactyls, which are usually grouped together as the Ungulata *par excellence*, are examples of parallel development on a grand scale, their many resemblances being for the most part independently acquired. The flesh eaters known as Carnivora include at least two, and probably three lines, which have been separately given off from the primitive flesh eaters, or creodonts.

Such a mode of development greatly increases the difficulty of determining phylogenies, which would be very much easier could every notable resemblance at once be accepted as proof of relationship. It often renders impossible the proper classification of some isolated genus which seems to have several incompatible affinities. It emphasizes the necessity of founding schemes of classification upon the totality of structure, and of determining the nature of characteristics, whether they are primitive or acquired, divergent, parallel or convergent, before attempting to assign them their proper taxonomic value.

We may find a practical identity in teeth, skull or feet as the outcome of these processes, but as yet no case is known where all these structures have become alike through the operation of either parallel or convergent development. Among the invertebrates the case is different. Hyatt has shown that the degenerate, straight-shelled, ammonoid genus *Baculites* is a polyphyletic group, and derived from several distinct stocks, both European and American. Würtenberger points out that the so-called *Ammonites mutabilis* is not a true species, but a composite group, made up by the convergence of several distinct lines to a common term. This case is peculiarly significant, because it would hardly have been detected had not the embryonic and young stages of the shells been preserved.

It seems the most obvious of commonplaces to say that numerous and close resemblances of structure are *prima facie* evidences of relationship. Yet the statement is true, even though the resemblances have been independently acquired, because parallelism is a more frequently observed phenomenon than convergence, and because the more nearly related any two organisms are, the more likely are they to undergo similar modifications.

All this brings us back to the thesis so frequently insisted upon already, that the only safe and trustworthy method of constructing phylogenies is by tracing the development, step by step, through all its gradations; and until this is done the classification of any group can be but tentative and provisional, that is, if we intend classification to express relationship.

No department of biological science is at present the scene of such vigorous controversy as that which deals with the factors of evolution, the causes which determine the development of new forms, and the problems of heredity which are inseparably connected with them. Paleontological evidence will prove to be of much importance in this connection also, but it cannot well have more than a corroborative value. Though the examination of long and complete phyla brings to light much that is suggestive concerning the factors which have brought these changes to pass, and any rational theory must embrace and explain these facts, yet the deciding weight must probably come through the physiological and experimental method. Time fails to deal with such far-reaching questions here, and yet it may be well to call attention to the necessity of avoiding a dogmatic and intolerant attitude, and to deprecate any premature attempt to exclude this or that class of factors from consideration. In most of the recent writings upon the efficient causes of evolution you will find expressed or implied the feeling that these matters are not so simple and intelligible as we once supposed, and that we are yet only upon the threshold of their solution. The study of paleontology will not tend to dispel this feeling of mystery.

Another department of biological science in which paleontology has proved of great value, and will become more and more so in the future, is that which deals with the geographical distribution and migrations of organisms. Though not a branch of morphology, this subject has a very significant bearing upon that science, and cannot be ignored in any comprehensive theory of evolution. This, again, is too large a field to enter upon at the close of a lecture. It must suffice, therefore, to hint at the many cases in the existing distribution of animals, which seem so puzzling and capricious, and which are so readily explained by a study of the past. That the nearest allies of the South American llamas should be the camels of the Old World seems unaccountable, until we learn that North America was the original home of the entire tribe. The occurrence of the tapirs in South America and in the Malay peninsula becomes intelligible enough, when we learn that this genus is of very high antiquity, and was formerly represented in every part of the northern hemisphere.

The more fully the past is recovered, the more completely the former land connections of the various continents are made out, the more comprehensible do the seeming anomalies of the present order of things become—a proposition which applies to more than problems of geographical distribution.

The foregoing consideration of paleontology as a branch of morphological science is necessarily brief and very inadequate, but it will suffice, I trust, to show that its claims upon the attention of morphologists should not be ignored, and that it is admirably fitted to throw light upon many obscure problems. In conclusion, let me point out that final and lasting results are not to be gained by an exclusive adherence to any method of morphological inquiry, but by a combination of all of them. Each is able to supplement the others, and it is folly to reject such aid. Already most encouraging results have followed from this combined method of work, and it is devoutly to be wished that its scope may be more and more extended. As an example may be cited the recent investigations upon the mammalian dentition. From paleontological phyla we have learned to distinguish the homologies of the cusps, and the way in which a complex tooth is gradually formed from a simple one. Embryology, on the other hand, has shown the relations of the successive dentitions to one another in a fashion that paleontology could by no possibility accomplish unaided. As another example may be mentioned Wincza's discovery of a bony clavicle in the embryo of the sheep, which was soon followed by the still more unexpected one of vestigial bony clavicles in certain extinct artiodactyls, confirming and explaining the first. Embryology has taught us that the large element in the carpus of the Carnivora known as the scapholunar was formed by the coalescence of three separate bones—the scaphoid, lunar and centrale. Later the fossils were unearthed, which showed that the embryonic and transitory condition of the modern forms was the permanent and adult structure of the primitive Eocene flesh-eaters.

The more the combined method is employed the more fruitful does it appear. Nor should the combination be restricted to the technically morphological subjects. Experimental embryology has already won some notable triumphs, and that is a physiological quite as much as a morphological province.

In the ever-increasing complexity of modern civilization a more and more important rôle is played by systematic coöperation, specialists combining for joint work which neither could accomplish alone. Is it Utopian to wish that some such organized scheme of attack upon biological problems shall be devised, when, instead of every man doing merely that which is right in his own eyes, we shall combine in a definite, orderly way to investigate a given topic in all its bearings? It may well be doubted whether any naturalist, however great his genius, will ever again be able to take such an exhaustive survey of biological data as Darwin did in his time. The enormous mass of accumulated facts already far transcends the power of any one mind to grasp, and it would seem that organized cooperation is the only method of dealing with such vast accumulations. When that time arrives, the paleontologist will be able to render even more conspicuously valuable services that he has done in the past.

W. B. Scott.

Princeton University..

ON PHOLADIDEA PENITA AND ITS METHOD OF BORING.

The Piddock of the northwestern coast, Pholadidea penita, is found in its curved conical burrow in the rocks near the tide marks. These rocks, so far as the writer's observation goes, consist of soft limestone or sandstone of varying hardness, the animal choosing the softer portions for its home. How the Piddock accomplishes the task of burrowing into the even moderately hard sandstone is a question upon which little light is thrown by an examination of the mature, or as I shall call it, the resting form, which is characterized by the complete absence of its foot muscles and an almost complete fusion of the mantle lobes along their ventral margin, leaving an opening hardly 2 mm. long. The inference is that Pholadidea penita is a degenerate form, as is the oyster. Further facts, however, will show that this degeneracy does not occur till late in life, when its burrow, the home of its old age, is completed.

The shell of the animal during its period of diligence, like that of other Piddocks, gapes widely in front. Through the upper portion of this gape protrudes a thick fold of the mantle which overlaps the antero-dorsal margin of each valve and secretes a layer of calcareous matter on the outside of the shell. The gape is much wider below

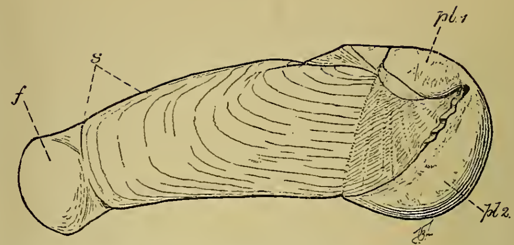

Fig. I. Left side of resting form, specimen 9 cm. long.

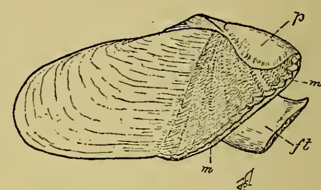

Fig. II. Left side of working form, specimen 6 cm. long.

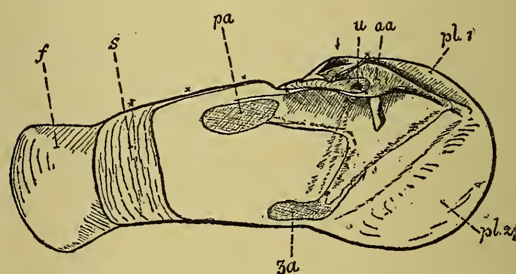

Fig. III. Inside of left valve showing hinge mechanism and muscle markings, specimen 9 cm. long; Siphon retracted in all. aa. Anterior adductor muscle mark; the arrow point indicates its posterior limit. 3a. Third adductor muscle mark at angle of pallial sinus. f. Cuticular flap. ft. Foot. m. Thick antero-ventral edge of mantle surrounding foot. p. Pad formed by antero-dorsal mantle folds. pa. Posterior adductor muscle mark. pl. 1. Plate secreted by antero-dorsal mantle fold, of that side. pl. 2. Plate secreted by m. in Fig. II. S. Additional extent of shell added at the same time with cuticular flap. u. Umbo. The leaders end in patch of abrasion, the point where the valves articulate. The small crosses indicate attachment of hinge cuticle.

and through it protrudes a strong cylindrical muscular foot, the muscles of which are attached at a point of vantage supplied by a curved process on the inside of each valve. The mechanical result of this arrangement is that the foot moves about a point near the common axis of the animal and its burrow and not at one side, thus enabling the foot to work with equal advantage in all directions.

The mantle lobes are fused, except in the antero-ventral region (and, of course, at the siphonal openings), where an opening is found sufficiently large for the protrusion of the foot. The edge of the mantle opening seems to be provided with circular muscle fibres, by means of which the opening is kept just large enough for the foot. Specimens of this form when removed from the burrow will be found to have the foot armed with grit, and a glance at its size and musculature is enough to convince one that it is functional.

These characters remain unchanged until the work of drilling the burrow is completed. The depth and size of the hole will be determined by the number and frequency of the neighboring burrows or the hardness of the rock. Assuming that the work is finished and the author is ready to rest from his labors, let us see what changes take place. The foot, being thereafter of no use, begins to atrophy, till at last the muscular tissue is entirely lost, the whole bulk being taken up by the genitalia and digestive tract. As the foot disappears, the opening through which up to this time it has protruded grows smaller by further fusion of the mantle lobes, till there is left at the extreme anterior end a small opening about one and a half mm. in diameter. This opening is supplied with a sphincter muscle and two valves on the inside, so placed that egress of water at this point may be prevented. The opening seems to be used in drawing in water and débris chancing to be in the burrow.

As this fusion takes place the gape of the shell becomes closed by plates secreted by the antero-dorsal mantle folds above and by the thick mantle now closing in front of the foot below. This results in the complete armature of the anterior end of the animal. At the posterior end an extra length of shell and two cuticular flaps, leathery continuations of the shell, are produced. The shape and size of these is such that the burrow is completely closed at this point by them as by valves. After these changes have taken place there is no more boring done, and we have now the fully matured but degenerate animal. It is interesting to note that not infrequently other clams Saxidomus are caught when very small in the burrow of the Piddock. Such forms have, it is well known, a very strong and muscular foot, which, however, becomes functionless in imprisonment and dwindles away until it is almost, if not entirely, lost. The shell becomes elongate or otherwise changed from the normal shape by pressure of the walls which imprison it. Mussels, too, attach themselves by their byssus to the wall of the burrow near its mouth, where it is narrow, and become much elongated.

The absence of an elastic hinge ligament is a striking character, not only of this form, but of Piddocks in general, and of another allied form, Teredo. The valves are held in position each relatively to the other by the common cuticular investment, which is, however, rather thicker and stronger along the dorsal line. The point at which the valves actually come in contact is morphologically the outside surface of the umbo, thus forming a double ball joint about which the dorsal cuticle is so disposed as to give rise to an incomplete capsular ligament. In place of the hinge ligament we find that the anterior adductor muscle, instead of remaining inside the shell, extends backwards and dorsal to the umbones, so that contraction of this muscle does not result in closing the valves, as it, aided by the posterior adductor, does in other dimyarians, but in separating them ventrally and approximating them dorso-anteriorly. Compensation takes place, however, by the development of a third adductor muscle, which occurs at the lower angle of the pallial sinus. This adductor muscle is in fact composed of pallial muscles diverted to this use. Such a muscle occurs in Zirphæa and Teredo and another Piddock which I have examined, said to have been brought in ballast from Panama.

By means of muscles arranged with respect to the point of contact, as these are, the valves of the shell can be moved mutually in any plane excepting a dorso-ventral one. The antero-ventral margin of the shell of the working form is armed with teeth, which are constantly renewed by shell accretion, forming a good rasp. Certain scratches in the wall of the burrow show that this rasp has been used in enlarging the hole, the anterior mantle pad and foot being used as fulcra. There are, however, other scratches at the apex of the burrow which indicate that the foot armed with sand serves also as a drill, but all attempts to watch the operation have so far been futile.

Specimens of this form have been found by the writer showing all degrees of degeneracy. Francis E. Lloyd.

Pacific University,
Forest Grove, Oregon.

SIR JOSEPH PRESTWICH.

The Nestor of English geologists—Sir Joseph Prestwich—late professor of geology at Oxford, died on the 23d of June, last, at the ripe age of 84 years. The life of Prof. Prestwich covers the most eventful period in the past of geology. The problem whose solution has established the principles of the new science all arose during his lifetime, and of these all he could say with truth

"quaeque ipse vidi
Et quorum pars magna fui."

Born near London on March 12, 1812, he received his early education partly in England and partly in France, becoming later a student of University College, where his attention was chiefly turned to chemistry and natural philosophy, geological study not being then a recognized part of any course. While there he founded among his fellow students the Zetetical Society, composed of about 14 young men who arranged to lecture to one another for the purpose of mutual improvement.

Necessity, rather than inclination, turned his course into business, in which he was closely occupied for nearly 40 years, but during this long time his thought and his holidays were employed in his favorite topic, geology. It was his enthusiasm and stern earnestness that enabled him to accomplish so much in hours that most men would have devoted to mere amusement. The necessary books and travel were obtained by the strictest self-denial in personal expense, sometimes, perhaps, to an excessive degree, but the results became manifest in a series of investigations that rapidly brought him to the front, and resulted in his appointment to the chair at Oxford in 1874.

To enumerate the successive publications that came from his pen would scarcely befit this notice. A glance at the many problems that engaged his attention and which were in part or altogether solved by his efforts will prove more instructive and interesting. One of his earliest papers appeared in the transactions of the Geological Society of London in 1836, and contains an investigation of the Coalbrookdale coal field, but his attention was soon directed to the English and French Tertiary strata and their correlation, and from these he passed to the younger or quaternary deposit on which most of his later work was done.

In several years reports had been current of the occurrence of human relics in the form of flint implements in gravels of very early date in France, but geologists on both sides of the channel received them with incredulity.

In vain did the discoverer, M. Boercher de Perthes lay the evidence before them. So firmly were they fixed in their traditional belief in the late date of the appearance of man that all his efforts failed to move them until Dr. Falconer visited the region, saw and was convinced. At his suggestion, Prestwich, Godwin, Austen and others went to Amiens, and the former in his paper before the Royal Society gained over his English brethren to the new faith which he had himself adopted on seeing the evidence presented in the valley of the Somme.

He even extended the limit of time which the French geologist had demanded by proving that the gravels were of at least two ages, and that the high level or older beds had been deposited before the valley itself had been excavated by the river.

In the same time was the report on the Brixham Cave in 1872, where new evidence of the vast antiquity of the human race was adduced and previous conclusions were more than supported. Those who can look back to the time can well recall the conditions and realize the boldness of the few who dared to stand for the new truth and face the storm of 'odium theologicum,' which set in at once and beat on their reputation. Years passed by before it began to blow over, and only disappointment, loss and mental suffering were the reward of many who read and believed and acknowledged their faith. It is hard now to understand the effort it cost twenty-five or thirty years ago.

Prof. Prestwich has taken an active part in the efforts to find coal in the southeast of England; in the discussion relative to the channel tunnel, in the investigation of deep sea temperatures and in the water supply of London, "nihil tetigit quod non ornavit."

His large work on geology, in two volumes, appeared in 1886 and 1888 with a geological map of Europe, and contains the matured results of his life's work. His energy continued almost to the last; papers on quaternary geology and the antiquity of man have been read or written as late as the year 1893.

Honors flowed in on the veteran geologist from all sides. He received the Wollaston medal in 1849, a royal medal from the Royal Society in 1865; he was President of the Geological Society of London from 1870 to 1872, Vice-President of the Royal Society in 1870 and 1871. He received the Telford medal from the Institute of Civil Engineers in 1874, was President at the reunion of the Geological Society of France, in 1880, and was elected a corresponding member of the 'Institute' in 1885. A short time only before his death he received from Her Majesty the honor of knighthood.

His later years have been spent at Darent Hulme, near Sevenoaks, Kent, a home after his own taste, as those who have had the pleasure of visiting him well know. Geology is worked into every feature and adorns every corner and panel. It stands in the beautiful chalk downs, overlooking the valley of the Weald, where he delighted to ramble and where his life was shared by Mrs. Prestwich, niece of Hugh Falconer, herself attached to the pursuits of her husband, whose latterly feeble health she guarded with loving care.

E. W. C.

CURRENT NOTES ON ANTHROPOLOGY.

RESEARCHES IN MEXICO.

The rich soil of Mexico and Central America is never scratched but it yields a harvest. How much there is in that land of promise for the ethnographer and antiquary is well illustrated in the brief description of his journey from Mexico City to Guatemala, contributed by Prof. Starr to the Chicago *University Record*, for May 22,

1896. He did not find the 'pygmies' of which there was some talk at the American Association last summer; but the presence of cretins in the barrancas near Guadalajara was established. In Chiapas, many cases of *pinto* was observed and also of goitre. No reference is made to the remarkable antiquities of this state, but doubtless they were not overlooked. The pottery, lacquer work and native costumes are mentioned. A number of notes were made for future studies.

Prof. Starr has also translated and published a pamphlet on Aztec place-names from the works of Father de la Rosa and Dr. Peñafiel. It is to be regretted that this list was not revised before publication by some competent student of the tongue. Several of the explanations are certainly erroneous, and others doubtful. The Nahuatl is not a difficult language either in its phonetics or its composition, and it now has excellent dictionaries and grammars, of easy access.

A NEW ANTHROPOLOGICAL JOURNAL.

The science of anthropology is developing so rapidly, the contributions to it are so numerous and in so many languages and publications, that Dr. G. Buschan of Stettin, very justly thought the time has come when a journal should be started intended to take in the whole field, and give a quarterly summary of the progress of the science the world over. This he has carried out in the *Centralblatt für Anthropologie, Ethnologie und Urgeschichte*, issued at Breslau (J. U. Kern's Verlag. Price 12 marks, 80 Pf., for this country).

It contains one or more original articles, one, for instance, by Dr. Orsi on the ancient necropolis of Novilara in Sicily, and one by Dr. Sergi on the distribution of the Mediterranean race. Most of the pages are, however, occupied with brief notices of the leading articles on the science in various journals, transactions and proceedings, or separately published, including books. They are intended to be descriptive rather than critical, and to serve as a running index of the literature of the science.

There is need of just such a publication, and every student of the science of man will be sure to find references to works and articles for which he will be grateful. It should acquire a good subscription list in the United States. D. G. Brinton.

University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS.

ADAPTATIONS IN CAVE-DWELLING ANIMALS.

The influence of environment upon organisms is nowhere more striking than in the case of animals which find themselves accidentally lost in caves and which succeed in accustoming themselves to the situation in spite of its difficulties. M. Armand Viré gives some notes on his observations, in the *Comptes Rendus.* The principle difference in the situation consists in the absence of light and in the rarity of animal prey. The eye always becomes atrophied to a degree which varies with the species and also with the individual; there is sometimes a difference between the two eyes of a single individual. The eyes are to a certain extent replaced by other organs of sense; the antennæ of the Campodes become, in some individuals, twice as long as usual, and sometimes longer than the entire body. The tactile hairs with which the body is covered obtain an exaggerated development, and in the crustaceans sometimes even invade the ocular globe. Hearing does not seem to be accentuated, but the sense of smell is very acute, and a bit of tainted flesh becomes invaded in a very few minutes with a large colony of animals. The organs of digestion become very considerably modified in those species which are naturally carnivorous, and in two Staphylins the mandibles were found to be completely atrophied. Every animal is more or less completely depigmented; but those which had no trace of color remaining began to have numerous little black spots disseminated over the whole body after they had been kept for a month in the light, and these spots were particularly abundant in those parts (antennæ and claws) which had been accidentally lost and were in course of restoration. C. L. F.

COLOR PHOTOGRAPHY.

M. GEORGES ADOLPHE RICHARD states in the *Comptes Rendus* that he has solved the problem (which has hitherto seemed insoluble) of reproducing and making permanent three separate proofs of the picture in the Becquerel process of color photography, and of superimposing them upon a single plate. His process consists in substituting for the reduced silver, which is deposited in the collodion at varying depth, corresponding to the crests of the standing waves produced by light of three fundamental colors, a coloring matter of the corresponding tone. There are two ways of accomplishing this: (1) the reduced silver is transformed into a salt which is capable of fixing or of precipitating the coloring matter in question, or (2) it is transformed into a salt which reacts upon the carbon derivatives and forms an artificial coloring matter in the place and of the thickness required. Three plates are formed for the three fundamental colors, the middle one on a gelatine film and the other two on glass. The superposition of these three layers in the exact place required offers no difficulty, and the colors are of absolute stability. The combined plate can, of course, be looked at at any angle, unlike the plate produced by the Becquerel process in its original form. At the same time comes the information that a Chicago photographer has perfected the Joly process; it would seem that the moment is not far distant when photographs which reproduce the natural colors of objects will be easily within reach. C. L. F.

THE EYESIGHT OF ENGLISH SCHOOL CHILDREN.

A REPORT has been presented to the British Education Department by Mr. Brudnell Carter on the vision of 8,125 children attending twenty-five elementary schools in London. The refraction of the eyes had in many instances to be determined from a simple ophthalmoscopic inspection owing to the objections raised by parents to the use of mydriatics, and interruptions occurred from holidays, non-attendance and other causes. 3,181 children, or 39.15 per cent., were found to have normal vision in both eyes; 1,016, or 12.5 per cent., had normal vision in the right eye and subnormal in the left; 700, or 8.6 per cent., had normal vision in the left eye and subnormal in the right; and 3,228, or 39.7 per cent., had subnormal vision in both eyes. Comparing the sexes, the total was made up of 3,928 boys and 4,197 girls; of these 43.7 per cent. of the boys had normal vision in both eyes, and 33.4 per cent. of the girls.

Mr. Carter is of the opinion that the eyes of London school children generally are not in any way injuriously affected by the conditions of elementary school life. Myopia is not of frequent occurrence, and Mr. Carter has failed to find any evidence of its progressive increase from younger children to the elder ones, or any correspondence between the degree and the prevalence of the defect and the quality of the lighting in the schools where it was found. He holds that the prevalence of subnormal vision is due to the fact that children so rarely look at distant objects.

THE OBSERVATORY OF YALE UNIVERSITY.

THE report of Dr. W. L. Elkin, who since it was written has been made director of the Observatory, to the managers for the year 1895–6, is as follows:

"The series of measures for the purpose of detecting possible large parallaxes of stars with large proper motion has been carried on during the past year by Dr. Chase and myself. A few stars have been added to the list to fill up the gaps which presented themselves in the course of observing. As at present planned, the work will be completed probably in the course of 1807, as far as the observations are concerned.

"The series on the parallaxes of the first magnitude stars is, as stated in my last report, practically brought to a close, and only a few points of discussion remain to be revised.

"A considerable portion of my time has been devoted to a final revision of the discussion of the work on Iris as it passed through the press. This has now been accomplished, and the work will shortly appear as Part IV. of the work issued by Dr. Gill on the determination of the Solar Parallax by Heliometer measures of Asteroids.

"Dr. Chase has passed through the press his work on the relative places of the principal stars in the cluster in Comu Berenices, and it is ready for issue as Part V. of our Transactions.

"I regret to say that we were not successful in the past season in securing photographic records of meteor trails. The apparatus was put in use during several nights of the August showers, but no meteors appeared of sufficient brilliancy to impress themselves on the plates, which had necessarily become somewhat fogged by the strong moonlight. We were equally unfortunate in our attempts on the Leonids and Geminids in November and December, respectively. During this year we have had only two lenses in use, as no further ones of sufficient size and quality were to be found in the market. It seems wise, however, in view of the favorable chances for the Perseids this year and the approaching maximum of the Leonids, to make an especial effort to secure a complete battery for our mounting, as originally planned."

GENERAL.

The National Forestry Commission, which, as has already been stated in this Journal, is composed of Prof. Charles S. Sargent, chairman, Prof. Arnold Hague, Prof. William H. Brewer, General Henry L. Abbott, Gifford Pinchot and E. H. Shuster, has now inspected the forestry of North and South Dakota, Montana, Idaho and eastern Washington. About two weeks will now be spent in traversing western Washington forests and exploring the Olympic Mountains. The Commission will then proceed to California, thence to Arizona and Nevada, concluding its labors in Colorado in September.

The German Geological Society held its 42d general meeting in Stuttgart, from the 9th to the 12th of August. In addition to the scientific sessions a number of excursions had been arranged. The German Anthropological Society held its 27th general meeting at Spires, from the 3d to the 6th of August, under the presidency of Prof. Virchow.

There has been erected this year at the Marine Biological Laboratory, Wood's Holl, a new building containing a lecture hall and a number of rooms for investigators. Like the other buildings, it is of wood, and finished in the simplest possible manner. The total cost, which has been defrayed by the Marine Association, was $2,900, exclusive of $500 for furniture. There are this year seventy-two investigators engaged in original research at the laboratory.

We learn from *Nature* that by means of a rearrangement of existing scholarships at the Charing Cross Hospital Medical School, and by the establishment of a special fund, memorials have been founded to Dr. Livingstone and Prof. Huxley, both old students of the school. The memorial to Livingstone takes the form of an entrance scholarship of 100 guineas per annum, and that to Huxley of (1) an entrance scholarship of £55, open to the sons of medical men; (2) a second year's prize in anatomy and physiology, and (3) a lectureship dealing with recent advances in science and their bearing on medicine and surgery. The first of these Huxley lectures will be delivered in the anatomical theatre of the Medical School on Monday, October 5th, by Dr. Michael Foster.

The death is reported by cablegram of Sir William Grove at the age of 85. He studied for the bar, and during the latter part of his life was Judge of the High Court of Justice. From 1840 to 1847, however, he was professor of experimental philosophy at the London Institution and made important contributions to physical science especially in the departments of electricity and optics, including the voltaic battery which bears his name. He was President of the British Association in 1856, and was one of the most influential members of the Royal Society.

Dr. J. M. Toner, of Washington, died on July 30th at the age of 71. He had made many contributions to various departments of medical science. In 1871 he founded the Toner Lectures, now endowed with $5,000, the income of which is spent annually on two lectures containing some important contribution to medical science. In 1882 he gave his library, consisting of 28,000 books and 18,000 pamphlets, to the general government, and this library is now a portion of the Congressional Library.

DR. T. M. DROWN has resigned from the committee of the American Chemical Society which is undertaking to unify the methods of color comparison and report on a standard for measurement of color in potable waters, and Mr. Allen Hazen, of Boston, has been appointed in his place.

THE International Electrical Congress met at Geneva under the presidency of M. Lurrettini from August 4th to 9th. Among the subjects proposed for discussion were magnetic units, photometric units, transmission of power to great distances, and the protection of high-pressure overhead conductors against atmospheric discharges.

A REPORT has been circulated in the daily papers during the past week stating that the steamer Hope was detained by an ice floe off the Greenland coast. This is now denied, though it is said that under the conditions of the present season it is not unlikely that the Hope will have any trouble with ice.

ACCORDING to the N. Y. *Evening Post*, a despatch from Tromsöe, Norway, says that the expedition organized in England by Sir W. Martin Conway for the exploration of the interior of Spitzbergen crossed the island from west to east, and back from east to west, in the middle of July. The crossing was extremely difficult, owing to the prevalence of storms, fogs and floods. This is the first crossing of Spitzbergen on record.

THE scientific societies of Mexico will hold a second national congress in the city of Mexico, beginning July 4, 1897.

IN order to give a wider circulation to the *Review of American Chemical Research*, edited by Arthur A. Noyes, which during the preceding year has been published in the *Technology Quarterly*, arrangements have been made to issue the *Review* also in the form of separate reprints from that journal. The reprints will, like the journal, be issued quarterly, and will be paged separately and provided at the close of the year with title page and index, thus making the *Review* a volume complete in itself. The purpose of the *Review* is to present in concise form, in a single publication, a complete summary of the results of current American chemical research.

THE first number of an 'Annuaire géologique et minéralogique de la Russie,' edited by N. Krichtafovitch, has been published by Weg in Warsaw. The contents will be written in Russian, French and German.

THE Marquis of Tweeddale, chairman of the Anglo-American and Eastern Telegraph Companies, has addressed the following to the American press: "A financial committee is about to be formed to inaugurate an international memorial to commemorate the inception and extension of submarine telegraphy connected with the names of Cyrus W. Field, Sir James Anderson and Sir John Pender. In view of its great international importance, the American press may think the desirability of establishing such a memorial a subject suitable to be dealt with in its editorial columns."

PROF. HOLDEN, of Lick Observatory, has received a letter from Miss Caroline W. Bruce, of New York, enclosing a check for $1,000 to be expended in purchasing needed apparatus for use at the observatory. This gift, together with that of W. W. Low, of New York, lately received, makes it possible to carry on important work, which would otherwise have to be laid aside.

MME. BAZANOVA, of Moscow, has given about $275,000 to the University of Moscow to found a clinic with twenty-five free beds for diseases of the ear, throat and nose.

THE Institution of Engineers of Japan now contains, according to the *Indian Engineer*, a total of 1,564 members. Of these 399 are full members, 1,121 associates, 11 honorary members, and 33 corresponding members. They include representatives of the different departments of engineering, and, as a rule, they have been well trained not only in the theory, but also in the practice of their work, and the majority of them have shown that they are thoroughly trustworthy. These facts easily explain why so few foreign engineers are employed in Japan.

IT appears from advices received in Washington that cholera in Egypt is now beyond the control of the authorities. The report dated July 11th says that during the week before last fresh outbreaks occurred in sixty-nine different places, and last week in eighty-seven. During the seven days up to the first instant, 1,200 deaths were reported, and in the following six days 1,700 deaths. So far 8,069 deaths have occurred from the present outbreak, and it is feared that these figures will be largely increased before the disease runs its course.

Mrs. Todd is contributing to the N. Y. *Evening Post* and *The Nation* a series of letters describing the eclipse expedition to Japan under the direction of Prof. Todd. She states that the imperial government has given free transportation for the party and instruments on all the railways and steamboats. It appears that in addition to the parties from England, France and America, the eclipse will be observed from Esashi by Prof. Terao, of the Tokyo observatory.

Mr. Ritchie, the President of the Board of Trade, has stated in the British House of Commons that he will introduce a bill dealing with the metric system during the present session. There will be no time to proceed with it, but its introduction will give an opportunity for consideration and discussion during the recess.

Prof. J. Milne writes to the London *Times*, calling attention to the fact that seismographs in Italy and the Isle of Wight showed the commencement of a disturbance at 8 p. m. on June 15th (the day of the earthquake and tidal wave in Japan), which reached a *maximum* the following morning. Prof. Milne considers that this illustration of the reliability of instrument records is an indication of the value of the earth messages which would be obtained at a geodynamic observatory, which, it is hoped, may sometime or other be established in Great Britain.

The third International Congress of Psychology met in Munich from the 3d to the 7th of August. Of the 174 papers, the following were presented before the general sessions in addition to an address of welcome by the president: 'Pain,' by Charles Richet; 'Criminal Responsibility,' by Franz von Liszt; 'On the Localization of the Emotions,' by Guiseppi Sergi; 'On the Association Centers of the Brain, with Anatomical Demonstrations,' by Paul Flechsig; 'The Theory of Sensation,' by Franz Brentano; 'The Psychology of Genius,' by Frederic W. H. Myers; 'A Genetic Study of Primitive Emotion,' by G. Stanley Hall; 'A New Method of Testing Mental Ability and its Application to School Children,' by Herman Ebbinghaus; 'Individual Psychology,' by Alfred Binet; 'On Memory for Sensations,' by W. von Tschisch, 'The Conception of the Unconscious in Psychology,' by Th. Lipps.

The Report of the Parliamentary Committee appointed to consider matters of pressing need to Ireland has been recently issued. The principal recommendation contained in the report is for the creation of a department of agriculture and industries, to consist of a minister and a council representing these respective interests.

The Prince of Wales has presented to the Natural History Branch of the British Museum the remains of the large male Indian elephant which was brought home by him on his return from India in 1876, and placed in the gardens of the Zoological Society, Regent's park. 'Jung Perchad' was one of the finest and largest of Indian elephants ever brought to England, and now forms the central and most conspicuous object in the great entrance hall of the Natural History Museum at South Kensington, where it was placed recently.

Natural Science states that Mr. E. A. Fitzgerald leaves England in September for Chili, to explore the summit of Aconcagua, 23,200 feet. It is stated that the sum of nearly £4,000 has been spent in preparation for the scientific work of the expedition.

The University of Edinburgh has conferred the degree of Doctor of Laws upon Francis A. Walker, President of the Massachusetts Institute of Technology.

Prof. Chas. D. Walcott, director of the U. S. Geological Survey, has been detained in Washington by office duties. He recently completed and submitted to the Secretary of the Interior the Annual Report of the Survey for the fiscal year 1895–96, which he anticipates will be published with less delay than has marked the issue of the previous volumes of the series. He left the city August 3d and proposed spending August in the field, giving a week in the early part of the month to investigations in the slate-belt of western Vermont and eastern New York with Prof. J. F. Kemp and T. Nelson Dale, and, later, going west and working in the mountain regions of Nevada and central Colorado.

Prof. Charles S. Prosser is in charge of the party studying the Permian and Lower Cretaceous formations of central and southern Kansas for the Kansas Geological Survey.

Charles Griffin & Co. have published the thirteenth annual issue of the *Year-Book* of the scientific and learned societies of Great Britain and Ireland. The work, which extends to 262 pages, gives the officers of the various societies and the papers read before them during 1895. The information is in most cases contributed by the societies and offers an accurate and comprehensive survey of the contemporary condition of science and the arts in the British Islands. The number of different societies is very great, and the amount of work accomplished is almost bewildering. A similar *Year-Book* for America would prove useful, but we fear its contents would be small in comparison.

Mr. Henry Harben recently established a lectureship, under the auspices of the British Institute of Public Health, of the annual value of fifty guineas, 'for the encouragement of original research in connection with public health,' the lecturer to deliver three lectures in the course of the year. Mr. Harben founded at the same time a gold medal of the value of fifty guineas, to be awarded annually for 'eminent services to public health.' The medal has been awarded to Sir John Simon, and Dr. Klein has been chosen for the first lecturer. Dr. Klein took as subjects for his lectures 'Recent Research in the Identification of the Typhoid Bacillus' and 'The Cholera Vibrio.'

We take the following items from *Natural Science:* Léon Diguet, who has recently returned from a scientific exploration in Mexico, is being set out again by the French Minister of Public Instruction. He proposes to study the Indians of Guadalajara, Sinaloa and Sonora, as well as the Cahuila Indians of S. California. Dr. M. Raciborski, of Munich, has been sent to the Buitenzorg Botanical Gardens. Prof. V. F. Brotherus, of Helsingfors, has gone to Central Asia to work out the bryological mountain flora of Issikul. A party of four, under the direction of Mr. T. H. Mobley, will start from Lacomb, Alberta, to explore northern Canada from Edmonton to the Arctic Sea. The trip is to occupy two years. Mr. J. C. Willis, late Frank Smart Student of Caius College, Cambridge, has been appointed Director of the Royal Botanic Gardens of Ceylon.

The first brochure of the third volume of the *Proceedings of the Rochester Academy of Science*, recently published, is a monograph of 150 pages, containing a study of the *Plants of Monroe County, N. Y., and Adjacent Territory*, by Florence Beckwith and Mary E. Macauley, assisted by Joseph B. Fuller. The list aims to include the names of flowering plants growing without cultivation in Monroe county and adjoining counties, the area in general being the lower drainage basin of the Genesee River, with that of Irondequoit Creek and smaller streams upon the lake border, and it is believed to be nearly complete for Monroe county. A map is appended designed to serve as a guide to the region. The total number of species native to the Monroe flora is 948 ; the introduced species number 250, making a total of 1198 species. There are 103 native and 13 introduced varieties, making in all 1304 species and varieties, of which 1208 are found in Monroe County. The monograph includes a full bibliography and an index to orders and genera.

The London *Times* states that the additions to the museum of Royal College of Surgeons of England during the past collegiate year have been numerous and valuable. In the department of human and comparative anatomy the most noticeable addition is a magnificent specimen of the gigantic extinct bird, the Moa (Dinornis maximus), from the South Island, New Zealand. It was obtained through the kindness of Mr. Hutton, of Canterbury, New Zealand. This skeleton is especially interesting, as possessing both coraco-scapulars and both big toes. Neither of these are present in the specimen in the British Museum. Professor Charles Stewart, F.R.S., presented four groups of Lepas fascicularis. These barnacles attach themselves to minute floating foreign bodies, whose buoyancy soon becomes insufficient of itself for their support. A secretion from the cement glands is, however, poured upon the surface of the foreign body in large quantities and covers it to a considerable depth with a natural float in the form of a spongy reticulum full of air bubbles. In one of the specimens part of the float has been removed to show the attenuated stalks of the barnacles attached to the foreign body. There is also a very good skeleton from a case of Osteitis Deforamans, showing in a marked degree the changes characteristic of that disease. Altogether some 360 specimens have been added to various departments of the museum.

At a meeting of the Geological Society of London, on June 24th, Sir William Dawson said that the whole of the facts were tending to the conclusion that instead of ascribing the phenomena of the glacial age to continental ice sheets, we should have to be content with local glaciers on the higher lands and cold ocean currents pervading the submerged lower levels. Evidently the phenomena could not be explained without giving attention to the evidence of continental submergence afforded by the clays containing marine remains and the ancient shore lines found at very high elevations. The action of shore and field ice during periods of gradual subsidence and elevation could alone account for the great beds of boulder clay holding marine shells and tests of modern foraminifera, and the term 'unstratified' till was not always appropriate, as where long continuous sections could be observed, successive beds were often marked by color lines, by rows of stones or by fossiliferous layers.

The London *Times* states that the naturalists of the English Marine Biological Association have recently been paying particular attention to the question of the collection of fishery statistics, and an important report on the subject has just been received by the Council of the Association. In this report an account is first given of the statistics at present collected and published by the Board of Trade relating to sea fisheries in England. It is pointed out that the methods at present adopted for collecting the statistics are not such as to give confidence in the accuracy of the returns, whilst their inadequacy in plan and extent cannot be questioned. The defects upon which emphasis is principally laid are the want of sufficient discrimination between the species of fish landed, the lack of all information as to the locality of capture of the fish, and the fact that no attempt is made to distinguish between the products of different methods of fishing. Various suggestions are made as to methods by which the statistics could be improved, and it is maintained that the only really satisfactory course would be to require the master of each fishing vessel to supply the Board of Trade with correct returns of the fish caught and of the locality of their capture. In the case of the larger vessels, at any rate, such records already exist and are supplied by the master to his owners. All that is required is that copies of these records should be furnished to the proper officers, so that the information may be utilized for the general benefit of the public and of the fishing industry. The report will be published in full in the forthcoming number of the journal of the Association.

The *Optician* states that a report which has just been issued by the Assistant Secretary of the Marine Department gives particulars of the working of the new tests for vision adopted by the mercantile marine during the 16 months ended December 31, 1895. A supplementary plate contains specimens of the colors of each series of wools used in the Holmgren test for color blindness. During this period the percentage of failures in color vision was slightly higher than under the old system, the percentage under the old system being .88, while under the new it amounts to 1.39. The total percentage of failures under the new system, including failures in form vision as well as those in color vision, was 2.8, while the total percentage of failures under the old system was .88. One commendable feature of the new system is the appeal to special examiners which is allowed when a candidate fails to pass in colors. Of the 101 candidates who failed in colors, 21 availed themselves of this appeal; 8 were passed and

13 rejected. For candidates who fail to pass the form vision test no appeal is provided, but they are allowed to be re-examined at intervals of three months. Twelve candidates out of the 115 who failed to pass the form vision test have been subsequently passed. The number of officers already in possession of certificates of competency who on coming up for examination failed to pass the tests was 53; 4 masters, 5 mates and 15 second mates failing in colors, and 1 master, 12 mates and 16 second mates in form vision. No case of failure to pass the test for color ignorance has been reported.

Natural Science states that two marsupials (*Dasyuroides byrnei*, n.g. et sp., and *Sminthopsis larapinta*, n. sp.) were discovered by the Horn expedition in central Australia, and are described by Prof. Baldwin Spencer in the *Proceedings of the Royal Society of Victoria*, vol. viii., pp. 5–13, as well as further described and figured in the account of the Horn expedition. *Dasyuroides* is a burrowing, insectivorous marsupial of nocturnal habits, which in the general form of the body closely resembles a large *Phascologale* or a small *Dasyurus*, while its dentition is also like that of those species of *Phascologale* which approach *Dasyurus*. The skull, on the other hand, agrees with that of *Sminthopsis* in the character of the nasal bones, while the hind foot in shape and in the absence of a hallux differs from that of both *Phascologale* and *Sminthopsis*. The specimens on which the description is based consist of six males and one female, and the dimensions of an adult male in alcohol are: Head and body, 182 mm.; tail, 130 mm.; ear, 18 mm.; hind foot, 38 mm. The new *Sminthopsis* is a small mouse-like form, separated from the two known species, *S. murina* and *S. crassicaudata*, by a long, very stout and highly incrassated tail, and by the greater relative length of the hind foot.

UNIVERSITY AND EDUCATIONAL NEWS.

Prof. C. S. Brown, of the Rose Polytechnic Institute, Terre Haute, Ind., has been elected adjunct professor of mechanical engineering in Vanderbilt University in place of Prof. William T. Magruder, who goes to the Ohio State University.

Miss Mary F. Winston, of Chicago University, has received the degree of Ph. D. *magnum cum laude*, at Göttingen University. Miss Winston is a graduate of the University of Wisconsin and subsequently studied at the University of Chicago. She is said to be the second woman to receive the degree of Ph. D. from a German university.

Mr. G. F. Stout, Fellow of St. John's College, Cambridge, and editor of *Mind*, has been appointed to the Anderson lectureship on comparative psychology, recently founded at Aberdeen.

The *Lancet* states that the Council of University College, Liverpool, have nominated Dr. H. E. Annett to a scholarship of the value of £150 a year, tenable for three years, awarded by the Commissioners of the 1851 Exhibition for further researches in scientific subjects and scientific study. Dr. Annett has given an undertaking to the Commissioners to proceed to one or more of the large Continental colleges where facilities exist for carrying on the study of pathology and bacteriology.

Prof. Lionel S. Beale has resigned the chair of medicine at King's College and the office of physician to King's College Hospital. Prof. F. Jeffrey Bell has also resigned the chair of comparative anatomy which he has filled for seventeen years.

A chemical dyeing school for instruction and research has been built at Crefeld under the auspices of the German government at a cost of about $100,000.

DISCUSSION AND CORRESPONDENCE.

THE NAMES EPIPHYSIS, CONARIUM AND CORPUS PINEALE: CORRECTION OF AN ERROR.

To the Editor of Science: In your publication, July 17, p. 71, of the Report of the Committee on Neuronymy which was adopted by the American Neurological Association June 5, 1896, occurs an error which is unaccountable, but for which I must be held responsible. After the word *epiphysis* comes the date 1895, as if indicating the adoption of that word by the Committee of the Anatomische Gesellschaft in that year. On the contrary, they prefer *corpus pineale*.

The occurrence of this particular error exemplifies the 'irony of fate.' Among the forty terms on the list this is the only one to which my own conversion was recent. For years I used *conarium* without variation. The change was due to four considerations: 1. The arguments of Prof. H. F. Osborn and Dr. E. C. Spitzka. 2. The recognition of the desirability of verbal correlation with the ventral extension, hypophysis ('*corpus pituitarium*') and the other dorsal outgrowth, paraphysis. 3. The fuller appreciation of the force of Dr. W. H. Dall's declaration, "The human mind wearies of too many names and much more readily assimilates a new meaning for an old one."* 4. The abandonment, or rather relaxation, of one of the requirements of technical terms which was enunciated twenty-five years ago, viz., 'independence of context for signification.'† It is hardly conceivable that any misapprehension should arise from the employment of one and the same word, *epiphysis*, for a part of the brain and for the end of a long bone.

Permit me to express the hope that journals that republished your article may likewise print the corrective portion of this letter, and also to state that the next number of the *Journal of Comparative Neurology* will contain an extended commentary upon the report of the Neurological Association, together with correspondence on the general subject between Prof. W. His and myself. BURT G. WILDER.

SIASCONSET, MASS., August 3, 1896.

* From a letter to me. Published as Aphorism xv. in the article 'Anatomical Terminology,' Reference Handbook of the Medical Sciences, VIII., 520, 1889.

† 'Intermembral Homologies,' Boston Soc. Nat. Hist., Proceedings, XIV., 172, April 5, 1871.

THE METRIC SYSTEM.

TO THE EDITOR OF SCIENCE: I was much interested in Mr. Stover's query, "Is not the country ripe enough to accept the metric system?" and wish to say that the practical difficulties are probably largely overestimated. Of all peoples those of the United States, are the most adaptive, and the change would involve those who are best able to assimilate the new method.

As Greeley proclaimed about 1871, "The way to resume is to resume," so the way to adopt is to adopt. If those from whom the initiative must come would initiate, there would not be much trouble. Let all architects and builders write their dimensions in metric measures, and they will soon find them executed without trouble.

This company manufactures pulleys, etc. A few years ago we established an agency in France and our orders came in metric measures. We simply sent to Chicago for a metric scale and then filled the order. It did not cause any noticeable trouble. It is just as easy for the saw-mill man to cut his lumber according to one measure as the other, and in a short time he would become equally familiar with both systems, and *then* the metric system would be established. The same results would follow through all the trades, but the workman will not use the improvement until he is obliged to.

R. D. D. SMITH.

DODGE MANUFACTURING CO.,
MISHAWAKA, IND.

SCIENTIFIC LITERATURE.

MATHEMATICAL PAPERS READ AT THE INTERNATIONAL MATHEMATICAL CONGRESS HELD IN CONNECTION WITH THE WORLD'S COLUMBIAN EXPOSITION, CHICAGO, 1893.

THE papers presented at the Chicago Mathematical Congress of 1893 have recently been issued in book form by Macmillan & Co., under the suggestive subtitle of Vol. I. of Papers Published by the American Mathematical Society. The papers are edited by the Committee of the Congress, Professors Moore, Bolza and Maschke, of the University of Chicago, and Prof. White, of Northwestern University. The committee were embarrased at the outset by the fact that no financial provision had been made for the publication, which was finally made possible by the generous subscription of a guarantee fund of one thousand dollars by the Mathematical Society, its members individually and other mathematicians. The handsome volume before us reflects great credit on all concerned in its production.

The Congress was decidedly cosmopolitan in the authorship of the papers presented and the subjects treated. Of the forty-five papers, fourteen were from America, two from Austria, four from France, twenty from Germany, three from Italy, one from Russia and one from Switzerland. Germany was officially represented at the Congress by an Imperial Commissioner, Prof. Felix Klein, of Göttingen, who brought nearly all the papers contributed by his countrymen. It is a singular circumstance that the British Empire did not furnish a single contribution nor a single representative. Roughly classified, seven of the papers deal with geometry, ten with theory of functions, eight with the theory of groups, seven with the theory of numbers, two each with differential equations, invariants and mechanics, and seven with miscellaneous subjects.

In his opening address before the combined Congresses on Mathematics and Astronomy, Prof. Klein drew attention to a matter of great interest to all scientists, viz., a present marked revulsion from the tendency of mathematics to run into isolated specialities, which has been so pronounced for a century. At present the movement is decidedly toward unification and breadth, not only in mathematics itself, but in its relation to other sciences. The general conceptions of 'function' and of 'group' are powerful coordinating elements. Two of the Chicago papers are especially mentioned by Klein as representing the new tendency. One of these, by Schönflies, deals with the connection between the theory of groups and crystallography. The other, by Burkhardt, discusses the relations between astronomical problems and the theory of linear differential equations. A third paper, by Fricke, on the automorphic functions and arithmetic (*i. e.*, theory of numbers), illustrates the work of Klein's own school in the unification of strictly mathematical branches.

Of the other papers on the theory of functions, one is by Bolza, on Weierstrass' system of hyperelliptic integrals; one by Hermite, on certain fundamental propositions in the theory of elliptic functions; one by Krause, on the transformation of the fifth degree of the hyperelliptic functions of the first order; two by Macfarlane, on the definition of the trigonometric functions, and on the principles of elliptic and hyperbolic analysis; one by Pincherle, in summary of certain results relative to the theory of recurrent systems of functions; two by Pringsheim, on the expansion of functions in series and convergency and divergency; and one by Stringham, on a formulary introductory to elliptic functions. Maschke, Moore, Meyer, de Perott, Taber and Cole have articles on special topics in the theory of groups. Halsted gives an account of some salient points in the history of non-Euclidean and hyper-geometries. It is, of course, impossible here to give any detailed account of the contents of these or the other valuable papers in the list. The moral of the present publication, as representing the International Congress, lies not so much in the specific contents of the book, as in the fact that America's workers in mathematics are constantly coming into closer affiliation with those of other lands and strengthening their scientific position by this connection. The other sciences have long had this advantage, but mathematics has received it only within a few years. Our position in this country has been so isolated, and our science so backward here in development, that it will probably be news to most of our colaborers in other fields that the development of mathematics in the present century has probably been as great in actual permanent substance as that of any other science now existing. And it is the function of such meetings as that at Chicago to stimulate the growth of the science and to secure it the recognition to which it is entitled.

F. N. Cole.

Columbia University.

RECENT TEXT-BOOKS OF GEOMETRY.

Elements of Geometry. By George C. Edwards, Associate Professor of Mathematics in the University of California. New York, The Macmillan Company. 1895. 8°. Pp. xvi+293.

Plane and Solid Geometry. Suggestive Method. By C. A. Van Velzer, Professor of Mathematics in the University of Wisconsin, and Geo. C. Shutts, Professor of Mathematics in the State Normal School, Whitewater, Wis.

Madison, Wis., Tracy, Gibbs & Co. 1894. 8°. Pp. viii+395.

Plane and Solid Geometry. By Wooster Woodruff Beman, Professor of Mathematics in the University of Michigan, and David Eugene Smith, Professor of Mathematics in the Michigan State Normal School. Boston, Ginn & Co. 1895. 8°. Pp. ix+320.

These three text-books of geometry all show points of interest and excellence, and bear testimony scientifically and pedagogically to a spirit of progress. It is natural to turn at once to the first few pages of each book, and examine the manner in which the difficult problem of giving the beginner a good start is treated. It is not easy to communicate to the student the fundamental principles upon which the geometric structure is to be based. A rigorous scientific analysis or discussion of these principles is entirely beyond his comprehension. It is generally necessary for him to commit to memory the first dozen pages, to exercise his powers of reason by tracing the subsequent development, and, having become somewhat familiar with the methods of logical argument, to return to the beginning of the text-book for a more complete appreciation of the fundamental ideas.

In order that the student may have some acquaintance with geometric notions before taking up the study of demonstrative geometry, it is desirable that such study should be preceded by simple mechanical drawing and a course in inventional geometry so-called. But the training that he will gain only from the study of demonstrative geometry is necessary before he can appreciate to any extent the character and content of the definitions, axioms and postulates of geometry. It is, of course, very satisfactory to have the first few pages of the text-book constructed so that they meet all the needs of the mature student who turns back to them for a rigorous scientific discussion ; but it is of prime importance that these pages should convey to the beginner intelligibly and helpfully the information which is neccessary for his first steps in the demonstration of geometrical truth. That the definition of a straight line should be based upon the notion of direction, as it is done in the text-books of Wentworth and Wells, in Davies's Legendre, in Byerly's edition of Chauvenet and in other popular works, or that it should be based on the notion of distance, as is done in the original edition Chauvenet, are points which may seem appropriate for criticism to the mature student who seeks to subject every definition to a scientific analysis ; but the beginner will accept at once certain notions of direction and distance, of straight lines and curved lines, and it will be fatal to his progress to stop him at the threshold of the subject for a complete discussion of these ideas.

In the introductory portions of the three books before us intuitive methods are used most largely by Edwards; scientific accuracy of treatment is maintained most fully by Beman and Smith. For example, Edwards uses direction in defining a straight line, and assumes that a straight line is the shortest distance between two points. Van Velzer and Shutts avoid the use of direction as a fundamental notion, but adopt as an axiom that the straight line is the shortest distance between two points. Beman and Smith, however, wishing to make no unnecessary assumptions, demonstrate at length, like Euclid, that one side of a triangle is less than the sum of the two other sides. The last mentioned work will probably be most satisfactory to the advanced student, but it is quite likely that the beginner may prefer one of the others.

The Elements of Geometry by Edwards consists of fourteen chapters, of which the first eight relate to elementary plane geometry, the following five to solid geometry, and the last one to the conic sections. The propositions are not numbered in the traditional manner, but the work is divided into articles which are consecutively numbered.

In many of the propositions the demonstration is preceded by a discussion, or 'analysis,' in which are obtained the materials for the construction of the formal proof. In many others the demonstration is of an informal character, a mere outline being given, which, however, the student will have no difficulty in completing. Unusual and ingenious methods of proof are frequent. The surfaces of the cylinder and cone are measured by unwrapping them upon a plane. In applying the method of successive approximation to calculating the area of the circle of unit radius, the formulæ are put in the very convenient form

$$\frac{1}{a_{2n}}=\sqrt{\frac{1}{a_n}\cdot\frac{1}{A_n}},\quad \frac{1}{A_{2n}}=\frac{1}{2}\left(\frac{1}{A_n}+\frac{1}{a_{2n}}\right),$$

where small letters denote the areas of inscribed, large letters the areas of circumscribed regular polygons, the subscript in each case indicating the number of sides. Several of the proofs given deserve censure. For example, that in which the author claims to prove that the sum of the exterior angles of a polygon is four right angles is worthless, and that which establishes the area of a rectangle is very incomplete.

The Plane and Solid Geometry of Van Velzer and Shutts consists of eight chapters, five relating to plane geometry and three to geometry of three dimensions. The so-called suggestive method is employed. Each theorem is illustrated by a figure, and a series of suggestions follows, so arranged as to indicate the successive steps of the demonstration. Frequently a 'model' is given showing how the suggestions are to be combined so as to produce a complete formal proof. Numerous original exercises are scattered through the text, the whole number being almost four hundred. Each chapter closes with a syllabus of the preceding propositions so as to facilitate the student's reference to them.

Although the Plane and Solid Geometry of Beman and Smith is more extensive than either of the other works under consideration, its publishers by giving it a very compact form have been able to make it even less bulky than the others. It consists of eight books, of which five are devoted to plane geometry and three to solid geometry. An appendix to book III. discusses the various methods of attacking geometrical propositions, while an appendix to book V. treats of the special topics, maxima and minima, concurrence and collinearity. The work contains almost eight hundred original exercises, and at the end are appended a table of formulæ and numerical constants, a biographical table, a table of etymologies and an index. A slight but sufficient treatment is given of symmetry, the notion of positive and negative magnitudes, the principle of continuity, duality, the method of loci and the parallelism between certain propositions of geometry and algebra. The work thereby gains interest and modernness. Clearness and conciseness are given to the proofs by breaking them up into successive steps numbered, in order that they may be the better referred to, somewhat after the manner of the equations in many text-books of algebra. From a scientific point of view, this work is one of the best yet published.

Thomas S. Fiske.

Columbia University.

American Fonostenografy.—A modern system of rapid shorthand * * * formulating and applying an entirely original principle of legibility and brevity—the fonostenografic root. By William McDevitt, LL.M. Judd & Detweiler, Printers, Washington, D. C.

The author of this work has sought to raise shorthand to the rank of an art of expression coordinate with speech and writing, and he has wrought with masterly hand his materials into a definite system based on practical scientific principles. The requirements of a rapid and legible system of graphic expression are clearly set forth and the means for supplying them are provided; and the structural laws on which the system is based are fundamental principles in the genesis and development of human expression, which the author seems to have attentively studied. He grasps firmly a cardinal principle of linguistic growth, *i. e.*, that meaning and sense inhere in context and not in the isolated syllable or word, and teaches that he who sets himself the task of mastering the composition of phrases, clauses and sentences acquires thereby the key to successful fonostenografic practice. A fundamental distinction between the principles of contraction employed in this system of shorthand and the rules of abbreviation applied in older stenographies is that in the latter vowels are not specifically symbolized because they *are* vowels, consonants because they *are* consonants, and final initial syllables because they are such—for in McDevitt's system of vocalized fonostenografy, contraction is attained by the omission of factors or elements which are not 'strong and significant,' without regard to the adventitious circumstance that the discarded element may be a vowel, a consonant, or even one or more syllables, *i. e.*, a sound or combination of sounds. This method of abridgement admits of a comprehensive application of the principle of the stenographic root to which the proper affixes may be joined.

The recognition and use of the fonostenografic root introduces for the first time in shorthand systems the rational application of the natural but unconscious linguistic process of adaptation to the purposive abbreviation of words. This root (also called 'sound root' or 'phonetic radical') is not of course the etymologic root of the word or words to be written; it is defined as the 'strong and significant' element of the word; in its use the author grasps and utilizes a well known law of verbal abridgment which supplies an easy and natural rule for the simple and effective contraction and abbreviation of vocables. It would seem that in his new system the author has found the golden mean between the highest rapidity and readiest legibility—between those phonographic systems which, owing to complex structure and consequent illegibilty in practice, can be acquired only by the highly gifted or the tirelessly industrious, and those other systems which have been rendered simple in structure by 'such limitations in principles and development' as to deprive them of the requisite adaptability to the exacting needs of the reporter. In the terse language of the author, "the former class appeals to a high standard of culture; the latter addresses itself to a lower plane of mental capability and development; the former taxes too heavily the head, and the latter demands an impossible dexterity of the hand." Hitherto shorthand has commonly been pursued empirically, with little or no regard to linguistic principles, and it is a gratification to note an attempt to bring it within the domain of linguistic science.

J. N. B. Hewitt.

A Concise Handbook of British Birds. By H. Kirke Swann. London, John Wheldon & Co. 1896. 16°. pp. 210.

The author of this recent addition to the apparently endless series of books treating of British birds, claims for his work a unique place among its fellows on the ground of its small size and conciseness.

No space is given to remarks on the faunal position of the region under consideration, analyses of the birds which occur in it, synopses or keys to higher groups, or other preliminary or explanatory matter, it evidently being assumed that the reader is already more or less an ornithologist who will use the book as a pocket manual for ready reference.

Consequently, immediately after a 'list of genera,' we begin with 'Order Passeres,' 'Family Turdidæ,' 'Subfamily Turdinæ'—names merely—'Genus Turdus,' which is briefly defined. Then follows the species with a short statement of its 'habitat'—a term which is arbitrarily used as "meaning the region inhabited during the breeding season"—plumages, manner of occurrence, haunts, notes, nest, eggs and food, all very much condensed and with no striving for literary effect, but making useful, if not very readable, summarized biographies.

The most interesting point in Mr. Swann's book for American naturalists is his pronouncedly un-British stand in favor of trinomials. He seems to fully recognize—indeed, to glory in—the depth of his depravity, and remarks that he cannot expect to "escape censure for adopting the despised system," adding the fair challenge that, "until some of our ornithologists can suggest some other way of allowing a name to a recognised race without giving it the name of a species, I will adhere to trinomials." After this bold declaration can any one doubt that Mr. Swann's excommunication will speedily follow?

Frank M. Chapman.

SCIENTIFIC JOURNALS.

PSYCHE, AUGUST.

The genus Orphula with its three New England species forms the subject of the continuation of A. P. Morse's paper on N. E. Tryxalinæ. A. R. Grote writes on the condition of the nomenclature of the species of Apatela. H. G. Dyar describes the early stages of *Cosmosoma auge*, and also the apparatus by which he conceives the noise made by *Dionychopus niveus* to be produced. Notice of a few recent publications completes the number.

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

SCIENCE IN AMERICA.

The annual meeting of the American Association for the Advancement of Science should be made the great scientific event of each year. We need special societies where students from the different centers of research may present and discuss the advances of a single science, and we need local academies where men of science working in different directions may meet on common ground. But more important than these is a meeting where all localities and all sciences are represented—a clearing house for the work of the year, where accumulations may be reported and balances adjusted. The conditions of science in America make such a meeting difficult but at the same time peculiarly desirable.

There is, indeed, no such thing as American science. We may regret that we have no school of American literature or of American art, but science is universal. It is not limited by language, nor by political and social institutions. We build us a city and a tower whose top may reach unto heaven, and our work is not stayed, though we have many languages and be scattered abroad on the face of the whole earth. But there is such a thing as science in America. We build us one city, but the stone and mortar must be taken from the ground on which we stand. We, who live and work in America, have certain advantages and certain obstacles, as compared with the great nations of Europe, with which we should seek to advance on terms of equal service.

Atmospheric conditions have led to success in astronomical observations and photography. The great extent and diversified surface of the land have offered unusual opportunities for geological research and have preserved rich paleontological remains. The surviving tribes of savages and the unobliterated relics of extinct races have given the anthropologist a favorable field. In astronomy, in geology, in paleontology and in anthropology we have not failed to take advantage of our position and stand equal at least with other nations. But the extent and newness of our *habitat* bring with them certain corresponding disadvantages. We have no one center, such as London, Paris and Berlin, where men of science may meet and be stimulated by personal contact. We must travel great distances, and at a time of year when traveling is most difficult, in order to attend the annual meetings of our Association.

Our unexplored resources have made desirable, and our more flexible institutions have made possible, the establishment of scientific departments under the government. The Geological Survey, the Coast and Geodetic Survey, the Weather Bureau, the Department of Agriculture and other institutions, have been supported by liberal subsidies and have contributed greatly to the advancement of science. On the other hand, the connection of science with politics is fraught with many dangers, and the alliance requires continual vigilance in order that the liberty of science may be maintained.

The rapid development of our material institutions has stimulated invention and the applications of science. But it is probable that in some cases the energy directed to applied science has been diverted from the advancement of pure science. The acquirement of large fortunes and an aristocracy of wealth have lead to the rich endowment of educational and scientific institutions. On the other hand, the attractions of commercial success have drawn too much of the best ability of the country, and we lack a leisure class contributing to, and taking an intelligent interest in, the progress of science.

Our advantages we have and need not lose. The drawbacks are such as can be obviated or mitigated by proper appreciation and generous effort. Men of science should unite and stand together, even though on occasion it may require self-sacrifice on the part of the individual. In every community, whether of men or of the lower animals, each member must be prepared to sacrifice something, and it may be everything to the general welfare. A community whose members are not ready to give and to take cannot survive.

No one can consider what a difference it would make to the world at the present day if the men of science of this century had not been faithful to their work, without realizing the responsibility of those of us who are now engaged in the advancement of science. Not only our material surroundings, but also our social institutions and ethical ideas, are dependent on the progress of science. Those who appreciate the extent to which this is the case will not willingly leave scientific work for the counting room or patent office; they will not only themselves do the best work in their power, but they will help others and will seek to make straight the way along which science must advance.

Our various scientific institutions should have the sincere support of all men of science. If our scientific journals seem less strong than those of Europe, this is not a reason for neglecting them, but rather for doing our utmost in their support. If our universities accomplish less original research than those of Germany, this should lead each to devote his best energy to research, not forgetting to advocate in season and out of season the truth that research is the essence of the university. If our National Academy of Sciences seems less active and influential than the Paris Academy, this is a reason for taking greater interest in its proceedings. If the American Association for the Advancement of Science does not accomplish as important work as the British Association, this is a reason for attending the present meeting.

Such institutions are essential for science, and those who do not aid in their support are parasites in the body politic. They are essential in part as connecting links between the man of science in his workshop and the intelligent public outside. Investigations require money; this will be forthcoming from the Nation, from the State and from the man of wealth if the needs and importance of science be brought into notice, but not otherwise. More than money, science requires recruits. The best ability of the younger men is needed and should be obtained. We must not depend on in-breeding, but should draw from the widest field.

Our scientific institutions are not only essential in order to keep science in connection with the outside world, but also to hold men of science in touch with each other. Specialization must not be carried so far that the final unity of science is forgotten, and men of science must not lose the stimulus of communication and personal contact. For, as Professor Newcomb wrote in his introduction to the new series of this Journal, "The experience of centuries shows that great successes in advancing scientific knowledge cannot be expected even from the most gifted men so long as they remain isolated."

In order to do the best we can for science in America our duties are many and are often difficult and conflicting. But at the present moment the next step should be in the direction of Buffalo. The decennial meetings in that city have hitherto been successful, both from a scientific and from a social point of view. If all those will attend next week who have at some time proposed to do so, or who would if it were not for relatively slight obstacles, the meeting can be made the most important in the history of the Association.

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*ZOOLOGY AS A FACTOR IN MENTAL CULTURE.**

It is not my purpose at the beginning of this address to weary you with apologies. I

*An address delivered before the department of Natural Science Instruction of the National Educational Association, July 10, 1896.

President David Starr Jordan, of Stanford University, expected to discuss the subject of this paper before the Association, but his absence on the commission to investigate the seals in the Alaskan waters prevented him from preparing the paper and from being present at the meeting. The writer was solicited to fill the gap a few days before the meeting.

wish simply to pay my tribute of respect and admiration to the great zoologist and still greater man whom I, with you, hoped to hear this day.

It is with regret that we miss his noble presence and speech, but there is also an element of gratification, for he is the fittest possible representative the government could have chosen as head of the commission to investigate the seals in Alaskan waters, and thus to furnish the definite information upon the basis of which the two foremost nations of the globe can honorably unite in a common cause.

In the able addresses which have preceded there has been shown with great clearness and force how the mind of man, cultivated by the disciplines of physics, chemistry and botany, has been made fitter to yield the flower and fruitage of noble effort. What then has zoology contributed, and what is it likely to contribute when used as one of the agents or means in the cultivation of the mind? And as with the agriculturist, every factor is of interest which can serve in adding to the productiveness of the soil and the quality of what is produced, so to us, mind or soul culturalists, every factor in mind culture is of vital interest. What then is this zoology which is spoken of as a factor in mental culture? As botany in its broad sense includes everything known and knowable concerning plants, so zoology includes everything known and knowable concerning animals; or as botany is plant-biology, so zoology is animal-biology, and deals with the form, structure, activities, development and classification of animals and their economics or relations to each other and to man. And if we include *Homo sapiens* among the animals, it will be seen that if man and his doings are a part of zoology, zoology, like every other center of knowledge and investigation, reaches out to infinity in every direction like the rays from a luminous point.

Although most of us are engaged in the profession whose high aim is to aid in starting the young on the road that leads to a truely liberal culture, it may perhaps be best, before discussing the part which zoology has taken and may take in liberal culture, to understand distinctly what is meant by culture or education, and especially by liberal culture. It seems to me that no one has so well pictured the ideal liberal culture or education, or has realized it more surely in a noble life than the great zoologist, Huxley. Hear his definition: "That man, I think, has a liberal education, who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength, and in smooth working order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of nature, and of the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of nature or of art, to hate all vileness and to respect others as himself."

What has zoology done to make such culture possible? First and foremost, it has aided most powerfully to render free the human mind; and without freedom no human soul can enter into the fullness of its kingdom; the true glory of this kingdom is not for slaves.

At the present day no Caesar on the banks of a Rubicon would make his crossing depend upon the omens gained from the flight of birds. We do not decide upon attending the meetings of the National Educational Association by the key in which the wolf howls or the quaver of the owl's hoot. We no longer expect our acquaintances to imitate the transformations of the companions of Ulysses in the palace of Circé, no matter how appropriate such transformations might be. No longer do we expect to see birds and beasts produced in the fruits of trees or from decayed wood washed by the sea; nor do we think that bees and other insects are generated by decomposing flesh. We know that no living thing exists without having received its life from a living parent like itself. Our path is no longer beset with hippogriff, basilisk or dragon, and our high hopes and noble aspirations are no longer at the mercy of fairies and genii. Living beings, as well as lifeless matter, are subject to law. 'Thus far and no farther,' applies to them as to the waves of the sea or the rush of a comet. The fairies are fled, the genii banished, the mermaid and the remora are captured, classified and harmlessly repose as objects of curiosity or instruction in the great museums. Zoological truth has freed us from their slavery.

Now that freedom has come how shall this subject be made an efficient means of mental culture, and what will its fruit be? In the first place, as for the subjects, the discussion of which has preceded this, Nature herself must be interrogated. The successful student of zoology, to quote again the trenchant words of Huxley, "absolutely refuses to acknowledge authority as such. For him, scepticism is the highest of duties, blind faith the one unpardonable sin. And it cannot be otherwise, for every great advance in natural knowledge has involved the absolute rejection of authority, the cherishing of the keenest scepticism, the annihilation of the spirit of blind faith; and the most ardent votary of science holds his firmest convictions, not because the men he most venerates hold them; not because their verity is testified by portents and wonders; but because his experience teaches him that whenever he chooses to bring these convictions into contact with their primary source, Nature, whenever he thinks fit to test them by appealing to experiment and to observation, Nature will confirm them. The man of science has learned to believe in justification, not by faith, but by verification." To complete this first law in the Decalogue of the scientific student it should be followed by this from his address upon Descartes' Discourse: "When I say that Descartes consecrated doubt, you must remember that it was that sort of doubt which Goethe has called 'the active scepticism, whose whole aim is to conquer itself;' and not that other sort which is born of flippancy and ignorance. "But it is impossible to define what is meant by scientific doubt better than in Descartes' own words. He says: 'For all that, I did not imitate the sceptics, who doubt only for doubting's sake, and pretend to be always undecided; on the contrary, my whole intention was to arrive at certainty, and to dig away the drift and the sand until I reached the rock or the clay beneath.'"

In this spirit, then, of reverent skepticism, of scientific doubt, must the teacher of zoology teach and the student learn. And if this is the spirit, the teachers are but elder brothers a little farther advanced, knowing a few more of the delusions and pitfalls which beset the way. Teacher and pupil work together—the one inspired by the great works of all his predecessors and by Nature herself, and he in turn inspiring and helping the student in his efforts. Such teachers, such pupils and such inspiring surroundings are described by Agassiz in his notable address upon Humboldt: "I was a student at Munich. That university had opened under the most brilliant auspices. Almost every name on the list of professors was also prominent in some department of science or literature. They were not men who taught from text-books or even read lectures made up of extracts from original works. They were themselves original investigators, daily contributing to the sum of human knowledge * * * and they were not only our teachers but our friends * * *. We were often the companions of their walks, often present at their discussions, and when we met for conversation or to give lectures among ourselves, as we constantly did, our professors were often among our listeners, cheering and stimulating us in all our efforts after independent research. My room was our meeting place —bed room, study, museum, library, lecture room, fencing room—all in one. Students and professors used to call it the little academy * * *. It was in our little academy that Döllinger, the great master in physiology and embryology, showed to us, his students, before he had even given them to the scientific world, his wonderful preparations exhibiting the vessels of the villosities of the alimentary canal; and here he taught us the use of the microscope in embryological investigation."

A rare privilege is it, my fellow teachers, to be not only teachers, but friends to our students. For Agassiz, Humboldt and Cuvier were his teachers and friends; for Darwin, were Henslow and Sedgwick. Darwin paid his debt of gratitude by never turning a deaf ear to an inquirer; and in the Origin of Species, the Descent of Man and his other works he becomes a companion to all of us and takes us into his confidence. And Agassiz, what shall we in America not say in gratitude to him! Who like him breathed confidence into the ardent young men who now are bearing the burden and heat of the day in the noble onward march of American science? Who like Agassiz showed us our rich inheritance and inspired this New World to arise and take possession of its own? As in holiness, so in literature, so in science, it is the living gospel, the living teacher whose inspiring touch awakens a spirit that thenceforward can never repose in idleness and indifference, but with a noble enthusiasm ever presses onward.

But, after all, the student comes back in his own mind to the serious personal question: How shall I begin; what can I do to gain this mental culture? Though the practice is difficult, the theory is simple. Observe, study, reflect. But reflection must always follow the others or there will result only empty subtleties, while without reflection observation and study are barren and fruitless. Perhaps it is unnecessary to add that zoological culture does not come from the study of a fourteen weeks' course, prepared by a man who does not know the subject at first hand. Learning the names and a little of the structure and some of the habits of a few animals is not zoological culture, although it may be a beginning. It is such a beginning as learning the Greek alphabet is for the appreciation of the immortal epic of Homer and the whole glorious array of Greek art and literature. Or it is such a beginning as a knowledge of the multiplication table is for mathematics. I have thought sometimes that in our enthusiasm for scientific study we have cut and trimmed and selected for our fourteen weeks' courses till verily when our students ask us for bread we have only a stone to offer.

Did Darwin think out natural selection and the survival of the fittest or Agassiz the glacial theory in fourteen weeks? Not every pupil can spend 28 years or even a tenth of that upon a single subject; it nevertheless remains true that the mental culture gained by the study of zoology will, as with other disciplines, depend *first upon the original power of the student* **and second upon the time and energy devoted to the subject.*

*The original ability of the student is mentioned prominently in this paper because, in too many discus-

If we take some of the aspects under which zoology may be considered, as anatomy, physiology, embryology, classification and economics, and think for a moment what is involved in understanding them, perhaps it will be clear why it is so insisted upon that to gain true mental culture from zoology time is required. Time for observation and study, and, after that, time for reflection, so that there may be assimilation and some kind of real comprehension of the subjects considered. And I take it that in the comprehension gained lies the very pith and marrow of whatever culture zoology can give.†

If anatomy is considered, what a field is there for observation and study. This animal machine with its muscles and nerves, digestive system and brain, bones and sinews; what nice adaptations they show for their various purposes, and to the far seeing eye how many bungles and compromises there are too. As compared with the machines made by human hands the animal machine is as a printed volume to a simple diagram. In these archives are stored the history of the past, the ascent or the descent from something different, but like the manuscript that has been written over and over after partial erasure, so is this structure clear only in part. Some words have been spelled out, but the master to decipher the whole manuscript is yet to appear.

And physiology, that is, the activities of the living animal, how beautiful they are, how diverse. The mother love that saves the world, the mighty thought of Newton or Shakespeare are somehow bound up with or in this living matter whose chemistry and physics even, still almost wholly elude us.

Then if we turn to embryology and try to trace with patient care the work of the unseen artificer who arranges the apparently simple and almost structureless mass of the ovum into heart and brain, muscle and nerve, and changes the formless into forms of beauty and power, be it butterfly, bird or man, we cannot but receive culture and uplifting; for are we not seeing with

sions upon subjects for culture, teachers and methods, it seems to be assumed that, given a proper subject of study, a good method and an expert teacher, the desired result will be attained. That is, the material upon which the teacher works is tacitly left out of the count, and the teacher is blamed or the method or subject is condemned if cultured men and women are not turned out regardless of their ability. It is a historical fact, however, that with good or poor teachers or with no teachers, with good or poor methods or apparently with no methods, and with a great variety of subjects, cultured men and women have appeared in all ages. Subject, method and teacher are only helps that the student uses according to his ability, and important as the helps are, the result depends infinitely more upon the native ability of the student than upon the helps. Subject, method and teacher cannot create they can only modify or facilitate development.

†It is not for a moment claimed that so thorough a study of zoology as is here advocated is the only way to obtain *useful* information concerning the animals upon the earth and in the water. To continue the comparison used in the text, a little knowledge of Greek is useful in studying astronomy, and for gaining a better appreciation of English words derived from the Greek, but no one claims that such elementary knowledge is Greek culture. So information concerning edible fishes, mollusks and the ordinary four-footed creatures, a knowledge of poisonous snakes, useful and harmful insects, and many other practical and useful things, may be known about the animals, but that is not the knowledge that makes culture, although the profounder knowledge advocated in this paper and which comes with culture in zoological science includes this which in itself is merely practical and useful. Real science or culture gives foundation principles which alone make applied or useful knowledge possible in the higher fields. While I believe most thoroughly that zoology for culture is a very serious subject and one requiring much time as well as much observation and reflection, it is not desired for a moment to discourage the study of zoology, or indeed any subject, for purely utilitarian or practical purposes. While indeed such knowledge cannot be called culture, it is often true, as aptly stated by Prof. Atkinson in discussing this series of papers, that study for purely utilitarian purposes is very likely to lead to the higher kind of study which does make for culture.

our own eyes what is described in the sublime words of the Psalmist: "I am fearfully and wonderfully made * * *. My substance was not hid from thee when I was made in secret and curiously wrought in the lowest parts of the earth. Thine eyes did see my substance, yet being unperfect; and in thy book all my members are written, which in continuance were fashioned when as yet there was none of them."

Classification requires knowledge of all the above, for it is an arrangement in due order of the complex beings of the earth from the microscopic animalcule to the mighty elephant. For the classification to be successful the mind must see the true relations between all the forms, must know their structure and activities and how they were curiously wrought and transformed from generation to generation for unnumbered ages; in a word, the classifier must know their evolution; or, in the noble words of Agassiz, he must 'become the translator of the thoughts of God.'

And lastly we come to the economics of zoology, that is, the relations of the animals to the earth, the plants, to one another and to man, and his relations to them. Here one is brought face to face, not merely with the glory of living, thinking and acting, but with destiny; with the solemn fact of life *with* death, or, more truly stated, life *by* death. More are born than can possibly survive even the short span granted for the typical life cycle. Indeed, it almost appears as if nature in her efforts for life had become a Moloch of death. How graphically Darwin has painted the picture of this scene of strife, the plant crowding its neighbors to get a little more sunshine or nutriment, the animals crowding each other and devouring both the plants and their fellows; and then there is the whole foul brood of animal parasites. In these latter days we know also that the plants are not simply content to strive for sunshine and soil in order to elaborate from the inorganic world the compounds that alone make animal life possible, but in turn, a multitude of them, which no man can number, the bacteria, are devouring the animals, including man. The knowledge of this fact, so largely due to the great Pasteur, has given new significance to hygiene and a new meaning to cleanliness.

This death and disease of the animals by means of the pathogenic germs, which also bring disease and death to man, has put a new aspect upon man's relations with the animals. They are indeed his kin, and *zoological economics* may almost be said to have become dignified into *zoological ethics*. None stands or falls alone. The earth is the mother of us all, but she bestows her gifts in a very roundabout fashion sometimes. The soil, air and sunshine of Montana may furnish the conditions for the grass; the old world gave the foundations of the life which we now find realized in perfect form in the sturdy beeves which grow and fatten on the Montana grass; and finally, without a thought of the sun, or the soil of Montana, or of the life which they made possible, or of the fear and suffering which may have resulted, we calmly nourish ourselves on the beefsteak while discussing politics, education or the hereafter. But often enough to take away undue indifference, the beef or other food may contain the germs of what is death to us, although it may be teeming life to the germs; and there is forced upon us a consideration or our relations with our living environment. If knowledge and reflection are sufficient, it does not take a very great philosopher to see that the economical standpoint changes with the change of organism. For the plant, the sunshine, the soil and the rain are for it. For the plant-eating animal, sunshine, soil and rain are to produce the plant for it. And from man's standpoint, all are for him; but if we change the standpoint slightly and judge of the workings of a tiger's mind by its actions, we would see that sunshine, soil, rain and dew, the plants, the fat beeves and even man himself are for the tiger's sole benefit.

Surely if the other sides of zoology call for imagination, acute observation, profound study and cold, logical reasoning for their comprehension, this side demands all these and in addition a philosophic spirit, that flower of the cultivated human mind.

I think what has been said will suffice to show that in zoology there is a factor of true mental culture; and that by it the philosopher, the philanthropist, the man of affairs, is better fitted in his own sphere for work and for leisure. If the student feels that some of the inspiration to this culture has departed, that the structure, function, embryology, classification and economics of animals have been almost all discovered and determined, and may be found in the ponderous volumes and monographs in the great libraries, refer him to Aristotle, Darwin, Dana, Gray or Agassiz, or to any of the devoted men and women who have been and are trying to find out the truth and to follow it, they will say: Be of good cheer, and not faint hearted. Look and listen with *brain* as well as eye and ear, for on every side are thrilling sounds whose music no human ear hath heard, and sights whose exquisite beauty no human eye hath seen.

In closing this address I cannot summarize my belief in the cultivating power of the earnest study of zoology better than by saying that a profound contemplation of the factors in the problem of animal life on the earth will bring out and cultivate the mind. It will show man his true relations to his fellow men and to his lowly fellows, the animals. It will not fill the mind with pride, for ultimate knowledge is as yet unattainable; it will rather give the humility expressed by Job: "Canst thou by searching find out God? canst thou find out the Almighty unto perfection?" or by Newton: "I do not know what I may appear to the world; but to myself I seem to have been only a boy playing on the seashore and diverting myself in finding now and then a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me." And another from one of the foremost physicists of our own day, Sir William Thompson, at the jubilee of his appointment as professor of natural philosophy at the University of Glasgow: "One word characterizes the most strenuous efforts for the advancement of science that I have made perseveringly through 55 years; that word is failure; I know no more of electric and magnetic force, or of the relations between ether, electricity and ponderable matter, or of chemical affinity, than I knew and tried to teach my students of natural philosophy 50 years ago in my first session as professor." Yet there is also the pean, if not of victory, of the consciousness of power that comes to him whose mind has been truly cultured by the disciplines brought before you in this series of addresses and none has a surer right to that consciousness or with a surer voice has expressed it than the zoologist in whose place I stand to-day: "The world of thought and the world of action are one in essence. In both truth is strength, and folly and selfishness are weakness. Say what we may about the limitations of the life of man, they are largely self limitations. Hemmed in is human life by the force of the fates; but the will of man is one of the fates, and can take its place by the side of the rest of them."

Simon Henry Gage.
Cornell University.

INSTINCT AND EDUCATION IN BIRDS.

The discussion, first provoked by the note in Science of February 14th relative to the origin of instinct and the inheritance of acquired habitual actions, and the remark of Prof. Wesley Mills (p. 441) that "before drawing conclusions from observations on domestic animals it is well to consider similar facts in connection with their wild congeners," have led me to make a few experiments upon a fledgling of our common kingbird (*Tyrannus tyrannus*), captured July 2d, as it was taking one of its first lessons in flight.

As is well known, the kingbird is exclusively insectivorous and generally captures its prey on the wing, though it does not refuse insects that may lurk in the foliage, and it may occasionally descend to the ground in pursuit of grasshoppers, whose movements have betrayed their whereabouts. Being thus in its activities so different from the omnivorous chick, and belonging, moreover, to the great group of Gymnopædes, or birds, which, naked-born, are fed in the nest, we might expect certain differences from the instincts and habits of the precocious, downy chick. Such differences may throw light upon the questions of comparative psychology though, as the material for purposes of generalization is augmented, they may prove to be variations of no direct suggestive value.

From July 2d to the 11th the bird, almost incessantly calling for food, was kept in the house and fed, from the hand, shreds of meat, moist bread and a few insects. Water was taken from the wet finger, not as a drop from the tip, but finger and all were seized, the subsequent motions of deglutition being the same as though any large morsel were being engulfed. To the present day (July 16th) the bird has utterly refused to accept the pendant drop; nor could it be induced to peck a drop from a leaf or from the surface of any object whatever.

On July 11th I offered the bird a small porcelain dish (such as is used for extract of beef) filled with water. Though hungry and presumably thirsty, no effort was made towards taking the water, but the dish was repeatedly seized with the same eager fluttering that characterized the general reception of any proffered article, edible or not. (It was noted that the tongue during this act was in rapid motion.) While making an unusually awkward lunge at the edge of the dish the bill was accidentally thrust deep into the water, and quickly withdrawn with an unmistakable air of surprise, followed by an effort to *eat* the water held between the mandibles. The jaws snapped; the tongue could be seen shooting back and forth, and the head, first held horizontally, was only slowly tipped backward and then, not in the way of the chick, described as instinctively perfect, but after the retching method of mouthing and swallowing any object not readily responsive to the contractions of deglutition and which must needs have the added assistance of the attraction of gravitation.

Though the porcelain dish was afterwards repeatedly offered from July 11th to the 16th and invariably evoked notes of approval, the bird in securing the liquid always bit the edge and never once dipped the beak beneath the surface, nor drank in the approved method of the chick. The earlier awkward movements, however, were greatly improved through repetition. The substance of the water seemed never to be visually observed, and the empty dish held in the hand evoked the same clamorous approval as when filled with water, and was later recognized even when accidentally met, though a saucer which had not contained food or water evoked no sign of interest.

On the morning of July 12th it was noted that if water was allowed to fall from a height the bird became greatly agitated, opened its mouth and vigorously struck at the descending drops, and several were swallowed with evident signs of relish. Up to this time, while in my possession, the animal had taken food only when placed by the fingers in the gaping mouth, and had made no effort to pick, selectively, the food from between the fingers ; nor had it even changed its position on the approach of food, but had remained in one place, fluttering and incessantly calling until the food was brought to it. On the morning of the following day falling drops were again struck at and seized, though the bird did not relish the accompanying wetting. At noon the drops were again seized and swallowed. Signs of disapproval of the wetting were shown on the morning of the 14th, and on the morning of the 15th the bird avoided falling water and was content with biting the edge of the dish.

From the above observations I am inclined to agree with Prof. Mills that the nature of eating and of drinking are not radically different and, as the physical condition of substances may pass imperceptibly from solid to liquid, so the physiological processes are practically the same whether the food is solid, pultaceous or liquid ; though I should not attempt to compare too closely the relative perfection of the two processes (p. 356). I do not, moreover, feel that the first act of drinking is in its totality necessarily instinctive (p. 355). In other words, 'when a chick first drinks on its beak being put into water' the act may be considered as, very largely, a result of self-teaching.

The phenomena of eating and of drinking have not, in the discussion, been definitely defined, and there has been some lack of discrimination in the use of the word 'swallow.' The beak, moreover, is mentioned by Prof. Mills and Lloyd Morgan, as the organ the stimulation of which produces the act of drinking, though Prof. Baldwin attributes the action to the stimulation of the sense of taste.

It seems to the writer that the entire process of eating and drinking should be divided into three parts, viz., (1) seizure, (2) mouthing or mulling and (3) deglutition. It is only in the first of these that the term instinct in the sense of inherited habit is necessarily used. Baldwin, Mills and Lloyd Morgan are practically agreed that the young chick seizes instinctively on being stimulated by some small, striking object at a suitable distance. This object may be nutritious or it may be a feather, a pencil or a nail head, a drop of water or a drop of ink. The mechanism is ready and the stimulus properly applied produces the instinctive mechanical, or, as Lloyd Morgan would prefer, organic action.

The object now held between the mandibles and mulled is subject to the examination, strikingly evident in the kingbird, of the tongue, an organ at the same time tactile, gustatory and locomotory. It stands at the portal which leads from instinctive to reflex action and is at once the inspector, reporter and director of that which first stimulated the eye and now, through a motor response, has been placed where it may stimulate other special sense organs : taste, touch and probably smell. It is here that instinctive action becomes guided by individual control, and intelligence begins to act through experience.

The mouth-parts of the young kingbird are large and the deliberate movements are easily observed. I feel therefore that this second and essential portion of the process of eating and drinking in the small-mouthed chick may have been neglected or overlooked. Moreover, the process of the perfecting of the action of eating and drinking through repetition and the guidance of the intelligence is, in the kingbird, comparatively slow and inclines one on the grounds of comparative psychology, to the belief that the complex act of the chick may be only *apparently* perfect from the first, the successive processes of coordination being in the chick much more quickly perfected.

The process in the kingbird as above detailed gives at least an opportunity for the more definite limitations of those actions which Prof. Baldwin has, perhaps unfortunately, called half-congenital.

The action of the callow bird in deglutition is probably performed as a reflex on the stimulation of the presence of food in the pharynx. Small fragments upon the beak and in the anterior portion of the mouth are not perceived and do not quiet the almost irritating clamor of the gaping young. The enormous size of the mouth, the thickened 'lips' and the bright colored concentric markings of the oral walls make a target, the sensitive center of which (the opening of the œsophagus) only a most awkward parent could fail to hit. We might argue that the young nestling has not, at first, a definite sense of taste, and actual experiment on the kingbird shows that most unsavory morsels when placed in the mouth are swallowed, though not without subsequent signs of surprise, if not of disgust. It is not, then, difficult to perceive that the young bird while still within the nest acquires, as a result of the selective activity of the parent, a taste for certain food. The discriminative exercise of the sense of taste is thus a result of direct tuition. The young cow-bird whose foster parent has been a vireo will doubtless acquire a relish for food very different from that enjoyed by, perchance its own brother, but, the ward of a graminivorous finch.

It may be objected that the orphan chick selecting food without the discriminative direction of a parent, is not a parallel case with the young kingbird: The bird in my poseession was so tame that when it reached an age comparable with the newly-hatched chick, I could take it into the fields and observe it as it foraged, chick-fashion, for itself. I think that I saw it capture its first insect; I, at least, observed its ability as an insect catcher develop from almost *nil* to expertness. During these excursions observations were made and data collected for the determination of the following questions: Is there an inherited discrimination in favor of the capture of certain edible insects in preference to others? If unsavory insects are unwittingly taken into the mouth are they swallowed? If ejected from the mouth are there signs of disgust? When unsavory examples are met a second time are they avoided?

To the first question I can reply that, at first, all insects were indiscriminately seized. A vile-smelling Hemipteron was as tempting as a luscious grasshopper or cricket. Distinctly unsavory insects (*Tetraopes*, *Coccinella*) were not touched a second time, except with the greatest caution; though species which were only moderately distasteful (*Lema*) might be taken and devoured, but *without* relish. In one case a large brown ant, the first found, was seized, mulled and vigorously ejected. The next day the bird was taken to the same tree and, on perceiving a second ant of the same species, eyed it closely and deliberately, and then shook its head and vigorously wiped its beak with unmistakable signs of recollection. I mention this particular case, though it is not the only one, to illustrate how quickly the bird was self-taught, for the ant was only one of a dozen different species of insects which were met, and it was so instantly seized that a prolonged visual image was not gained. I might add that the kingbird subsequently refused even to try the edible qualities of a large black ant of a different species, though the bird watched the insect's movements with much interest. Profiting by mistakes it soon learned to examine critically all strange food before the tongue should force the contents of the mouth on towards the pharynx.

Can we not then conclude that the forcing of acceptable food and drink into the pharynx is not 'instinctive,' but is the result of a series of satisfactory discoveries of the young bird which lead up to the placing of the food where it will bring about the stimulation of the reflex center of the gullet and the accomplishment of the final act of swallowing—a series which is intelligently adopted by the bird and improved by practice.

It is perhaps well, before closing, to revert to the peculiar habit of the bird in snapping at falling drops. From the first, the attention was markedly attracted by flying insects and any small objects in motion seemed to have a peculiar charm. From this fact I am inclined to think that the seizing of drops was no more than the striking at moving objects, though it is possible that the adult habitually takes water on the wing by seizing falling drops of dew or rain. H. C. BUMPUS.

A NORTHERN MICHIGAN BASELEVEL.

KEWEENAW POINT and its southwestern extension in northern Michigan is composed of rocks of Keweenawan and Cambrian ages, and exhibits three chief topographic features. Beginning at the south is a broad area of the so-called Eastern or Potsdam sandstone. This is in a horizontal position, and rests unconformably upon the rocks to the north and south. North of this area is the main trap range of the Keweenawan, which consists largely of basic lava flows, but with lesser quantities of acidic lavas. Interstratified with the lavas are numerous layers of sandstone and conglomerate. The majority of these are thin, but in the upper parts of the series some of the conglomerates are of considerable thickness. The breadth of the main trap range varies from about 4 miles to nearly 10 miles. In a general way the traps and detritals strike northeast and southwest, and dip to the northwest at angles varying from 25° to 55°. At the southwestern part of the area considered, a wing of the trap range swings to the north as the result of a fold. This area is known as the Porcupine mountains. The distance from the southwest part of the Porcupine mountains to the end of Keweenaw Point is about 120 miles. To the northwest, overlying conformably the main trap range, is the upper division of the Keweenaw series, which consists wholly of conglomerates and sandstones. The dips on its southeastern border average about 25°, but they become less and less toward Lake Superior and at the shore they do not average more than 8° or 10°.

For a full description of the Keweenaw series see the Copper-bearing Rocks of Lake Superior, by Roland D. Irving, Monograph V., United States Geological Survey, and in connection with the present description see the maps of plates I., XVII., and XIX.

A recent visit to this area convinced me that this district had been almost completely baseleveled. The two most advantageous points found by me from which this baseleveled area may be seen are, first, the top of the hill occupied by a church in the village of Rockland, and, second, the top of the rockhouse of the Quincy mine, occupying the highest ground above Hancock. From the Rockland point, looking to the northeast the main trap range appears to be an almost level plain. To the southwest the plain is nearly as level, but the Porcupine mountains rise considerably above this plain. The explanation of this monadnock is simple; the core of the Porcupine mountains is hard quartz-porphyry and felsite, rocks more resistant than the interstratified traps and detrital rocks of the main trap range. From the Quincy rockhouse on a clear day the eye sweeps from the Porcupine mountains on the southwest to the end of Keweenaw Point, to the northeast, that is, over the entire 120 miles, and to the northeast Isle Royale may been seen. Again ignoring the immediate foreground, there is an impression of almost absolute horizontality, with the exception of the Porcupine mountain mass, to the southwest, and of some peaks on the south side of the main range far out toward the end of Keweenaw Point to the northeast. These northeastern monadnocks are supposed to be parts of the Gratiot Bluff, Mount Bohemia, and Mount Houghton range, which is known to consist of hard quartz-porphyry and felsite.

The immediate foreground both at Rockland and at the Quincy mine is exceedingly rough, and these two places are typical of the range. When traversed the range is found to be cut by steep ravines, to be carved into bluffs and hills, and everywhere one is ascending or descending. The apparent plain is evidently composed of the higher points of the range, which rise just about to the altitude of the ancient baselevel. Scarcely a remnant of the plateau which once must have existed is left. As determined from the topographic map of the outer part of Keweenaw Point, made by the United States Lake Survey, the Lake Superior baseleveled area is at an elevation of about 1350 feet. The culminating points from near Eagle Harbor east run as follows : 1349, 1344, 1292, 1330, 1312, 1335, 1330 feet. The last is East Bluff, and this is only about 4 miles from the end of the Point. Upon account of the northwest dips these and most of the other bluffs of the district have comparatively gentle slopes in that direction and steep slopes to the southeast where the layers are broken across. Such a remarkable uniformity as given above in the height of peaks carved from tilted rocks of varying hardness could not be the result of erosion of an elevated area. The only satisfactory explanation yet offered for such phenomena is the standard one of an elevated, baseleveled plain which is undergoing a second cycle of degradation. The culminating points of the south part of the range which rise above the baseleveled area are as follows: A point about 3 miles south of west from Gratiot Bluff, 1534 feet; Gratiot Bluff, 1435 feet; Mount Bohemia, 1469 feet; Mount Houghton, 1429 feet. These points therefore rise from 100 to nearly 200 feet above the baseleveled area. According to Irving, many of the ridges of the Porcupine mountains have elevations of 1600 to 1800 feet, while but small parts of the lower portions are as low as 1400 feet. This places the higher points of the Porcupine mountains from 250 to 450 feet above the baselevel.

For the greater part of the area the present cycle of erosion is evidently at its full maturity, and for the outer part of the Point, from which the altitudes above given are taken, just past that stage.

The Potsdam sandstone to the southeast and the upper division of the Keweenawan to the northwest of the main trap range, on account of their softness, are everywhere cut below the ancient baseleveled plain. These areas, unlike the trap range, are in large part so nearly reduced to the level of Lake Superior as to show very much less irregularity of surface than the main trap range. Although cut by river valleys and ravines, and although there are slopes everywhere and in many places very considerable irregularities of surface, the comparative flatness, as contrasted with the Keweenawan rocks of the main trap range or with the Huronian and Archean rocks to the south, is very marked.

A cursory glance at the maps of the district in question shows that when topographic maps of the entire area are made, and its drainage studied, numerous interesting features will probably appear. The trap range is traversed by the stonger streams, such as the Presqu' Isle, the Ontonagon, the Fire Steel and Flint Steel rivers, and Portage

Lake, but the majority of the smaller streams flows to the north and to the south from the central trap area, and they are thus consequent.

The west branch of the Ontonagon river flows from Agogebic lake along the southeast border of the trap range for 20 miles or more. Here it joins the other main branch and the river breaks directly across the trap range in a southwesterly direction.

The only transverse cut where the trap range is reduced almost to the level of Lake Superior is at Portage Lake, and this place has been utilized for a ship canal. From Portage Lake the banks rise steeply from 500 to 700 feet, nearly to the baselevel above. No explanation for this exceptional reduction has been offered. One is tempted to believe that here must have been unusual fracturing or faulting, and this idea is encouraged by the presence adjacent to Portage Lake of a number of important copper mines on the amygdaloids. It is well known that the amygdaloid mines occur where there has been much crushing of the porous rocks, as a result of the differential movement between the layers of trap. A partial explanation of the Portage Lake gap may be the comparative narrowness of the range at this point, as a result of steeper dips. This increased steepness of dip implies greater accommodation between the layers, and therefore more fracturing of the rocks.

The Little Montreal river, which rises on the trap range, flows in a nearly east and west course for 15 miles in one of the softer divisions of the Keweenawan series between two harder divisions, before turning abruptly to the south and breaking through the porphyries, felsites, and traps. Had it continued four miles farther, in a course little south of east, it might have reached Lake Superior at the end of Keweenaw Point without breaking through the resistant formations. A close examination of Irving's Plate XVII. of Monograph V. referred to shows many other interesting points in reference to the drainage.

In a recent number of SCIENCE, July 17, 1896, I described a central Wisconsin baseleveled area, more nearly perfect than that at Keweenaw Point. From center to center of the two districts is about 150 miles. The central Wisconsin district has not been so deeply dissected as Keweenaw Point, but this is readily explained by the fact that it is not so near either of the Great Lakes, and therefore erosion has not so thoroughly stretched its fingers over it. The central Wisconsin baseleveled plain is at an altitude of about 1450 feet. The Keweenawan baseleveled plain is at an altitude of about 1350 feet. Therefore the baseleveled areas of the two districts are probably but parts of a far more extensive baseleveled region.

The area intervening between the two districts consists of Huronian and Archean rocks. Resistant quartzites and mica-schists are characteristic rocks of the Huronian, and gneissoid granite is the dominant rock of the Archean. Since the most resistant rocks were not reduced to the sea level at Keweenaw Point or in central Wisconsin, one would expect that the more widespread, equally resistant rocks of the Huronian and Archean would also project above the baseleveled plain. As a matter of fact topographic maps of the Marquette and Penokee districts made by the U. S. Geological Survey, and under my own direction of the Michigamme district southwest of the Marquette district, show that extensive tracts of country are at altitudes from 1600 to 1800 feet or more, thus verifying the expectation. The variations of level of the ancient uneven plain throughout the region, however, are probably not so great but that Davis's term peneplain may not properly be applied to it. So far as I know, H. L. Smyth was the first to call attention to this fact for the Michigamme district.

In my previous article I suggested that the period of this ancient denudation was Cretaceous, and gave reasons for the belief that the predominating agent in the process was sub-aërial erosion.

C. R. Van Hise.

CURRENT NOTES ON PHYSIOGRAPHY.

SAN FRANCISCO PENINSULA.

The geology of the San Francisco peninsula by Lawson (16th Ann. Rep. U. S. G. S.) closes with a chapter on its geomorphy, in which it is shown that two fault blocks—San Bruno and Montara, the first more carved than the second—dominate the form of the region. The bounding faults trend northwest, and the fault scarps faced southwest. After faulting and well advanced dissection, a progressive emergence of the two blocks in unison revealed marine terraces at various levels on their flanks. Recently a slight submergence has drowned the lower stretches of the valleys, the Golden Gate being then made a waterway. An effective colored relief map, photographed from a model, brings out the topography very clearly.

TURKEY LAKE, INDIANA.

A biological study of Turkey lake, Indiana, under the direction of C. H. Eigenmann, of the Indiana University Biological Station, gives many details concerning outline, depth and temperature (Proc. Indiana Acad. Sci., V., 1895) that may serve as typical for the smaller morainic lakes of the prairie States. For dimensions the surface is five and a-half long by about a mile wide, with a perimeter of over twenty miles and an area of 5.66 square miles. Soundings have shown the bottom to be of rolling morainic form, like the adjacent county. The greatest depth is nearly 70 feet; the average depth, 17. Small natural changes have occurred in depth or outline, except for the conversion of shallow marginal water into swamps. The catchment basin being small, it is estimated that only seven inches of water are drained off through the outlet, while thirty inches pass away by evaporation. The action of ice in forming beaches is described, following Russell.

GEOLOGY AND SCENERY OF SUTHERLAND.

This attractive little book of a hundred pages by H. M. Cadell, now appears in a second edition (Edinburgh, Douglas, 1896) and gives us northern Scotland in a nutshell. Although chiefly occupied with geological structure and succession, and with diagram and experimental illustration of the 'secret of the highlands,' due attention is given to the topographic forms characteristic of each formation. The bold mountains of nearly horizontal Torridon sandstone, of which the superb Suilven is among the most striking, are benched and cliffed around by the harder layers, and seem to bear witness to the long undisturbed attitude of these ancient strata; but they are neatly shown to have recovered from a tilted position into which they were thrown in pre-Cambrian times. Eight page plates, a dozen figures, an orographical and a geological map illustrate the text.

GEOGRAPHY IN THE ENGLISH UNIVERSITIES.

Sir Clements Markham, in his recent annual address to the Royal Geographical Society, announces that the geographical readership at Oxford, subsidized for ten years past by the Society, will be continued by the University without outside aid; the position still being held by Mackinder. Oldham, at Cambridge, has a less assured position, the subsidy there being still continued. Herbertson, at Manchester, is not mentioned, as the Society has not given a subsidy there. It is proposed that a London School of Geography of university rank should be formed under the auspices of the Society. In comment, it may be said if Great Britain to-day supplies the most active explorers and holds the greatest colonial possessions in the world in spite of the lack of instruction in geography so generally complained of, what will she become when this branch of instruction is duly organized!

THE PAMIRS.

An entertaining narrative of exploration by Curzon over the Pamirs to the source of the Oxus (London Geogr. Jour. July, Aug.) discusses the meaning of Pamir, discarding the 'roof of the world' as fantastic, and concluding, with much appearance of truth, that a Pamir is an elevated valley (12,000–14,000 ft.), floored with broad slopes of waste from the adjoining lofty mountains (20,000 ft.+), drained by a medial stream, which runs noisily over a stony bed, meanders through a peaty tract or spreads in a lake; buried in snow for seven winter months, but affording abundance of summer pasturage, although devoid of trees and cultivation. The further statements that the Pamir is 'a mountain valley of glacial formation,' and that the inability of the medial stream to scour for itself a deeper channel is due to the 'width of the valleys and the consequent absence of glaciers on any scale' seem to be open to question. Eight different Pamirs are described and mapped.

W. M. Davis.

Harvard University.

CURRENT NOTES ON ANTHROPOLOGY.

THE SIGNIFICANCE OF THE METOPIC SUTURE.

A well studied memoir on this subject is that of Dr. G. Papillault, published by the Anthropological Society of Paris (La Suture Métropique, et ses Rapports avec la Morphologie Cranienne, pp. 122. Paris, 1896). His results are derived from a comparison of a long series of skulls of different ages, sexes and races. They clearly indicate that the presence and persistence of the metopic suture is an evidence of superior mental (cerebral) activity and superiority, because this persistence unquestionably finds its point of departure in the brain itself. It is seen most frequently in women and children, and is not uncommon in the Negritos. These facts, however, do not impair the author's position. The superiority he refers to is relative to weight and height, and in that sense he claims that the brain of the female and the child does rank above that of the adult man.

He does not affirm the intellectual superiority of metopics in an absolute sense, but that the capacity and functional energy of their brains are greater in proportion to the whole body than in others. Moreover, he very pertinently adds that nothing is more difficult than to pronounce positively on the intelligence of a race or an individual. Civilization and success are not sure criteria, as every one must admit. The demonstration of his position is ably argued.

THE SVASTIKA AND THE TRISKELES.

It is singular to how many possible origins these famous symbols lend themselves. The latest is proposed by the well-known explorer, Karl von den Steinen, in a paper contributed to the Bastian Memorial Volume. He believes that the svastika was developed from the conventional outline of the stork, and the triskeles from that of the domestic fowl! He brings forward considerable learning and ingenuity to demonstrate his thesis, and succeeds in rendering it as plausible as a dozen other hypotheses which have been advanced. How the svastika came to be in America, where we have no storks, he fails to explain; in fact, does not refer to the American examples of these figures, which for an Americanist, *ex professo*, is an unexpected oversight. At the close he makes some observations on the Runic alphabets, which he believes are something more than modifications of Latin letters.

The Bastian Memorial Volume contains several articles of interest to students of American ethnography; as Dr. Boas, on secret societies among the Kwakiutl Indians; Seler, on the ruins of Quiengola; Dieseldorf, on the Toltecs; Ehrenreich, on the Botocudo language, etc. D. G. Brinton.

University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS.

In the issue of this Journal for June 19th, will be found full details regarding the present meeting of the American Association for the Advancement of Science at Buffalo. It will be remembered that the first meeting of the Council will be at noon on Saturday, August 22d, and the first general meeting will be on Monday, August 24th. The work of the sessions has been made continuous, not being interrupted by Sunday or by a day for excursions. The affiliated societies, however, meet on the 21st and the 22d, and all who are able should be present at Buffalo on those days.

Prof. Hubert A. Newton, of Yale University, died in New Haven on the night of August 12th. We hope to give in a future number some details regarding Prof. Newton's life and his important contributions to astronomy and mathematics. Yale University and American science have recently suffered most severe losses in the deaths of Professors Whitney, Dana, Eaton and Newton.

Advices by cablegram regarding the eclipse expeditions state that Prof. Schaeberle and Prof. Todd in northern Japan were unsuccessful or only partially successful in their observations, but that the weather was clear and fine in Norway.

Cablegrams to the daily papers report that Dr. Nansen has arrived at Vardo Island, Norway, on board the steamer Windward, which recently went to Franz Josef Land in order to bring back the Jackson-Harmsworth expedition. It is stated that with Lieutenant Hansen he left the steamer Fram, in which he had hoped to be carried to the pole, in March, 1895, in Lat. 84, Long. 10.27, to explore north of the Franz Josef route. The party journeyed through an unknown polar sea, and explored north of Franz Josef Land to Lat. 86.14. No land was seen to the north of Lat. 82; only ice. They wintered on Franz Josef Land, living on whale meat and bear meat. The Fram was reported to be a good ice ship, and will arrive later this year. There was no sickness on board. Although the expedition failed to reach the object of its search, it got four degrees farther north than did any previous expedition.

The second International Congress of Applied Chemistry was opened at the Sorbonne, Paris, on July 27th, about 1,600 delegates being present. The admirable address of the President, M. Berthelot, is published in the *Revue Scientifique* of August 1.

The sixty-fourth annual meeting of the British Medical Association was opened at Carlisle on Tuesday, July 28th, under the Presidency of Dr. Henry Barnes, physician to the Cumberland Infirmary. As compared with the meeting in London last year the attendance was not large, about 700 members being present, but the addresses by the Presidents of the sections and the proceedings of the sections contain much that is of interest, not only to the medical profession, but also to those engaged in advancing medicine as a science. Following the British Association for the Advancement of Science, the Medical Association will meet next year in Canada, having accepted the invitation of the Montreal branch. Prof. T. G. Roderick, professor of surgery in McGill University, will be President. The Association will probably meet in Edinburgh in 1898.

The sixty-eighth meeting of the German naturalists and physicians will be held at Frankfort from the 21st to the 26th of September under the Presidency of Prof. H. von Ziemssen. Lectures before the general sessions will be given by Drs. Hans Buchner, Richard Lepsius, Max Verworn, Ernst Below and Karl Weigert. Before the medical sections there will be a discussion of the results of recent investigations of the brain led by Professors Paul Flechsig, Ludwig Edinger and E. von Bergmann. American men of science will be welcomed at the meeting. Membership cards can be obtained from the Secretary, Dr. Hugo Metzler, Frankfort, on payment of M. 15.

SECTION C., Chemistry, of the A. A. A. S., has printed in advance a provisional program, which shows that as usual the papers presented before this section will be numerous and important. Physical, inorganic and organic chemistry will be taken up on August 25th; didactic, analytical and technical chemistry on August 26th; technical and sanitary chemistry on August 27th; agricultural and biological chemistry on August 28th. More than sixty papers have been already promised.

THE admirable leadership of the department of natural science instruction of the National Educational Association is shown by the addresses given before the recent meeting and published in this JOURNAL. We learn from the President, Prof. Charles S. Palmer, of the University of Colorado, that it is proposed to secure a committee at the approaching meeting of the American Association for the Advancement of Science, and also from the several college associations which will cooperate with the committee from the National Educational Association in discussing the position of natural science in the schools and the establishment of natural science requirements for admission to college.

IT seems probable that owing to contrary winds M. Andrée has not undertaken to launch his balloon. Reports that the balloon has been seen in the Arctic regions are not likely to be very reliable, as the natives have been promised rewards for bringing news of the explorers.

HERR OTTO LILLIENTHAL, while experimenting with his flying mechanism on August 11th, met with an accident which resulted in his death. It is reported by cablegram that he started from a hilltop at Rhinow, near Berlin, and after floating for some distance the apparatus got out of order, causing him to fall to the ground. Herr Lillienthal was 46 years of age.

A PARTY under the charge of Mr. W. G. Miller, of the School of Mining, Kingston, Ont., will leave that place on September 1st to explore the chief mineral localities of the Kingston district. Though primarily intended for students of the school, we understand that others would be admitted to the party. Travelling will be done by canoes, and it is estimated that the expense of the trip will not exceed $20 for three weeks.

ON the afternoon of July 26th there was a heavy hail storm in Paris which did great harm to the conservatories, trees and plants of the *Jardin des Plantes*. M. Milne-Edwards has reported to the Paris Academy that it will be many years before the damage can be repaired.

ACCORDING to the *Botanical Gazette*, Dr. V. F. Brotherus, of Helsingfors, left about the middle of April upon a botanical journey in central Asia. He will explore the high mountain flora of Issikul, giving particular attention to the mosses.

THE London *Times* states that Captain H. H. P. Deasy has left England for a journey across Tibet from west to east. He intends on the way to throw away soldered-up tins containing parchment notices in English and French into the tributaries of the Tsanpo and into the other large rivers which he may meet with, in the hope that some of them may be picked up far down stream, possibly in the Brahmaputra, Salween, and Mekong, and thus help to solve the vexed problem of the origin and connections of these rivers. The notices will be consecutively numbered and the tins in which they will be enclosed will have a brass label soldered on the outside, bearing the words, 'Please open this' in English and French, and Captain Deasy's name. The parchment inside bears the request that it be forwarded without delay to the Royal Geographical Society, London, with as accurate a statement as possible as to where it was picked up.

ON the occasion of Prof. Bastian's seventieth birthday, which occurred on the 28th of June, his bust in marble was given to the Museum of Ethnology in Berlin. A *Festschrift* containing papers by 32 leading German anthropologists was also presented to him. Prof. Bastin is, as we have recently stated, now absent on an expedition through Central Asia.

PROF. VICTOR HORSLEY has been presented, on the occasion of his retirement from the chair of pathology, University College, London, with a testimonial including an album which contains photographs of fifty-one of the subscribers to the testimonial, together with a record of the work which each of them has done either in conjunction with Prof. Horsley or in the Brown Institute and in the Pathological Department of University College during the time these laboratories were under his direction.

Dr. L. H. Bauer, editor of *Terrestrial Magnetism*, is making a magnetic survey of Maryland under the auspices of the State Geological Survey, now being conducted by Prof. Clark, State Geologist.

George Whitefield Samson, D. D., LL. D., formerly President of Columbian University, Washington, died in New York city on August 8th, aged 77 years.

The deaths are announced of Prof. August Kanitz, Director of the Botanical Gardens at Klausenburg, and of Prof. F. R. Simony, the Alpine explorer, who died on July 20th, at the age of 83.

The 'Leopolinisch-Carolinische Academie,' of Halle, is about to publish Cuvier's first composition, which is on the edible crabs of the French coast, and dates from the year 1788. The Academy has in its possession a number of letters of Cuvier, which it is also intended to publish.

The Observatory of the School of Technology at Karlsruhe will be removed to Heidelberg. Its director, Prof. Valentiner, has been made professor in the University of Heidelberg.

An observatory for terrestrial magnetism has been established in connection with the astronomical observatory in Munich and Dr. Franz von Schwarz has been made director.

The Vienna Academy of Science proposes as the subject of the Baumgartner Prize ($5000), to be awarded in 1899, 'The extension of our knowledge of ultra violet rays.'

We learn from *Natural Science* that a new zoological garden has been opened at Königsberg, in Prussia, under the directorship of Dr. J. Müller, formerly of the Garden in Berlin; also that a State Entomological Experiment Station, for which the money has been voted by both Chambers, is to be built near Stockholm.

The first number of the twenty-second volume of the *Botanical Gazette* is published from the press of the University of Chicago, and, like the other journals of the University, is admirably printed on fine paper with wide margins. Profs. George F. Atkinson, of Cornell University, Volney H. Spalding, of the University of Michigan, Roland Thaxter, of Harvard, and William Trelease, of the Missouri Botanical Garden, will hereafter act as associate editors.

Prof. W. Nernst, of the University of Göttingen, has become the scientific editor of the *Zeitschrift fur Elektrochemie.*

Gauthier-Villars et fils announce an atlas containing fifteen large plates from photographs taken with the Röntgen rays by J. M. Eder and E. Valenta. The work on the same subject by E. E. Guillaume, also published by Gauthier-Villars, has reached a second edition.

It appears that a new and very objectionable manner of advertising has been devised in Great Britain. In the bedrooms of some of the leading hotels, not only toilet articles, but also patent medicines are placed, in the hopes that guests will use and pay for these.

The Paris Municipal Council authorized on July 10th the establishment of stands for automobile cabs. It is also considering the use of auto-mobile omnibuses, which, if adopted, will throw 27,000 horses out of employment! France seems to be distinctly in advance of England, Germany or America in the use of horseless carriages.

The volume of *Biological Lectures* of the Marine Biological Laboratory, of Woods Holl, for 1895, is announced by Ginn & Co. as nearly ready. The volume will contain the following lectures: 'Infection and Intoxication,' Simon Flexner; 'Immunity,' George M. Sternberg; 'A Student's Reminiscences of Huxley,' Henry Fairfield Osborn; 'Paleontology as a Morphological Discipline,' W. B. Scott; 'Explanations or How Phenomena are Interpreted,' A. E. Dolbear; 'Known Relations between Mind and Matter,' A. E. Dolbear; 'On the Physical Basis of Animal Phosphorescence,' S. Watasé; 'Segmentation of the Vertebrate Head,' William A.

Locy; 'Segmentation of the Head,' J. S. Kingsley; 'Bibliography: A Study of Resources,' Charles Sedgwick Minot; 'The Transformation of Sporophyllary to Vegetative Organs,' George F. Atkinson.

WE learn from *Nature* that the observatory at Athens will hereafter publish a daily weather report containing twenty-five stations in Greece, and about double that number of exterior stations. The report is accompanied by two charts, one showing the isobars and general meteorological conditions over a large part of Europe, and one showing wind and temperature over Greece and adjacent islands.

THE New York *Medical Record* states that Rabies has broken out among the cows, dogs, sheep and hogs in Path Valley, Centre County, Pa., and it is feared that the disease will become general throughout the county.

ACCORDING to *Natural Science* a party of four, under the direction of Mr. T. A. Mobley, will start from Lacomb, Alberta, to explore northern Canada from Edmonton to the Arctic sea. The trip is to occupy two years.

ACCORDING to *Nature* the Russian Geographical Society has awarded this year its Constantine medal to M. A. Rykacheff, for his work in the domain of physical geography. Beginning in the year 1874 with a work on the distribution of atmospheric pressure in Russia, he continued to publish a series of researches on the diurnal variations of pressure, the prevailing winds of the Caspian and the White Seas, the tides in the atmosphere, the freezing and thawing of the Russian rivers, the variations of the levels of rivers in Middle Russia, in connection with variations in the amounts of rain and snow, the diurnal variations of temperature over the tropical oceans, etc. The Count Lütke medal has been awarded to Admiral Makaroff, for his work on the temperature and density of water in the northern Pacific, based on the measurements made in 1886–89 on board the *Vityaz*. His maps of the distribution of surface temperature in August, and of temperature at a depth of 400 meters, are especially worthy of notice. The Prjevalsky prize was awarded to M. Berezovsky, for his explorations of the northern borderlands of Tibet. A Prjevalsky medal was awarded to J. A. Schmidt, for his twelve geodetical expeditions to different parts of Central Asia and Siberia; and one to Dr. H. A. Fritsche, for his magnetic measurements in China, Mongolia, Siberia and Russia. Two small gold medals were awarded to F. F. Müller, for his magnetic work in East Siberia, and to A. A. Lebedintseff, for his researches into the chemical composition of water in the Black and Azov Seas. Eighteen silver medals were awarded for various works of lesser importance.

A PART of the collection of butterflies of the late Prof. A. M. Butljero has been presented to the Academy of Sciences of the University of Moscow. The collection of Mexican insects made by the late Julius Flohr has been bequeathed by him to the Museum of Natural History, Berlin; the same institution will also receive in event of the death of Herr Hans Fruhstorcher his valuable collection of butterflies.

ACCORDING to the London *Times*, some important alterations are now being carried out at Kew Gardens. The temperate house projected by the late Prince Consort was originally designed to comprise a central structure, two octagons and two wings. The wings were not added; but the government has now granted the necessary funds, and already such progress has been made that the south wing is nearly completed, and the north wing will be constructed at the earliest possible date. When finished, the temperate house will be one of the most striking, and probably the largest of the kind in existence. Its central avenue will be 600 ft. long, and there will be a clear view from end to end. This, it may be added, will be just double the length of the present largest house—the palm house—in the gardens. The building will be used especially for the accommodation of succulent plants, agaves, the taller cactuses, and the like, from such sub-tropical countries as the Cape, the highlands of Mexico and the Canary Islands. Limited in the area of their growth, the plants have hitherto been necessarily confined in tubs, but in their new quarters they will be planted out in beds, where they may be expected to flower and add a new attraction to the Royal Gardens. There has just been established near what is known as the rhododendron dell in the arboretum a small bamboo garden. The species are mostly Japanese, Chinese and Himalayan and are probably the finest collection now in Great Britain. The naturalized bamboos have already created a great deal of interest, which may be followed by their more general cultivation. Two interesting official publications may also be mentioned—one in course of being issued and the other projected by the staff at Kew. The former is a complete list of the plants cultivated in the gardens, which it is hoped will fix a standard nomenclature, thus doing away with the confusion of identical plants known under two or more names. The other book will be a guide to the economic plants, and will include a summary of their qualities and uses.

The London *Times* states that a Pasteur filter on a large scale has been exhibited by Messrs. J. Defries and Sons on their premises in Houndsditch. It has been constructed by them for the municipal authorities of Darjiling, with the sanction of the Indian government, and will be sent out there immediately. The filter consists of a series of iron 'cells,' or circular vessels, each of which contains 250 Pasteur porcelain tubes. These tubes resemble hollow candles and stand upright in the floor of the cell. The water filters through them from the outside to the inside under pressure or by gravity, and all impurities are arrested on the surface of the porcelain, which is formed of a special clay or mixture of clays. The filter is cleaned periodically, or as often as may be necessary, by scraping off the deposit from the surface of the tubes and by passing through them dilute hydrochloric acid, which dissolves and carries away the earthy salts deposited in the interstices of the porcelain. The principal of this filter and its successful application to domestic purposes have been well known for several years and have gradually overcome the distrust with which sanitary science is inclined to regard all fillters. Its efficiency seems to be well established not only by laboratory experiments, but—far more convincingly—by the practical results in the reduction of water-borne disease obtained by its use in the French army. The interest of the present exhibit lies in the size of the installation. It consists of 38 cells and 9,500 tubes, which will deliver 150,000 gallons per day.

As we are going to press with the present number of Science we have received provisional programs of the several sections of the approaching meeting of the American Association for the advancement of science. The number of papers entered at a date considerably in advance of the meeting is as follows: Section A. Mathematics and Astronomy, 8; Section B. Physics, 19; Section C. Chemistry, 60; Section D. Mechanical Science and Engineering, 23; Section E. Geology and Geography, 17; Section F. Zoology, 17; Section G. Botany, 35; Section I. Social and Economic Science, 9. In each of the sections other papers will doubtless be offered, which will be entered on the daily programs published during the meeting. It is a great advantage to have the programs in advance of the meeting and we regret that it is now too late to print them in full in this issue of Science. We hope to publish full reports of the sectional meetings, but no one who is able to be present at Buffalo should neglect to attend a meeting which promises to be of especial interest.

UNIVERSITY AND EDUCATIONAL NEWS.

THE HULL BIOLOGICAL LABORATORIES.

The Chicago *University Record* gives an account of the exercises held on the occasion of the laying of the corner stone of the Hull Biological Laboratories on July 3d. The address in the convocation tent was given by Prof. G. L. Goodale, of Harvard University, who spoke on 'Some of the Relations of Natural History to Thought and Modern Life.' President Harper made a statement regarding the importance of Miss Culver's gift for the development of science, in the course of which he made the following important announcement regarding the place of investigation in the medical school: "In laying these corner stones to-day we are laying the foundations of a school of medicine, for aside from the distinct work outlined in each department there is that great and important service to be rendered in the establishment of a school of medicine, the chief work of which shall be investigation.''

The company then adjourned to the site chosen for the Laboratories, where the corner stones of the buildings were successively laid with appropriate ceremonial and addresses. Head Professor John M. Coulter gave the address at the foundation of the Botanical Laboratory; Associate Professor Jacques Loeb, at the site of the Physiological Laboratory; the address written by Head Professor Henry H. Donaldson was read by Assistant Professor E. O. Jordan at the site of the Anatomical Laboratory, and Head Professor Charles O. Whitman spoke at the Zoological foundation.

In the evening the University gave a dinner to Miss Helen Culver and the men of science present from other universities. Short speeches were made by Profs. Goodale, Barnes, Forbes, Burrill, McMurrich, MacBride and Holmes representing their respective institutions. Profs. Whitman, Loeb, Jordan and Coulter spoke in behalf of the biological faculties and Profs. Chamberlin and Judson on behalf of other departments. Finally President Harper told very simple the story of the gift, of its unexpectedness, of its coming entirely unsolicited and the manner in which it relieved the pressing wants and satisfied the most sanguine hopes of the departments concerned. At last late in the evening he announced that Miss Culver would say a few words. Then with the guests standing in their places at the tables, Miss Culver expressed very quietly her pleasure and satisfaction in being able to do what she could for the cause of higher education, and modestly claimed for herself only the credit of being an agent in carrying out what she felt would have been the desires of the man whose name the laboratories are to bear, Mr. C. J. Hull.

SCIENCE AT OXFORD.

WE called attention in a recent number of this JOURNAL to an important article in *Nature* on the position of science at Oxford. Prof. E. Ray Lankester, Linacre professor of zoology at Oxford, has addressed the following letter on the subject to *Nature:*

''Will you allow me a few lines in which to express my entire agreement with your recent article on this subject, if only to emphasize the fact that I am not the author of the article, and that the opinions there expressed are not those of an isolated individual. The reason for the comparative neglect of natural science at Oxford is that, however well-disposed some individuals may be, the college tutors and lecturers as a rule dislike it. They dislike it for two reasons: First, because it cannot be taught in the college parlors called lecture rooms; and second, because they are, as a rule, ignorant—owing to their own defective education—of the nature and scope of the immense field of study comprised under the head 'natural science.' They do not know either the enormous educational value of natural science, or its vital importance to our national life and development.

''And lastly, if they did know, there is no conceivable motive which could operate so as to induce them to sacrifice some of the rewards and educational domination, which are at present enjoyed by the long-established classical and historical studies, to newer lines of work in which the present beneficiaries and their academic offspring can have no share.

''The situation is a 'dead-lock,' and only an intelligent Parliamentary Commission (if such is possible) can put matters on to a fair and healthy basis. Probably the scandal of the present paralysis of our beloved Oxford will have to become even greater and more outrageous than it is at this moment, before the necessary remedy is applied.

''But happily the vitality of Oxford is indestructible. The misused and monopolized resources of Oxford will assuredly some day be devoted to the true purposes of a great university.''

GENERAL.

THE authorities of Princeton University have issued a circular of information regarding the sesqui-centennial celebration which takes place on October 20th, 21st and 22d. The most important ceremonies will be held on October 22d, when degrees will be conferred and announcements will be made of the endowments secured. During the week preceding these exercises lectures will be given by some of the foreign visitors. Prof. William Libbey is Secretary of the Reception Committee and should be addressed by those desiring programs or tickets.

We learn from the *Academische Rundschau* that the total number of students matriculated in the German universities during the present summer semester is 29,864. This is 1,000 more than last summer and the largest attendance ever recorded, surpassing by about 400 the largest previous attendance which was in the summer of 1889. Berlin leads with 4,649 students, followed by Munich, Leipzig, Tübingen, Heidelberg, Erlangen and Göttingen, at each of which there were over 1,000. The students are distributed among the faculties as follows: Protestant theology, 2,959; Catholic theology, 1,502; law, 8,077; medicine, 7,931; pharmacy and dentistry, 1,415; philosophy, philology and history, 3,607; mathematics and natural science, 3,020; agriculture, 1,353. The total number of foreigners, including Austria and Switzerland, was 2,189, of whom 513 were Russians, 450 Americans, 139 English and 56 French.

The *Botanical Gazette* states that Prof. Thos. A. Williams, professor of botany in the Agricultural College of South Dakota, has been appointed assistant in the division of agrostology of the Department of Agriculture. Mr. F. S. Earle, of the Alabama Polytechnic Institute, has been promoted to the professorship of biology made vacant by the removal of Prof. Underwood to Columbia University.

Prof. G. B. Mathews has resigned the chair of mathematics in University College, North Wales.

The chair of mental philosophy and logic established sometime since in the University of Cambridge has never been filled, owing to lack of endowment. £700 annually have now been appropriated for the chair, £200 of which is due to the generosity of Prof. Sidgwick, and it is expected that a professor will soon be appointed.

Sir Walter Gilby has founded in the University of Cambridge a lectureship on the history and economics of agriculture, having guaranteed for this purpose £25 a year for twenty-one years.

Mr. S. Henbest Capper, of Edinburgh, has been appointed to the newly-founded Macdonald Chair of Agriculture in the McGill University, Montreal.

The following appointments are announced in German universities: Dr. Kurt Rümker has been made full professor of agriculture in the University of Breslau; Dr. Fr. W. Küster, professor of physical chemistry in the University of Göttingen, and Dr. Wilhelm Sandmeyer, professor of physiology in the University of Marburg. Dr. Max Fischer, of Halle, has been made professor in the Agricultural Institute at Leipzig. Prof. Hofmeister, of Prague, has been called to the chair of of physiological chemistry in the University of Strasburg; General M. Rijkatschef has been appointed director of the Physical Observatory in St. Petersburg, as successor to Dr. Wild. Dr. Richard Lorenz of Göttingen, has been made professor of electro-chemistry in the Polytechnic Institute in Zurich. The railway inspector, Herr Troske, has been appointed professor of engineering in the Technical High School of Hanover. Dr. Schleiermacher, of the Technical High School in Karlsruhe, has been promoted to a full professorship of electro-chemistry, and Dr. Schuberg, of the University of Heidelberg, to an assistant professorship of zoology. Dr. J. Biehringer has been appointed docent in general and technical chemistry in the Technical High School in Braunschweig, and Dr. Benecke docent in botany in the University of Strasburg.

DISCUSSION AND CORRESPONDENCE.

GIFTS TO THE LICK OBSERVATORY.

Miss Caroline W. Bruce, of New York City, has given the observatory a sum of money to procure a large comet-seeker, and to provide photometers for visual use with the thirty-six-inch equatorial.

Mr. Walter W. Law, of Scarboro'-on-Hudson, has likewise made a liberal gift towards providing for the publication of the Observatory Atlas of the Moon mentioned in the *Publications*, Volume VIII., page 187. The grateful thanks of the Observatory are offered to these friends, who have made it possible to undertake new work. Edward S. Holden.

Mount Hamilton.

ON LIFTING MONOLITHS.

Dear Science: It is a subject upon which I have frequently thought, but concerning which I have seen nothing written, that all the megalithic and Cyclopean structures of the world were erected at a time or under circumstances that may be called pre-mechanical. Neither in America nor in any other part of the world has the account of the moving of a 'big stone' been written down. There is not a modern machine capable of lifting some of these great stones and herein lies the secret. If you will examine the twine, sennit, cables, ropes of modern savagery, you will at once see that in prehistoric times machinery could not have been utilized in lifting the great monoliths. There was not in all the world, during the periods when the megalithic monuments were being set up a derrick, or chain, or rope, capable of sustaining the weight. In Washington the stone cutters and contractors do not dream of hoisting the big stones that form the bases of monuments, though they are only pebbles compared with those of Teotihuacan or Baalbec. They move them on rollers, by means of crowbars and capstans turned by men or mules or horses, simple enough to have been familiar to the ancients. But even such affairs would be like rags hitched to a stone weighing a hundred tons or more. There is no use in looking for the machinery for the transportation of the megaliths; there was none. Time was the essential factor. A people that could pry up one end of a stone could put a roller under it. If they could move it twenty feet in a day, that would be over a mile in a year. Flotation, cribwork, inclined planes, levers, wedges were the utensils of horizontal and vertical motion. Count Wurmbrand has figured, in Matériaux pour l'histoire primitive et naturelle de l'homme, a company of men in India carrying a menhir upon a framework of wood and bamboo. If two hundred men could get around such a device and each bore two hundred pounds, the total weight could not exceed twenty tons. In studying the history of architecture one is almost justified in thinking that the size of the stone lifted has steadily decreased with the perfecting of lifting devices. Speed is the point aimed at. To fill a given space the modern crane derrick will do the work quicker with small blocks and much cheaper from every point of view than it could be done with a single large block. Without dwelling further upon the economic side, the fact remains that all the megalithic and cyclopean structures of the world were erected by means of the cooperation of human hands, using the simplest mechanical powers and without lifting machines of any kind.

Otis T. Mason.

THE 'KANSAN' GLACIAL BORDER.

To the Editor of Science: I have been extending the delimitation of the 'Kansan' glacial border westward from Lock Haven, Penna., during the past month, and a few of the points noted are of more than ordinary interest.

The first is regarding the possible existence of two glacial lobes from northeast and northwest which met and neutralized one another over the area north from Bradford, Penna., instead of proceeding south along the level valley of the Tunangeawant. A comparison of the 'Wisconsin' border of Lewis & Wright and the 'Kansan' border shows that they approach one another and almost coincide at the New York apex, while they diverge more and more as they extend southward. The 'Kansan' portion of the eastern lobe is lacking in fragments of crystalline rocks, while the same portion of the western lobe carries them. A study of the moraines of recession will easily settle the question thus proposed.

The second is that the 'Kansan' deposits over the Allegheny region bear out the deductions made from a study of similar deposits in eastern Pennsylvania that there has been but one epoch and that of comparative recency. A great deal of discussion has gone on regarding alleged 'high-level gravels' in the Allegheny region. This was on the basis of the 'Wisconsin' border being the extreme limit of ice action. The work of the past month shows that the Allegheny river was completely covered with ice as far south as Franklin (where the work is now being carried on), and all the localities noted by Messrs. Chamberlin, Wright and others along the tributaries to the Allegheny from the north were covered by the Kansan advance and filled with its débris, They were afterwards more or less excavated and filled with later modified Wisconsin material; but immediately and at a moderate interval in the past, as is shown by two facts: the state of the crystallines in the Kansan drift, and the condition of the river gorges.

The writer, several years ago (*Am. Jour. Sci.*), made the statement that the majority of glacial students seemed to have failed to consider the state of the surface immediately before the first glacial advance. He, thereupon, stated that all portions of surface outcrops too hard to be ground into flour would form a rusty gravel, with the rustiness due to previous weathering, and not to lapse of time since deposition. This is fully proved in the Kansan drift in western Pennsylvania, where red granite cobbles have been found on top of the hills east of the Allegheny river, and from four to five hundred feet above it, and these have been glaciated on one or two sides, where the smoothed surface acquires the aspect of 'rusty gravel,' while on other sides the old surface weathering remains undisturbed to such an extent that the rock has lost entirely its black bisilicates, is completely kaolinized and is pulverulent. One side is scraped down to the hard and rusty interior, and the other remains as it lay on the surface when picked up by the ice. In the same way local Pocono and Carbonic sandstones will show a hard glaciated surface and a pulverulent angular surface in the same fragment and in hundreds of instances. These lie in red clay on local white sandstone. With these ancient relics are sparingly mixed river-rolled sandstones and shales as highly polished and as hard as any in the Wisconsin deposits. These are found under conditions which exclude their being residual from local weathered conglomerates, and, as in eastern Pennsylvania, they bear witness to the close association of Kansan and Wisconsin formations.

The best proof, however, lies in the state of the river bottoms. My assistant, Mr. Joseph Barrell, has discovered and studied the abandoned channel, not hitherto noted, of Oil Creek below Petroleum Centre, and will discuss it fully later. I wish to call attention to the importance of his discovery that both the old and the present channels are of equal depth; both are filled with Kansan and modified Wisconsin drift, and the creek has not cut down to its preglacial or Kansan level since the glacial epoch.

As the finding of Kansan drift over the region shows that high and low level gravels could accumulate from the same source, so the discovery of this filled valley, under exactly similar conditions which obtain in the Lehigh region, shows that Kansan and Wisconsin advances, as far as the State of Pennsylvania is concerned, were closely allied and not very remote.

Edward H. Williams, Jr.
Lehigh University, August 3, 1896.

A LARGE LOBSTER.

The subject of the size attained by the lobster has been recently treated by Herrick in his work on the Habits and Development of the American Lobster.

Various exaggerated reports of lobsters weighing 30 to 40 pounds have appeared as newspaper items, but the authenticity of such statements is questionable.

Herrick describes a specimen captured at Boothbay, Me., in 1891, and now in the museum of Adelbert College, which is probably the largest on record which has received accurate measurements.

On April 10, 1896, there was captured near Block Island a fine specimen which closely approaches in size the one described by Herrick. This was entangled in a trawl line in deep water, and so captured. It passed through the hands of Mr. E. C. Smith, a lobster dealer of Newport, R. I., and is now in the possession of Mr. F. W. Wamsley, of Woods Holl. It is destined for the museum of the Academy of Natural Science at Philadelphia.

The specimen is a male, perfect in every respect, and weighed alive slightly over 22 pounds. I have carefully measured it and find that the total length from tip of rostrum to end of telson is 21 inches. The greatest breadth of carapace is $5\frac{1}{2}$ inches, while the girth just behind the cervical groove, from edge of branchiostegite of one side to same position on other side, is $13\frac{5}{8}$ inches. The crushing chela is on the left side. The length of its propodus is 13¼ inches; the girth just proximal to dactyl is 16½ inches. The propodus of cutting claw is somewhat smaller; length 12¾ inches, girth 12¼ inches.

The pleon is 11 inches in length, and the girth of tergum of second segment—spine to spine—is 8⅝ inches.

Apparently this specimen is larger than the one described by Herrick, if we consider only the length. This is due to the perfect rostral spine, which was broken in the Boothbay specimen. If we take the length from base of rostrum to tip of telson—a fair measurement to give an idea of bulk—we find the Block Island specimen is 19 inches, while the one from Boothbay is 19¼ inches.

By taking the average of the differences in measurements of the two specimens, I find that the one described by Herrick is larger by about six per cent.

While therefore this specimen is not the largest on record, its perfect condition warrants its description, as it so nearly approaches the maximum in size of the American lobster so far authentically reported. F. C. WAITE.

HARVARD UNIVERSITY, August 1, 1896.

SCIENTIFIC LITERATURE.

Mars. By PERCIVAL LOWELL. Boston: Houghton, Mifflin & Co. 1895. 8°. Pp. 228+viii; xxiv illustrations.

I am pleased to comply with the Editor's request for a review of Mr. Lowell's interesting book.

The reviewer of a work on organic evolution would find it difficult to avoid mentioning Darwin. Schiaparelli holds a similar place in the literature of Mars. An intelligent criticism of any recent book on Mars must consist largely of a review of Schiaparelli's observations and ideas. Of his predecessors it will be well to mention, for the benefit of non-astronomical readers, the following: (*a*) Galileo (1610), who discovered the phases of the planet, thereby proving that its light, though very red, is really reflected sunlight; (*b*) Huyghens (1659), who first observed marking on the surface; (*c*) Cassini (1666), who determined the length of the Martian day, and discovered the white polar caps; (*d*) Sir William Herschel (1783), who observed the waxing and waning of the polar caps with the seasons; (*e*) Beer and Maedler, who published the first map on the planet's surface features, and discovered at least three of the so-called canals; (*f*) Dawes (1864), whose drawings show a dozen of the canals; and (*g*) Hall (1877), who discovered the two satellites.

Schiaparelli's work extends continuously from 1877 on. It is impossible to do justice to his labors in this article. He extended our knowledge of the planet enormously in nearly every line—in reference to the polar caps, the so-called seas and continents, but especially in reference to the so-called canals, their appearance and disappearance, their doubling, etc. His entire work bears the impress of a scientific spirit *par excellence.* His observations cover the period 1877–92, but his technical results are comprised in a few papers, and a dozen 8vo. pages suffice for a masterly popular exposition of his general results. His brief papers contain at least the suggestion of all the theories recently exploited by popular writers, though he was not concerned with establishing a theory, but rather with ascertaining facts.

Schiaparelli's remarkable observations of the network of straight canals and their doubling were questioned for years, but the confirmation they finally received at Nice and elsewhere largely removed the doubt.

Mr. Lowell's book on Mars is based upon the Flagstaff, Arizona, observations made by himself between May 31 and November 20, 1894, and by Prof. W. H. Pickering and Mr. A. E. Douglass between May, 1894, and April, 1895. Mr. Lowell delivered a lecture under the auspices of the Boston Scientific Society, on May 22, 1894, in which he is reported (*Boston Commonwealth* for May 24, 1894,) to have announced that his observatory—not yet completed—was for the purpose of making "an investigation into the conditions of life in other worlds, including last, but not least their habitability by beings like or unlike man. This is not the chimerical search some may suppose. On the contrary, there is strong reason to believe that we are on the eve of pretty definite discovery in the matter."

Speaking of Schiaparelli's canals on Mars, Mr. Lowell is reported to have said in his lecture, "the most self-evident explanation from the markings [canals] themselves is probably the true one; namely, that in them we are looking upon the result of the work of some sort of intelligent beings. * * * The amazing blue network on Mars hints that one planet besides our own is actually inhabited now. * * * We stand upon the threshold of a knowledge of our closest of kin in the world of space, of the the most important character."

Mr. Lowell went direct from the lecture hall to his observatory in Arizona, and how well his observations established his pre-observational views is told in his book. In outline his conclusion is that there is a scarcity of water on Mars; that the melting of the polar snows is the source of water supply for the planet; that a network of straight canals conducts the water from the poles over the planet; that what we see and call canals are not water, but vegetation along the banks—a suggestion made several years ago by Schiapparelli and by Prof. Pickering; that since the canals are all straight, *i. e.*, run on great circles, and are of uniform width, and in general several of them intersect in one point, then they probably are the handiwork of the Martian inhabitants; that the planet is probably inhabited by highly intelligent beings; and that the irrigation problem is their chief concern.

It will be seen that Mr. Lowell's results agree perfectly with his pre-observational views quoted above; but in justice to him it must be said that he has written vigorously and at length (pp. 158–161) of the dangers of bias on the part of those having preconceived notions, and in numerous paragraphs throughout the book severely criticises those who write on the subject without having made the observations. So I suppose we shall have to forget his remarkable preliminary lecture.

Before examining Mr. Lowell's evidences of intelligent beings on Mars, let us look at his idea of how the world would receive such a discovery. He believes the world would not welcome it. "To be shy of anything resembling himself is part and parcel of man's own individuality. * * * The civilized thinker instinctively turns from the thought of mind other than the one he knows." Various astounding hypotheses "commend themselves to man, if only by such means he may escape the admission of anything approaching his kind. * * * It is simply an instinct like any other, the projection of the instinct of self-preservation."

Here Mr. Lowell is certainly wrong. In my opinion, he has taken the popular side of the most popular scientific question afloat. The world at large is anxious for the discovery of intelligent life on Mars, and every advocate gets an instant and large audience. Scientific men are quite ready to admit the possibility of life wherever the environment is shown to be suitable. While we can safely say that other suns than ours have their planets and some of those planets probably support life, yet only two cases have come under satisfactory observations: the Earth and the Moon. The former is inhabited; we may safely say the latter is not. In size certainly, and in physical condition probably, Mars is somewhat nearer the Moon that the Earth; and while the affirmative side of the question, 'Is Mars inhabited?' will get at least a just hearing, those who advocate that side must prepare the burden of proof.

Speaking of the melting of the northern polar cap of Mars, Schiaparelli wrote in 1892: "From this arises a singular phenomenon which has no analogy upon the Earth. At the melting of the snows, accumulated at that pole during the long night of ten months or more, the liquid mass produced in that operation is diffused around the circumference of the snowy region, converting a large zone of surrounding land into a temporary sea and filling all the lower regions. This produces a gigantic inundation. * * * The white spot of snow is surrounded by a dark zone, which follows its perimeter in its progressive diminution, upon a circumference ever more and more narrow. The outer part of this zone branches out into dark lines, which occupy all the surrounding region, and seem to be distributary canals by which the liquid mass may return to its natural position. This produces in these regions very extensive lakes. * * * This inundation is spread out to a great distance by means of a network of canals, perhaps constituting the principal mechanism (if not the only one) by which water (and with it organic life) may be diffused over the arid surface of the planet; because on Mars it rains very rarely, and perhaps even it does not rain at all. * * * Such a state of things does not cease until the snow, reduced to a minimum area, ceases to melt. Then the breadth of the canals diminishes, the temporary sea disappears, and the yellow region again returns to its former condition. The different phases of these vast phenomena are renewed at each return of the seasons, and we have been able to observe them in all their particulars very easily during the oppositions of 1882, 1884 and 1886, when the planet presented its northern pole to terrestrial spectators. The most natural and most simple interpretation is that to which we have referred, of a great inundation produced by the melting of the snows. * * * We conclude, therefore, that the canals are such in fact, and not only in name. * * * that the lines called canals are truly great furrows or depressions in the surface of the planet, destined for the passage of the liquid mass and constituting for it a true hydrographic system."*

At the 1894 opposition the axis of Mars was tilted so that the region between the south pole and 40° north latitude was presented to terrestrial observers, the north polar region being hidden from sight. Mr. Lowell's observations covered one-fourth of the Martian year, from May 1st to August 1st, Martian time. His book pays special attention to the melting of the south polar cap, and to what he considers to be the train of related phenomena; since around and upon those phenomena he builds his argument for intelligent life on that planet. On May 1st, Martian time, the south cap was "in rapid process of melting. * * * As it melted, a dark band appeared surrounding it on all sides. Except, as I have since learned, at Arequipa, this band has never, I believe, been distinctively noted or commented on before, which is singular, considering how conspicuous it was at Flagstaff." (This last sentence is indeed surprising, as scores of drawings published in 1892 and earlier show this dark band very conspicuously; it is well known to all observers of Mars, and Schiaparelli's description of the same phenomena at the melting of the north polar cap is very familiar.) "As the snows dwindled, the blue band shrunk in width to correspond," and finally, when the cap had entirely disappeared, its encircling dark band had also vanished. Mr. Lowell believes the dark band was water, and that it disappeared by flowing away from the pole towards the equator in canals, circulating through the planet's arid regions. In proof thereof he submits that he has observed a slow wave of dark area to advance equator-ward from the poles; that the canals nearest the south pole grew dark and thereby became visible first; then those nearer the equator; then those at the equator; and finally those north of the equator; in other words, in the order that water flowing from the south pole would reach different parts of the planet.

It will be seen that the Flagstaff observations upon the melting of the south polar cap and the flow of water therefrom are identical with those made (and published) by Schiaparelli in the case of the north polar cap in 1882, 1884 and 1886; but these observations by Schiaparelli are not mentioned in Mr. Lowell's book. The Flagstaff observations in a measure confirm Schiaparelli's general results and extend them to the region of the south pole.

Of the origin of the canal system Schiaparelli writes entertainingly: "Their singular aspect, and their being drawn with absolute geometrical precision, as if they were the work of rule or compass, has led some to see in them the work of intelligent beings, inhabitants of the planet. I am very careful not to combat this theory, which includes nothing impossible. * * * The network formed by these was probably determined in its origin in the geological state of the planet, and has come to be slowly elaborated in the course of centuries. It is not necessary to suppose them the work of intelligent beings; and notwithstanding the almost geometrical appearance of all of their system, we are now inclined to believe them to be produced by the evolution of the planet, just as on the Earth we have the English Channel and the Channel of Mozambique."

Of the gemination of the canals Schiaparelli

*For this and other passages from Schiaparelli's Italian papers I am indebted to Professor Pickering's translation in *Astronomy and Astro-Physics*, 1894.

writes: "In consequence of a rapid process, which certainly lasts at most a few days, or even perhaps only a few hours, * * * a given canal changes its appearance, and is found transformed through all its length into two lines or uniform stripes, more or less parallel to one another, and which run straight and equal with the exact geometrical precision of the rails of a railroad. * * * One of these is often superposed as exactly as possible upon the former line, the other being drawn anew. * * * But it also happens that both the lines may occupy opposite sides of the former canal and be located upon entirely new ground. The distance between the two lines differs in different geminations, and varies from 360 miles and more, down to the smallest limit at which two lines may appear separated in large visual telescopes—less than an interval of 30 miles." Schiaparelli explains that the variations might be the result of "extensive agricultural labor and irrigation upon a large scale. Let us add further that the intervention of intelligent beings might explain the geometrical appearance of the gemination, but it is not at all necessary for such a purpose. The geometry of nature is manifested in many other facts, from which are excluded the idea of any artificial labor whatever. * * * It would be far more easy if we were willing to introduce the forces pertaining to organic nature. Here the field of plausible supposition is immense, being capable of making an infinite number of combinations, capable of satisfying the appearances even with the smallest and simplest means. Changes of vegetation over a vast area * * * may well be rendered visible at such a distance. * * * For us, who know so little of the physical state of Mars and nothing of its organic life, the great liberty of possible supposition renders arbitrary all explanations of this sort, and constitutes the gravest obstacle to the acquisition of well founded notions."

Such, in effect, is all that Schiaparelli has written by way of explanation of his remarkable discoveries, and he who runs may read his scientific mind.

Mr. Lowell's book contains a beautiful map of the portion of Mars lying between 70° south and 40° north latitude (on Mercator's projection). It represents the *ensemble* of the individual sketches made by Messrs. Lowell, Pickering and Douglass at Flagstaff in November, 1894. It contains 183 canals, lying both in the light and dark regions of the planet. Of those lying in the light reddish regions, 63 appear to be identical with those discovered by Schiaparelli and his predecessors, and 72 appear to be new. Mr. Douglass is credited with the discovery of 44 canals in the dark regions of the planet. I infer from Mr. Lowell's book that the canals in the dark regions were not seen and confirmed by either Mr. Lowell or Prof. Pickering, though they were observing Mars at the same time and place. Evidently, then, these observations at Flagstaff were difficult, and Mr. Lowell considers them to be new, though they are not new. In 1892 Prof. Schaeberle observed them, and wrote that "Crossing the darker areas are still darker streaks which often extend hundreds of miles in nearly straight lines. One end of a given streak usually terminates in the equatorial region at a point where the dark area protrudes into the bright area, and the so-called canals seem to be continuations of the streaks" (*Publications* Ast. Soc. Pacific., iv., 197). It was often noticed in 1894 by the writer and other Lick observers that the dark areas on Mars were composed of a mass of details so complex as to defy the draughtsman's skill; but I think Mr. Douglass, at Flagstaff, is the only observer who has verified Prof. Schaeberle's 1892 observations that these markings were arranged in nearly straight lines. If the observations by Messrs. Schaeberle and Douglass are to extend the canal system over the dark areas, just as Schiaparelli's extend them over the bright areas, they constitute a most important advance in Martian work. The recent observations of canals or other details within the dark areas, the recent spectroscopic and polariscopic observations, all strongly oppose the favorite theory that the dark areas are seas, but support the common theory that the bright areas are land.

Mr. Lowell observed a few double canals, probably a fourth as many as Schiaparelli saw.

At the exact point where two or more canals cross each other the observers noticed that there was in nearly every case a dark circular or oval spot acting as the hub from which the canals radiated as spokes. To these swollen junctions Mr. Lowell applies the name 'oases.' A few of these spots were observed by Schiaparelli and others, but the Flagstaff observers have greatly extended the list.

As explained above, Mr. Lowell accepts the suggestion made by Schiaparelli and others that the canals form the planet's hydrographic system; that the changes observed may be due to vegetation, to irrigation on a large scale. He holds that the *visible* canals and the 'oases' are due to vegetation along the lines of the *real* canals; and that the whole system essentially proves, or at least renders it very probable, that Mars is inhabited by a highly intelligent race whose chief concern is irrigation. His argument is made with great skill. Every fact is considered to point in that direction, and every observed phenomenon is considered to be accounted for, though in explaining the mysterious doubling of the canals he admits that "we are here very much in the dark." It is held that the canals being vegetal in character, and watered from the melting snow at the poles, are seasonal, developing in the order of their distance (in time) from the poles, and reach their highest development at or shortly after the time of summer solstice. Such, in fact, is the train of phenomena which Mr. Lowell claims to have observed, starting from the south pole and extending to about 40° north latitude. Schiaparelli observed similar phenomena in the vicinity of the north pole, when that region was in position for observation. His sketches made at or shortly after the northern summer solstice cover the region from the north pole to about 40° south latitude.

Let us examine Mr. Lowell's irrigation scheme. A hydraulic engineer would ask some questions which Mr. Lowell does not discuss in his book. In the southern summer Mr. Lowell has the planet's surface covered with canals running in every direction, from the south pole to at least 43° north latitude; as far as the tilted position of Mars permitted him to see. We do not know but that they extended entirely to the north pole. In the northern summer Schiaparelli's system of canals extended from the north pole southward to 30° south latitude, or further; in fact, as far as the position of the planet permitted him to see. And it is agreed by Mr. Lowell that his principal canals are identical with Schiaparelli's. So we are asked to believe that the equatorial region of Mars, forming a strip at least 70° wide, can be and is irrigated from both the north and south poles; the 'canals' in the two cases of opposite flow being identical! The corresponding problem on the Earth would be to irrigate San Francisco, Chicago, New York, Rome, Tokyo, from the snow melting at the South Pole; and to irrigate Valparaiso, Cape of Good Hope, Australia, from the snow melting at our North Pole: all the irrigated land lying between New York, etc., on the north and the Cape of Good Hope, etc., on the south to be irrigated alike from the North and South Poles. Mr. Lowell ventures no explanation of how this engineering problem is to be worked out, though he states that the canals form a system "precisely counterparting what a system of irrigation would look like; and, lastly, that there is a set of spots placed where we should expect to find the land thus artificially fertilized, and behaving as such constructed 'oases' should."

If the visible canals are due to irrigated vegetation in strips 30 to 60 and more miles wide, traversing the planet's surface in straight lines in every direction, all the canals hundreds and many of them thousands of miles long, from four to ten canals radiating from a common point, intersecting at all angles a great many other canals radiating from other centers, how is the water distributed over this large and complex area? It starts from the polar snows, we are told, and flows thousands of miles to and beyond the torrid zone, spreading in a general way over the whole planet. Do these streams lie in the valleys, or on the slopes and ridges? There is no evidence whatever that the surface is remarkably level. The canals, apparently, do not turn aside for anything. The path of least resistance seems to be unknown.

The crater *Tycho*, on our moon, is the center of a system of markings radiating in all directions in straight lines, hundreds and thousands of miles. They cross hills and valleys with perfect indifference. Because they are straight and radiate from a center, did they have an intelligent personal origin?

Is a seasonal change on Mars evidence of an intelligent population? The virgin forests and prairies of America donned and doffed their annual green suit even better before the advent of man than to-day.

The organic origin of the dark areas on Mars has great advantages, as Schiaparelli said; but the addition of intelligent beings to the hypothesis adds to, rather than removes, the difficulties, and leads to pure speculation. If we attempt an explanation of the irrigation system we can, in our dilemma, only say that the Martians are more intelligent than we are!

The most striking feature of the Flagstaff observations relates to the detection of a large number of canals and 'oases.' It is a question how far these observations have had confirmation, and how far they need it. The observation of 44 canals in the dark areas by Mr. Douglass confirms Prof. Schaeberle's 1892 observations, but they were evidently not seen by Messrs. Lowell and Pickering. Mr. Lowell gives a long list of canals in the bright areas, but it is uncertain whether or not they were seen by more than one observer. His list contains nine canals that were seen on only one occasion; they are drawn on the final map and given names. His list contains one canal that *was not seen at all*, but on *one* occasion was *suspected*; it is put on the map and given a name.

Mr. Lowell accepts the line of reasoning put forth by Proctor and others as to the extent of Mars' atmosphere, viz.: That the mass of terrestrial atmosphere is to the mass of Mars' atmosphere as the mass of the Earth is to the mass of Mars; which leads to the result that the density of the atmosphere at the surface of Mars is about half the density of our atmosphere at the summit of the Himalayas. This is in complete harmony with the Lick spectroscopic results of 1894, which pointed to that density as the maximum limit, but is quite out of harmony with the earlier spectroscopic results.

It is well known that the atmosphere of Mars is practically cloudless. There is some evidence of clouds near the terminator (sunrise and sunset line), and some in favor of occasional small clouds over the portions fully exposed to the sun's light and heat. For two or three weeks in October, 1894, all the surface features were partially obscured and rendered indistinct, as if by general haziness, after which they again became distinct. Mr. Lowell believes that the Flagstaff observers saw several hundred clouds near the terminator, though he makes no use of them in explaining Mars' hydrographic system. They are not needed for irrigation purposes. The atmosphere is supposed to be very rarefied, the polar snows melt, the water in some manner evaporates into the atmosphere to form the polar caps by precipitation the following winter. If snow is precipitated at the cold poles, why should not rain be precipitated in the warmer regions? If the atmosphere is thin and takes up the evaporated water in a clear noon sky, why should not the rarefied atmosphere cool rapidly at night and rain be precipitated, especially in the valleys? If the atmospheric circulation is slow, as it is supposed to be, the visible effects of night rains could well progress from the poles toward the equator, through the valleys, and a delicate system of surface levels would not have to be provided. This is not put forth as a theory of the canal system, except to emphasize the fact that we should give Nature a chance to do this work before we resort to artificial irrigation.

In 1890 there began at Mount Hamilton a new class of observations on Mars, relating to the bright projections on the terminator. Similar observations were made in 1892 and 1894. There is no doubt that they are very important, and great stress was laid on them. There are some arguments in favor of there being clouds, but many more in favor of there being mountains. The observed phenomena are fully explained by supposing a mountain chain to lie across the terminator and to disappear from sight by the planet's diurnal rotation. The observed projections were such as would be produced by the sun shining on the mountain tops outside the terminator, and the observed adjacent depressions were such as would be formed by the shadow of the mountain range lying within the terminator. Concerning the

1894 Flagstaff observations of the terminator by Mr. Douglass, Mr. Lowell writes that "Of the 736 irregularities observed, 694 were not only recorded, but measured. Of these, 403 were depressions. It is singular, in view of their easy visibility, that, with the exception of Schroeter, in the last century, no one should have noticed them before."

Mr. Lowell rejects 346 out of 403 depressions as not real, since they lay on the dark areas of the planet and were due to the smaller irradiation at those places. He holds that the remaining 57 depressions were due to clouds within the terminator, and 291 projections were clouds outside the terminator; because if they were mountains the number of depressions should equal the number of projections. To my mind, the argument is not convincing. If we remove 196 of the projections which are described as 'long and low,' and which some experience in observing them leads me to ascribe to excessive irradiation, we shall have 95 projections and 57 depressions of the 'short and sharp variety.' When we consider that these clouds or mountains (or something else) are immersed in an illuminated atmosphere, we cannot expect the projections and depressions to be equal in number. The problem will not be settled until it is determined whether or not the projections occupy fixed and the same positions at many successive oppositions—the phase and atmospheric conditions being equal.

I confess my inability to unravel Mr. Lowell's discussions of Mr. Douglass' observations. When it was a question of detecting a twilight effect it was the illuminated atmosphere which formed the visible and measurable terminator. When it was a question of proving that Mars was extremely level, and would, therefore, lend itself to general irrigation, it was the land surface that formed the visible terminator; and since this terminator was always "comparatively smooth, * * * we know that, relatively to his size, he has no elevations or depressions on his surface comparable to the lunar peaks and craters." Lastly, the several hundred irregularities observed on the terminator, varying from those extremely high to those very low, were attributed to clouds. The terminator, then, is formed by the illuminated atmosphere and not by the land surface; secondly, there are no significant elevations and depressions on the surface, because the terminator, formed by the land surface, is comparatively smooth; and thirdly, the extensive irregularities on the terminator, which 'may be seen every night,' are due to clouds.

Mr. Lowell writes of the 'long and low' irregularities that the projections averaged $0''.136$ in height; the depressions $0''.125$ in depth. These are the distances from the approximately elliptic arc that would have formed the apparent terminator if the irregularities had not existed. Thus we have the heights of the irregularities from a curve that did not exist given to three decimals of a second of arc! And there is nothing to show that the varying distances of the planet were taken into account, either. Every practical astronomer knows that the *first* decimal place is uncertain; the systematic errors in such cases can easily and generally do exceed a tenth of a second. To say that the results are accurate because they are the mean of a large number of observations is to say that if a stranger to Colorado's clear atmosphere should waken unexpectedly on Pike's Peak and guess the distances to several hundred neighboring peaks, the mean of all the guesses would be very near their average distance.

There is not much demand for mathematical analysis in a popular book on Mars, nor is the application of that little always happy. On pages 133–134, after stating that practically all the canals follow the arcs of great circles, and necessarily appear curved when viewed obliquely, the author writes, "apparent straightness throughout is only possible in comparatively short lines. For a very long arc [of a great circle] upon the surface of a revolving globe tilted toward the observer to appear straight in its entirety it must lie due north and south." This is incorrect. If the apparent center of the planet's disc is at 18° south latitude, which was the average for Mars in 1894, then every arc of every great circle that can be drawn in any direction through any point that lies on the minus 18° circle of latitude will appear straight twice every day. An infinite number of such circles can be drawn. Mr.

Lowell's misconception of the mathematical principles of the 'great circle' is fundamental. Does it render null and void his conclusion that the canals lie on arcs of great circles?

Mr. Lowell found that the surface markings on Mars came to the central meridian about twenty minutes later than the predicted time; a discrepancy, it should be said, to which Prof. Keeler called special attention in 1892.

To what extent Mr. Lowell's future observations will modify his map is uncertain. Drawings of Mars by different observers even on the same night and with the same telescope are proverbially different. So far as the drawings by the three Flagstaff observers have been published, the proverb still seems to be in force.

Mr. Lowell is entitled to great credit for devoting his private means so generously to establishing and conducting an observatory, and for his efforts in search of the best, but imperfect, atmospheric conditions. He is likewise fully aware of the necessity of making the observations continuously and systematically. Whatever advances Mr. Lowell may have made in Martian study, or may make in the future, will be fully accredited to him and warmly welcomed by all astronomers.

Mr. Lowell's book is written in a lively and entertaining style, and is printed and illustrated faultlessly. It is true that the theories advanced are mostly old ones, suggested by Schiaparelli, Pickering and others, many of them having been elaborated by Flammarion and others; but Mr. Lowell has presented them very fully and suggestively. Scientifically, the leading faults of the book are: First, that so elaborate an argument for intelligent life on the planet, embracing a complex system of seasonal changes, should be based upon observations covering only one-fourth of only one Martian year; and, secondly, that there should be so many evidences of apparent lack of familiarity with the literature of the subject.

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Text-book of the Embryology of Invertebrates. By Dr. E. Korschelt and Dr. K. Heider. Translated from the German by Edward L. Mark, Ph. D., and W. Mc. Woodworth, Ph. D., with additions by the authors and translators. Part I.: Porifera, Cnidaria, Ctenophora, Vermes, Enteropneusta, Echinodermata. New York: Macmillan & Co. 8vo. Pp. xv+484. 1895. $4.00.

The first Heft of the special part of Korschelt and Heider's well-known Lehrbuch, of which this is the English translation, appeared in 1890; the second Heft appeared in 1892 and the third in 1893. The three parts together form a volume of some fifteen hundred pages, illustrated by some nine hundred figures. They complete the special part of the work, that which presents the facts of embryology. A general part, to deal with theories and conclusions, is promised.

The first volume of Balfour's Comparative Embryology, dealing with invertebrates, appeared in 1890, and following that, the work of Korschelt and Heider was the first attempt at a 'broad and comprehensive' treatment of the whole field of invertebrate embryology. The book has been for several years in the hands of zoologists all over the world and is recognized as an excellent and indispensable reference book, the only one of its kind since Balfour. The labor involved in reading the special papers dealing with each group of animals treated and in sifting and arranging their results is so enormous, and the work of Korschelt and Heider has been so well done, that the book is likely for many years to remain without a rival. It is too well known to need critical treatment in this place.

The translation under consideration covers the first three hundred and twenty pages of the original. The remaining four-fifths of the book is to be rendered by another translator.

The German has been more freely rendered than in Mark's translation of Hertwig's Text-book of Embryology, and this gives the present book better literary form and makes it easier reading. At the same time the original has been so closely followed that nothing is lost of its meaning. The few instances where the English is not perfectly clear are not likely to confuse anyone who is prepared to read the book. Here are some of them: On p. 17 'differenten' is rendered by differentiated, which does not express the meaning of the original and might mislead a careless reader. On p. 164, the German 'Kreuzweise gestellt' is rendered by 'placed crosswise,' which in English would nearly always be taken to mean 'placed across the long axis of the body,' though it might, in English, mean 'arranged in the form of a cross.' This is the meaning of the German.

On p. 191 the sentence beginning 'The embryo is now surrounded by' would be ambiguous if taken by itself, although it is entirely clear in the original. These instances and other similar ones are scarcely worth calling attention to in a work of such general excellence, and every zoologist has reason to be grateful to the translators for their self-sacrificing task.

The book is something more than a translation since both the authors and the translators have added to it numerous notes, which serve, for the most part, to call attention to the contributions that have appeared since the German editions were printed. These additions will be found particularly valuable to the specialist in directing his attention to the recent literature, but in most cases too brief to be of direct use to the student. The additions are distinguished from the original text by the use of brackets, and following each is an indication of its authorship. The authorship of these additions can be a matter of little interest to the readers of the book, and one could wish that the additions had been expanded and the text rewritten to accommodate them.

The translators have added to the lists of literature appendices, which include the literature which has appeared since the publication of the German edition and constitute a very important addition to the book. In matters of bibliography the papers issuing from the Zoological Laboratory of Harvard University have long been models and these appendices are no exception.

Finally the translators have added excellent indexes, subject and author.

The publishers have done their part of the work satisfactorily, and especially so with reference to the illustrations, most of which it would be difficult to distinguish from the originals.

Jacob Reighard.

Artistic and Scientific Taxidermy and Modelling. A manual of instruction in the methods of preserving and reproducing the correct form of all natural objects, including a chapter on the modelling of foliage. By Montagu Browne. London and New York: Macmillan & Co. 1896. $6.50.

It is something like twenty years since the appearance of Montagu Browne's Practical Taxidermy, a book of some 150 pages, and the present handsome volume of nearly thrice that size may be taken as representing the improvements in the art of taxidermy which the author considers to have taken place during the last twenty-five years. The book opens with a brief review of the origin and progress of taxidermy, next comes a short chapter on tools, and then follows a long and valuable section devoted to formulas for various killing, preservative, modelling and other compounds, most of which have been tested, and many of which have been devised by Mr. Browne. This chapter, which includes notes on the permanency of pigments, will prove most useful to both the amateur and professional preparator, for in it are brought together a host of recipes which, even when printed elsewhere, are scattered far and wide. Here, for example, are to be found many of the methods used in the preparation of the beautiful invertebrates sent out by the Naples Station, and here are formulas for making the gelatin casts which have come so much into vogue of late years. Few, however, will agree with Mr. Browne's wholesale denunciation of arsenic as a preservative, and fewer still will accept in its stead whiting and chloride of lime, much less pepper! Arsenic may be used with too free a hand, and exposure to light and air may go far towards preserving fur and feathers from the attacks of insect pests, but arsenic certainly prevents the ravages of Dermestes, and there is nothing like it for preserving intact ligamentary skeletons and the sterna of mammals. Especially is this true where hundreds of small 'rough skeletons' are of necessity kept in the duplicate series to be worked on as occasion demands.

From the chapter on collecting one infers that those useful articles, the auxiliary barrel and cyclone trap, have not found their way across the Atlantic, but we pass on to the mounting and casting of animals which occupies the body of the book. It may be said here that the personal equation is quite as important a factor in taxidermy as in other matters, and while the author's advice and methods are mainly good there are many points wherein it is impossible to agree with him. Mr. Browne also takes it too much for granted that specimens are to be mounted fresh, whereas the majority of specimens which come under the hand of the taxidermist are dry skins, and only too often very poor dry skins. Hence more detailed instructions for relaxing and cleaning dried skins would have been acceptable. The various groups of vertebrates are treated in order, considerable space naturally being devoted to birds. Here the criticism would be that the advantages of skinning birds through the side are slight, the disadvantages numerous, and we would advise the taxidermist to open and mount his birds by a median cut. Also, we consider that mounting a bird with the entire skeleton inside is a great waste of valuable time; we have seen it tried, and the result did not justify the time and labor expended. In fact, the quality of the finished work depends not so much on the mechanical devices employed as on the artistic eye and skilled hand of the workman. The good taxidermist, any more than the artist, needs not to build upon a skeleton, although a knowledge of anatomy is indispensable to each.

The method of mounting mammals over paper casts is dwelt on with veritable enthusiasm, and although we have never seen it practiced, it would seem to be a most excellent plan for obtaining light and accurate specimens. The paper cast is certainly most admirable for copying cetaceans and large fishes, but the reader will not find it so simple in practice as it seems in theory, particularly if undertaken in a damp climate. Also it needs as much skill in this mode of mounting as in any other to avoid stiffness in posing.

The greater portion of the book, after the chapter on birds, is given over to describing various methods of moulding, casting or modelling fishes, reptiles, batrachians and invertebrates, and to the making of accessories, such as flowers, leaves and rockwork. This, supplemented by the recipes noted in the beginning, contains some of the most valuable information in the book, and will well repay study, since it treats of extremely useful technical processes which usually have to be learned from some expert. It is a pity, however, that in treating of flowers the reader is not told where he can obtain the oft-mentioned 'Mintorn fabric,' or, failing in this, advised to procure waxed cloth from some dealer in artificial plants, or in the materials for making them.

Finally, there is a very full bibliography of taxidermy, and last, but not least, an index.

From what has been said it will be rightly inferred that the value of this book lies not so much in the portion devoted to taxidermy proper as in that treating of other and related subjects; it can not supersede such a work as Hornaday's Taxidermy, but it is nevertheless indispensable to the preparator for its merits in other lines.

It may not be out of place to say that, to a great extent, the pages of this book reflect the changes that have taken place in museums during the past few years. The time was when the museum of natural history was almost wholly for the scholar, the cultivation of the public being quite a secondary consideration. Birds and mammals were represented by more or less poorly stuffed specimens, and anything of a pictorial nature, or even the replacement of colors or of soft parts, was religiously tabooed. Now it is recognized that at least one of the objects of a public museum is to give the public glimpses of living creatures as they really appear, and it is admitted that it is better to replace such appendages as combs and wattles, or even to obscure the scales of a bird's foot with paint, than to show the public dried, distorted and dingy effigies. The visitor does not care to count the scales on a snake's back nor the rays of a fish's fin, but he does wish to know how the living snake looks and in the gorgeous but evanescent colors in which so many fishes are decked. The shrivelled, faded and often imperfect spirit specimen may furnish taxonomic facts to the naturalist, but the public should have something else.

F. A. Lucas.

U. S. National Museum.

② SCIENCE

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*A COMPLETED CHAPTER IN THE HISTORY OF THE ATOMIC THEORY.**

THE great discovery of the law of gravitation was left reasonably complete by its author. The explanation of this fact is obvious. No other force of sensible magnitude complicates the action of gravitation; its law appeals to simple geometrical relations; and the facts had been well observed and reduced to order. Accordingly, by a few numerical comparisons of the hypothesis with the facts, Newton established the truth of his conjecture, so that it has been generally accepted as a law of nature. The first suggestion of the theory was quickly followed by its final triumph.

Very different has been the history of the discovery which most chemists regard as next in importance to that of Newton. The discovery that matter consists of an aggregation of infinitesimal units or individuals was made by Dalton; but the first suggestion of this kind had been made at least twenty-two centuries before Dalton. Leucippus and Democritus were the earliest recorded believers in this doctrine; Epicurus adopted it; Lucretius expounded it in strains of noble eloquence. But all the early suggestions were quite barren and unfruitful for the advancement of science, for no one before the present century was in a position to make any verifiable hypothesis; and science grows by means of hypotheses so closely in touch with facts as to be verifiable. In later times, Leibnitz accepted the notion of a certain kind of atomic structure of matter; Newton accepted, and reasoned soundly upon, a view which Dalton recognized as akin to his own. Kant

* Address by the retiring President of the American Association for the Advancement of Science at the Buffalo Meeting.

seems to have adopted the contrary opinion, and to have believed that matter is infinitely divisible. But Bernouilli made the conjecture, which has since been verified, that a given volume of gas consists of a very large number of very small discrete particles, which we now call molecules; and Higgins, an English chemist, a contemporary of Dalton, was the first to apply the notion of atoms to the explanation of chemical phenomena, although he did not think clearly in regard to the weight of atoms, and so formed no useful hypothesis. Accordingly the net result of twenty-two centuries of thought on this subject was to form a conception of a possible structure of matter, without imagining any way of establishing the truth or error of this conception, or even of gaining any evidence whatever in regard to it. But, if any are inclined to visit this failure with reproach, it is interesting to notice that the first man who was aware of the quantitative relations which are adapted to throw light on the matter did not fail to make the most full and complete use of this knowledge.

Dalton, and not the ancients, ought to be regarded as the discoverer of the atomic structure of matter, because he invented a hypothesis, involving such a structure, which was capable of being so compared with facts as to be proved or contradicted; because he actually began such a comparison of the hypothesis with the facts; and because all the evidence from facts, varied as it has since become, supports the hypothesis substantially in the form which he gave it. He who suggests that a certain benefit is desirable, or who conjectures that it is possible, shall not fail of due credit; but he who *confers* the benefit will receive the credit due the benefactor.

Since Dalton's discovery, much has been done to confirm and enlarge our knowledge of the atomic structure of matter. New evidence has been acquired in favor of it, because the theory has been ready to extend over whole realms of facts of a kind unknown to Dalton, to explain them, to facilitate their study; and also ready to predict facts, unknown till they were sought in consequence of the prediction, but found when they were sought.

The history of the atomic theory for ninety years would fall into several distinct chapters. One of these chapters, not the least interesting of them, would tell of a very large amount of work, some of it of consummate accuracy, of which the object was to attain some knowledge of the nature or construction of atoms. Since the last meeting of our Association in this city, work has been accomplished which, if I rightly judge, has ended this particular chapter. That the chapter may at some future time be resumed is, of course, not absolutely impossible; but for the present it has come to a definite close. My own interest in the matter suggests, and the coincidence in time now mentioned perhaps justifies, my selection of this completed chapter in the history of the atomic theory as the subject of the address which our constitution requires of me this evening.

This chapter naturally concerns more intimately the members of the sections of Physics and Chemistry. To these I can hardly hope to say anything not already well known to them; but members of other sections may, perhaps, not be entirely uninterested in an account of the conclusions reached.

Dalton's theory was founded on three facts. These facts are often called Dalton's laws; one of them, because he discovered it; the others because he first recognized their important relations to chemical theory. One of these is the law of definite proportions: in any chemical compound, the ratio of the components is constant, is invariable, is definite. This truth had been recognized by others; it was finally established as a result of the discussion between Berthollet and Proust, a discussion well worth recalling for the dignified courtesy and simple love for truth shown by both the disputants. A second of these laws of Dalton is the law of equivalent proportions: if two elements, which combine with each other, combine also with a third, then the ratio in which they combine with each other (or a simple multiple of it) is also the ratio of the quantities of those which combine with the same quantity of the third. That this was true, at least in some cases, was known before Dalton. The third law is the law of multiple proportions: if two bodies combine in more than one ratio, those ratios are simple multiples of each other. This truth was discovered by Dalton.

These three laws are statements of *facts*. Careful and multiplied experiments have convinced us that, if these statements are not rigorously exact, their deviation from accuracy is less than the accidental errors of the best experiments used to test them.

Perhaps it is worth while to delay for a moment, in order to state to what degree of precision such experiments have been brought. The degree of precision with which any supposed law can be verified depends on the skill of the investigator, on the instrumental equipment available, and on the conditions of the problem. Often the conditions of the problem impose very stringent limitations on the precision of our experiments. For instance, the truth known as Ohm's law has been verified, in the case of metallic conductors, to one part in a million millions; but in the case of liquid conductors, the conditions are such that the precision attainable so far has been only a millionth as much. Huyghens' law, relating to double refraction, has been verified to one part in half a million, and there seems to be no possibility of attaining any considerable increase in the precision of the observations. These are examples of the very highest degree of precision which has been secured in the verification of supposed laws of nature.

The precision which can be attained in chemical analysis, even of the most elaborate kind, is much less than in the cases just mentioned. The determination of atomic weights is the chemical process in which the highest degree of precision is demanded. If we denote the precision of such determination by the words 'good,' 'excellent,' 'admirable,' 'consummate,' then we may fairly say that in a good series of determinations the average difference from the mean of all will be less than one thousandth part of the ratio sought; in an excellent series, less than one three-thousandth part; in an admirable series, less than one ten-thousandth part; and in a consummate series, less than one fifty-thousandth part.

Now the work of Stas was all admirable in precision, and much of it was consummate, and he made experiments expressly intended to verify the law of definite proportions. The average error in this series of experiments was not more than one part in thirty thousand; and his result was, that, if the composition of the compounds examined is not rigorously constant, the variations are too small to be detected. The law of equivalent proportions was verified with the same degree of precision; the accuracy of the law of multiple proportions has been thought to be deducible from the truth of the two other laws.

To some such degree of precision, then, Dalton's laws are the expression of facts. With these facts for a guide, and with no theory founded on the facts and explaining the facts, all chemical computations could be made, and chemical formulæ could be established. And, if a theory should be devised, and accepted, and finally overthrown, these facts would remain, unchanged for our perpetual guidance. Some of Dalton's contemporaries accepted the facts as a sufficient guide, and refused to burden them with the weight of the theory. Some were engrossed, for the time, in following out practical consequences of the facts; some distrusted conclusions supported by but a single line of evidence; some, perhaps, distrusted the capacities of the human mind. But the facts were accepted.

All scientific men, all sensible men, have a great respect for facts. Perhaps one cannot have too great a respect for facts; but his respect may be wrongly directed. Facts are often very interesting in themselves; they often have an important relation to human welfare; their discovery is often a great intellectual triumph; and we may regard them as the miser regards his gold, forgetting that the most precious use of facts is to help us to see beyond them. Facts are evidence; but we seek a verdict. Facts are a telescope; we desire enlargement of vision, further insight into nature. Facts are openings which we laboriously hew in the walls which shut us in; they cost enough to be valuable, but their real value is in that which they promise or disclose. Facts are a foundation for our building; the structure must rigorously respect the lines of the foundation; but it is a pity to believe that the basement walls are the chief beauty desired by the architect or owner. As Tyndall phrased it in a lecture at Manchester, "Out of experience in science, there always grows something finer than mere experience. Experience, in fact, only furnishes the soil for plants of higher growth."

In the present case the soil was fertile, the finer growth has been rapid and vigorous. Dalton inferred that chemical elements consist of very small units or individuals; that all the units or individuals of any given element are equal in weight; and that combination takes place by the grouping together of different units or individuals. This is Dalton's atomic theory.

In Dalton's time there was no fact opposed to this novel conclusion; but there was no second set of facts to support it. The progress of chemistry depended on making due use of Dalton's three laws, and they were quickly and generally accepted; but whether the hypothetical chemical units or individuals actually exist or not, although a most interesting question, did not press for instant decision. Most chemists regarded with favor the idea of the actual existence of the chemical units or individuals. Dalton called them atoms, and perhaps the name brought misfortune; for many thought that the new theory was, that matter is made up of units or individuals which cannot be divided by any possible force. The word 'atom,' the word 'indivisible,' like the word 'individual,' properly mean that which is not divided in the phenomena considered. An absolutely indivisible atom, like an irresistible wave or an immovable rock, can be spoken of to puzzle children, but for adults, as Clifford said, "If there is anything which cannot be divided, we cannot know it, because we know nothing about possibilities or impossibilities; only about what has or has not taken place." I judge that many, probably most chemists and physicists understand the word atom correctly; many others understand it to mean that which cannot be divided by any possible force, and so misunderstand it. For instance, the author of the 'History of the Inductive Sciences' failed to understand the word as chemists and physicists understand it, and so supposed that he rejected the atomic theory. Many chemists would reject the theory that matter consists of very small units which *cannot* be divided. I suppose that very nearly all believe that matter is made up of small units which are not divided in any chemical or physical change yet observed. This is the atomic theory of Dalton.

A few years after Dalton had formed the

atomic theory, and had obtained the first experimental evidence on a matter which had enlisted attention for more than two thousand years, Davy showed, by brilliant experiments, that certain bodies were compounds, although they had resisted all previous attempts to decompose them. Since the first use of electricity had so important results, men were ready to suspect that even supposed elements might ultimately prove to be compounds. It was therefore in a congenial soil that Prout's hypothesis took root. Trusting to experiments of not much accuracy, Prout suggested, in the year 1815, that probably the atomic weights of other elements were divisible, without remainder, by the atomic weights of hydrogen; or, in other words, that they are whole numbers, if the atomic weight of hydrogen be taken as unity.

The new suggestion was most attractive, for two reasons: On the one hand, the truth of the new suggestion would lead to a very great practical advantage. The labor of determining atomic weights would be immensely simplified and lessened if we could know beforehand that the numbers to be found were integers. And, on the other hand, the new suggestion, if approved, would promise a most interesting and valuable hint as to the nature of matter and the structure of atoms. If, for instance, the atoms of carbon and nitrogen and oxygen weigh precisely as much as twelve and fourteen and sixteen atoms of hydrogen, then it is a very plausible hypothesis that each of these atoms is really composed of the material of twelve and fourteen and sixteen atoms of hydrogen, compacted into a new atom. Davy had led many to suspect that perhaps some atoms might be compound, and the new suggestion, looking in the same direction, was received with favor by many, among whom were great discoverers, and great experimenters, and great teachers of chemistry. In England, where Davy and Prout both lived, Thomson had great influence. It was Thomson who, in the *Journal of Chemistry*, of which he was the editor, first announced Dalton's discovery. Thomson wrote the history of chemistry. Thomson's 'System of Chemistry' was thought worthy of translation into French at a time when French was the mother tongue of chemistry. And Thomson accepted Prout's hypothesis as probably true. But Turner made more accurate and more numerous determinations of atomic weights than any other English chemist; and he rejected Prout's hypothesis. Berzelius, the great Swedish chemist, whose determinations of the atomic weights of all the elements then known were regarded with so much admiration by all chemists, pronounced Prout's hypothesis a pure illusion. But Dumas, than whom none in France stood higher, whose opinion had great weight on account of the excellence of his many determinations of atomic weights, accepted Prout's hypothesis with a slight modification, and believed that his experiments had established its truth. Stas, the distinguished pupil of Dumas, began his work with a bias in favor of the hypothesis; but when his first series of admirable determinations of atomic weights was published, he pronounced the hypothesis a pure illusion, entirely irreconcilable with the numerical results of experiment. But Mallet, who has made several excellent determinations of atomic weights, and Clarke, who has recomputed and reduced to order all the published determinations, declared themselves forced to give Prout's hypothesis a most respectful consideration. It is obvious, then, that ten years ago it was not finally settled whether the hypothesis was or was not true.

The hypothesis, then, has disappointed our hopes of any practical advantage in conducting to a knowledge of the exact value of any atomic weight. But nevertheless the hypothesis has not been neglected. As was said, if it is true, we may expect from it new insight into the nature of atoms. Accordingly, an immense amount of labor has been expended in attempting to determine whether the atomic weights of certain elements are or are not divisible without remainder by the atomic weight of hydrogen. Now since our last meeting in this city results have been attained which show that further effort in this direction is not justified by the hope of any theoretic advantage. The chapter has come to an end. Prout's hypothesis cannot be proved by experiment.

When we attempt to decide by experiment whether Prout's hypothesis is true, the nature of the problem, and the limitations of our present knowledge and of our available manipulative skill, impose three conditions to which we must conform.

In the first place, we can more readily test the correctness of Prout's hypothesis by determinations of the smaller atomic weights. The reason is obvious. All analytical work is affected with some accidental error or uncertainty. When Herschel wrote his admirable 'Discourse on the Study of Natural Philosophy' he said that it was doubtful whether we could depend on the result of a chemical analysis as having an uncertainty less than one part in four hundred. Work of much greater accuracy has been done since this statement was made; but, for the moment, let us assume that, even now, the uncertainty of a determination of an atomic weight is a four-hundredth part. This uncertainty affects a large atomic weight much more unfavorably for our purpose than it affects a small atomic weight. For instance, Stas found the atomic weight of lead to be 206.91, if we take the atomic weight of oxygen as 16.00. The assumed uncertainty, one four-hundredth part of this, is 0.53 ; so that, on our assumption, the true value is somewhere between 206.38 and 207.44. These numbers differ more than a unit; no one has a right, on this showing, to assert that true value is the whole number 207.00, nor that it is not so.

But a small atomic weight may be much less unfavorably affected by the same proportionate uncertainty. For instance, recent determinations show that the atomic weight is 15.88 when the atomic weight of hydrogen is taken as unity. The assumed uncertainty, one four-hundredth part of this, is 0.04; so that, on our assumption, the true value is between the limits 15.84 and 15.92. These numbers differ by only one twelfth of a unit; and both of them differ much from the nearest whole number, 16.00. It is, therefore, by determinations of small atomic weights that we may hope to decide the truth of Prout's hypothesis.

But among the smaller atomic weights, some, in the present state of our knowledge, can be more accurately determined than others. Accordingly a second condition imposed on us by the limitations of our knowledge is that we must determine, with what precision we can, those small atomic weights which admit of the maximum of precision. There are eight atomic weights upon which, with the experimental data now available, the decision of the matter may be fairly made to depend. These elements are lithium, carbon, nitrogen, oxygen, sodium, sulphur, chlorine and potassium; the atomic weights are, in round numbers, 7, 12, 14, 16, 23, 32, 35.50 and 39. If numerous and careful experiments show that these atomic weights are whole numbers Prout's hypothesis has a solid basis in fact; if seven are whole numbers and the other is 35.50, then Dumas's modified statement of the hypothesis has a solid basis in fact, for 35.50 is divisible without a remainder by *half* the atomic weight of hydrogen.

One more condition is imposed on us by the limitations of our knowledge and manipulative skill. Our experiments determine most atomic weights, not with reference to hydrogen, but with reference to oxygen. Experiment, for instance, does not determine directly that the atomic weight of lithium is seven times that of hydrogen, but that it is seven sixteenths that of oxygen. If the atomic weight of oxygen is uncertain, the atomic weights of the other seven elements, with reference to hydrogen, are all uncertain in the same proportion, although with reference to oxygen they are now determined with very small uncertainty. Accordingly the third condition imposed on us in attempting to learn the truth about Prout's hypothesis is that the atomic weight of oxygen must be well determined.

It may be remarked that it would be a great gain, as all chemists will see, if several other atomic weights could be determined by direct comparison with hydrogen, provided the precision attainable was of the degree which I have called admirable, or even excellent. Now, methods have been devised by which the atomic weights of lithium, sodium and potassium, as well as of several other metals, could be referred directly to hydrogen, by experiments which present no great difficulty and which are capable of the required precision. Further, a method has been devised by which the atomic weight of chlorine can be determined with direct reference to hydrogen, by experiments capable of the required degree of precision, but involving considerable difficulty in manipulation. But, until some such methods shall have been employed by some one, we must be content with the inferences which can be drawn from data of the kind now available, which depend on our knowledge of the atomic weight of oxygen as the corner stone of the system.

Our knowledge of the atomic weight of oxygen ten years ago depended largely on the experiments of Dumas. His results differed from the whole number 16.00 by one four-hundredth part; he himself judged that the uncertainty remaining might be one two-hundreth part. If we accept this estimate of uncertainty, we may say that he proved that the atomic weight of oxygen is included between the limits 15.88 and 16.04. No one could assert that the true number is, or that it is not, the whole number 16.00. A proportionate uncertainty, therefore, existed in the other seven atomic weights just mentioned. Accordingly, ten years ago we could not well discuss the question whether these atomic weights were divisible, without remainder, by the atomic weight of hydrogen.

The atomic weight of oxygen is, accordingly, doubly important for our purpose. The atomic weight is a small one, well adapted to aid in the solution; and, further, many other atomic weights, also well adapted to aid in the solution, depend on a prior knowledge of this constant. It is for this twofold reason that the work done since our last meeting at Buffalo is important and interesting. The members of this Association have not failed to take upon themselves a fair proportion of the considerable labor involved.

Since that time not less than ten or eleven independent determinations of the atomic weight of oxygen have been successfully concluded.

Cooke and Richards were the first to complete and publish their result; they used a new and ingenious process. Keiser was next; he employed a method for weighing hydrogen which he had independently invented (though it had been previously invented elsewhere) which is the best yet used. In both these series of experiments the hydrogen was combined with oxygen by manipulation something like that of Dumas; but the improvement which permitted the direct weighing of the hydrogen made the essence of the process novel. Then Noyes devised a new method of weighing hydrogen directly, and a new manipulation for combining it with oxygen, and carried out the process in an apparatus having the advantage of great simplicity. Further, since our last meeting the Smithsonian Institution has published a work containing three series of determinations of the value in question.

In England, Lord Rayleigh used another novel method of combining oxygen and hydrogen, in which he weighed both elements in the form of gas. He also made two series of determinations of the ratio of the densities of the gases. Scott determined the ratio of the volumes of the gases which combine, in several series of experiments of great accuracy. Dittmar and Henderson rendered an important service by repeating, with many modifications, the experiments of Dumas; with the advantage which the later experimenter commonly has over the earlier, they were able to secure a much higher degree of precision and to eliminate the sources of constant error which Dumas detected too late.

In France, Leduc repeated the experiments of Dumas and also determined the ratio of the densities of the two gases.

In Denmark, Thomsen has applied a different process, in which the atomic weight of a given metal is compared with those of oxygen and of hydrogen successively.

We have, then, eleven series of determinations of the atomic weight of oxygen. One of these, for reasons which, so far, are chiefly matter of conjecture, differs much from the mean of all the others. These other ten are concordant; they differ, on the average, only one part in twenty-two hundred from their mean, and the greatest difference from the mean is about one part in a thousand.

Since these experiments have been made by different processes, by different men, under varied conditions, and since the greatest difference from the mean of the whole is only one part in a thousand, it is probable that the mean of all differs from the truth by much less than one part in a thousand. The errors of our experiments are of two kinds—accidental and systematic. If we shoot a hundred times at a mark, about half of our shots fall a little to the right and about half a little to the left. These are accidental errors; accidental errors are lessened as our manipulation improves, and they but slightly affect our final mean. Systematic errors affect all our results in the same direction. Suppose we fire a hundred shots at a target one thousand yards distant, not examining the target, till the shots are all fired. If, now, the sights of our rifle were set for five hundred yards, all our shots would strike too low. This is a systematic error; systematic errors diminish as our knowledge increases.

Accidental errors can be rendered harmless by taking the mean of numerous determinations made by the same method. But systematic errors must be detected and avoided. That they have been detected and avoided in any given case can never be definitely known; it can, at best, be presumed from the fact that experiments by different methods give the same result.

As to the atomic weight of oxygen, accidental errors have now been fairly eliminated, and we can make definite numerical statements on this point. If each of the ten sets of experiments were to be repeated, with the same skill and knowledge, there is not one chance in a thousand that the new mean would differ from the present mean by as much as one part in sixteen thousand. Again, if ten new sets of experiments were to be made by new methods and new experimenters, there is not one chance in a thousand that the new mean would differ from the present mean by as much as one part in twenty-five hundred.

As to possible systematic errors, modesty in statement is incumbent upon all scientific men. But we have now ten independent results in which the difference from the mean is at most only one part in one thousand. We may then fairly assume that the systematic error of the mean is less than one part in one thousand. Again, we have lately been able to take one step in advance, which throws needed light on precisely this point. It has been found possible to weigh some hydrogen, to weigh the requisite oxygen, and to weigh the water which they produce. If, now, there were some undetected systematic error in weighing either one of these three substances, occasioned, for instance, by some impurity remaining undetected in one of them, the sum of the weights of the hydrogen and oxygen would differ from the weight of the water produced. If a pound of sugar and a pound of water produce only one pound and three quarters of syrup, there was a quarter of a pound of sand in the sugar. Now it has, I think, been proved that, if the sum of the weights of the hydrogen and the oxygen is not precisely equal to the weight of the water produced, the difference is too small to be detected, and cannot be more than one part in twenty-five thousand. If there really were a difference of this amount, and, further, if this difference were due to an error at the precise point where it would be the most mischievous, it would render the atomic weight of oxygen uncertain by one part in about twenty-eight hundred.

Taking into account the presumption from the concordance of the results of different experimenters and the presumption from the agreement just mentioned, I think we are justified in assuming that the remaining systematic error is not more than one part in sixteen hundred, and that it probably is not more than one part in three thousand.

If this is a reasonable assumption, the net results of the experiments made in Denmark, France, Great Britain and the United States is that the atomic weight of oxygen is between 15.87 and 15.89, and that probably it is between 15.875 and 15.885. By no stretch can we imagine that the truth lies in the whole number 16.00, nor in the even fraction 15.50. We cannot sanely believe it to lie in the number 15.75, having modified Prout's hypothesis into the new statement that all atomic weights are divisible, without remainder, by one *quarter* of the atomic weight of hydrogen. It will be obvious that, if we are still resolved to accept some form of the attractive illusion, we must assume that the true divisor is as small as one eighth of the atomic weight of hydrogen, for the value $15\frac{7}{8}$ is included within the limits given.

Then there is one small and well determined atomic weight which utterly refuses to support Prout's hypothesis or any modification yet stated by believers in the hypothesis. Further, now that the atomic weight of oxygen is well established, we can compare, with hydrogen taken as unity, the seven other small and well determined atomic weights which have been mentioned.* We see that every value differs from an integer; for lithium, nitrogen and potassium the difference is about one part in two hundred thirty; for sodium, sulphur and chlorine, about one part in one hundred eighty; for carbon and oxygen, about one part in one hundred thirty. On the average, these values, which are the best determined in chemistry, differ from whole numbers by about one part in one hundred eighty. There is less than one chance in a thousand that these numbers can possibly be so much in error. These are the numbers best fitted to test Prout's hypothesis, and their evidence against it is decisive.

* The values are as follows: Li=6.97, C=11.91, N=13.94, O=15.88, Na=22.87, S=31.83, Cl=35.19, K=38.84.

It ought to be added that the evidence against Prout's hypothesis seemed to many to be decisive, even without the knowledge of the atomic weight of oxygen which has recently been acquired. But the evidence can now be stated in a much more direct and simple manner; and it has gained in force, for to the seven fit instances at hand before there is added an eighth, which happens to be the most weighty of the whole.

In order to present the evidence against Prout's hypothesis when we lack an accurate knowledge of the atomic weight of oxygen, we have first to assume this value. We may, for one trial, assume that this value is the whole number 16.00, which is required by Prout's hypothesis, and see whether, on this assumption, the other seven atomic weights in question are very nearly such as the hypothesis requires.* But the average deviation from the numbers required by the hypothesis is one part in five hundred, and one deviation amounts to more than one part in three hundred. We may make another trial by assuming for oxygen, not the whole number 16.00, but that value which shall make the sum of all the deviations the least possible; and we may also take one quarter of the atomic weight of hydrogen as our divisor.† But the average deviations from the numbers required by the theory is, even in this case, one part in six hundred and the atomic weight of that element for which the determinations of friends of the hypothesis agree with those of its opponents to one part in thirty-five hundred, is supposed, after all, to be in error by one part in five hundred. The atomic weight of oxygen, computed expressly to give every possible advantage to the hypothesis, differs from the whole number required by the theory by one part in two hundred fifty.

We read in our school books of the bed of Procrustes, to which the tyrant fitted his compulsory lodgers; if they were too short he stretched them on the rack; if they were too long he lopped off the superfluous length. This fable was really a prophetic vision; the bed is Prout's hypothesis; our friends who admire it want to stretch the most unyielding quantities, and to lop off numbers which have been determined with the greatest precision. Either the experiments are in error by an amount which seems incredible, or the hypothesis is an illusion. If the supporters of the hypothesis would avoid the conclusion they must supply better determinations, or they must detect real and tangible sources of error in those already made.

The hypothesis was most interesting and attractive; it promised, if sustained by experimental evidence, to give the means of such insight into the nature of the matter and into the intimate structure of the atoms that it was well worth all the attention which has been given to it. That it should fail of support, that its promises could not be kept, is a matter of regret; but it is time to recognize that our hopes are quite cut off. That other elements are composed of the same substance as hydrogen may or may not be true, but we have now no hope of proving it by determinations of atomic weight. It would not be difficult, perhaps, to modify Prout's hypothesis again and again, so as to to bring it into some accord with the facts. We may imagine, if we will, that the observed numbers, if determined without error, would all be divisible by the eighth part of the atomic weight of hydrogen, or the ninth, or the tenth, or by some smaller fraction. But such a hypothesis is of no interest and of no utility, be-

* The values on this assumption are as follows: Li=7.02, C=12.00, N=14.04, O=16.00 (assumed), Na=23.07, S=32.04, Cl=35.46, K=39.14.

† The values are as follows: Li=7.00, C=11.96, N=13.99, O=15.94, Na=22.96, S=31.96, Cl=35.33, K=39.00.

cause it is incapable of proof or disproof by experiment. The reason is obvious. If we suppose that all atomic weights are divisible by one tenth of the atomic weight of hydrogen, then, in case the theory is erroneous, the average deviation of the actual atomic weights from those required by the theory is only the fortieth of the unit. The man who supports a theory which has no physical basis would assert that all such ascertained deviations were due to errors of experiment. Others would reply that you cannot prove that a man is a good marksman by crowding the targets so near each other that not even his random shots can miss them all. But his backers might make so uncritical a claim.

No, Prout's hypothesis, if subdivided far enough, may be true for all which can be proved with the balance; but in such new form it is of no use and of no interest, for it cannot be proved so as to become a safe basis for further inference. In its present form there is no root of truth in it.

So far I have argued that Prout's hypothesis is not true as heretofore enunciated, and that, if some further modification of it is true, we cannot know it. This conclusion has been sustained by the evidence of the chemist's balance. A conclusion supported by a single kind of evidence may command the confidence of one who has been long familiar with the evidence and who has become capable of weighing it. But for others the concurrence of evidence of different kinds rightly adds greatly to its cogency. In this case there is such concurrent evidence. There is other proof that the atoms of some well studied elements are not *additive* structures. Let me briefly describe the nature of this evidence.

When certain elements are volatilized in a colorless gas flame, or in the electric arc, their molecules are made to vibrate, so as to produce light. By the study of this light we can in time learn much of the nature of the vibrating system. The observed facts are gradually reducing to order, and one result is very striking. In the case of three closely similar elements before mentioned, lithium, sodium and potassium, the complexity of vibration is precisely similar in all, and the numerical relations among the component vibrations are precisely similar in all. Therefore we are compelled to assume that the complexity of structure is the same in all, and that the relations of the component parts, and of the forces acting between them, are the same in all. To illustrate the nature of the argument: the complexity of vibration and the numerical relations among the component vibrations in the case of a large church bell are precisely similar to those in the case of a bell only one third as large. Then, even without the direct evidence of other senses, we must presume that the two bells are similar structures, having similar parts, similarly related. We cannot believe that the larger bell is made of a small bell loaded with weights, nor of three small bells bound closely together. The larger and the smaller are of the same order. The larger is not made of more *parts* than the smaller; it is made of more *metal*. So with the atoms of these three elements; the larger are not made up by the addition of parts which preserve their identity and remain undivided. But all we know of chemical combination relates to structures which are made by the addition of parts which preserve their identity and remain undivided. Then Prout's hypothesis assumes an analogy which does not exist; and deductions from an imaginary analogy will themselves differ from the truth, much as fairy tales differ from history.

There are still other sources of evidence drawn from the specific heats of the elements; the evidence is of the same kind and leads to the same conclusion, but I simply allude to it.

It seems to me, then, that the exact quantitative similarity of the spectra of these elements shows that they are not compounds one of another, subject to the great chemical law of the addition of undivided parts; and that also the magnitudes of the small and well determined atomic weights differ from the values hitherto suggested by applying the law of the addition of undivided parts, and differ by five, ten and fifteen times the greatest experimental error we can reasonably assume.

So the citadel which defends the secret of the atom cannot be taken by way of Prout's hypothesis. We have carried on the assault for eighty years, and we are now satisfied that the way is blocked; we tried to breach, not a wall, but the solid mountain itself. We shall doubtless learn the structure of the atom, but we cannot learn it in the way we hoped. This chapter in our study of the nature of atoms has been fully ended.

If Prout's hypothesis cannot serve us you will doubtless ask what other ways are open by which we may learn something of the structure of atoms. To answer is difficult; to answer adequately is impossible. Perhaps I may mention four lines in which it has been hoped by some that the desired advance could be made, and may indicate what it is reasonable to expect of each.

One of these indications of a possible source of knowledge as to the structure of atoms was suggested by certain chemical observations on some of the rare earths. My brief explanation will not do justice to the conception of the eminent chemist who investigated the phenomena. As I have said, the atom is something which, as a matter of fact, remains undivided in all chemical changes. Most atoms seem to resist every force which we can apply. But it is possible that the amount of resistance which they can offer may vary greatly; it may be that in the case of some elements the resistance is such that in some reactions the atoms remain undivided, and not in others. From the study of such cases, if there are such, we might expect much help. Now, in the case of the common and well studied elements, the occurrence of such cases has not been suspected; but some of the rarer elements, examined by a process which is frightfully laborious, have exhibited phenomena which suggest, as a hypothesis to be further studied, such a subdivision of atoms. But it is probable that we have mixtures of distinct elements which we do not yet know how to separate from each other by simple analytical processes. This chapter, we may fairly presume, will be valuable; but not because it will tell us anything new about the structure of atoms.

Certain spectroscopic phenomena have suggested that some elements may be decomposed by the action of a high temperature. For instance, it has been thought not impossible that, at the temperature of the electric arc, potassium compounds quite free from sodium should begin to show the spectrum of sodium, because at this temperature potassium is decomposed so as to produce sodium. This hypothesis has been carefully investigated; in part, by the accomplished physicist who is its author; in part, at his suggestion and invitation. It is found that, if years are given to the preparation of potassium compounds free from every trace of sodium, then it is impossible to obtain from them any phenomena suggesting a decomposition into sodium. Here, again, the new chapter, as far as it relates to the structure of the atom, is likely to be but short.

A third suggestion did not rest upon any observed chemical phenomena, but was a purely intellectual creation. This is the hypothesis that atoms are vortex rings in a frictionless fluid. It belongs to the mathematical physicist, rather than to the chemist, to discuss this interesting suggestion. It may be said that it has seemed not impossible that the chemist should find a vortex ring capable of exerting certain chemical forces. But the fate of the hypothesis rested, not with the chemist, but with the mathematical physicist; and it has been found that the theory demands that the weight of a body composed of vortex atoms should increase with rise of temperature. It is scarcely possible that this can be the fact; if, then, the mathematical and physical reasoning involved is sound, it is scarcely possible that atoms consist of vortex rings. The probability is, therefore, but small that we are to learn of the nature of atoms by means of this hypothesis.

Some spectroscopic and other optical phenomena seem to promise more light as to the structure of molecules and atoms, though the dawn is not yet. Thanks to the concave grating, we can determine the frequency of vibration of the light from any source with great accuracy. When the light is complex we can determine, with great accuracy, the relative frequency of the component vibrations. In the cases which have been best studied, the observed frequencies have been reduced to rather simple numerical relations. From the study of these relations we may expect, in time, to determine the structure of the vibrating systems. But the way is long and difficult. Let us illustrate the nature of the method by means of a familiar example, namely, by the study of the structure of a sonorous vibrating system by means of the study of the sonorous vibrations produced by it.

Let us suppose a person deprived of the sense of hearing, but master of the whole mathematical theory of sound. Suppose, further, that he has an instrument which will do for sound what the spectroscope will do for light. With this instrument, let him observe the frequency and the relative intensity of the vibrations produced by certain musical instruments which we cause to vibrate for him, but withhold from his inspection. Let us, first, sound for him a single note on a piano. The vibrations produced are, as you know, somewhat complicated. Our imagined experimenter, with his instrument, observes vibrations whose frequencies are 100, 200, 300, 400, 500 and 600 in one second; and he also observes that the vibrations of 100 and 500 are of nearly equal intensity, that the vibrations 200, 300 and 400 have more than twice as great an intensity, and that vibration 700 is very feeble. From these facts, if his attainments are sufficient and his imagination sufficiently fertile, he can determine what system produced the sound. He imagines every possible vibrating system—drum, cymbals, trumpet, flute, organ-pipe, harmonium-reed, violin-string, piano, harp and more. Next, assuming each imagined system of such size or tune as to produce one hundred vibrations a second for its gravest tone, he computes what other vibrations will also be produced and what the intensity of each. He finds, for instance, that a closed organ-pipe will give only the frequencies 100, 300, 500, but will not produce the other observed frequencies 200, 400, 600. Therefore, he concludes, the sound we produced for his study is not due to a closed organ-pipe. He finds, after many trials, that the observed frequencies and intensities could be produced by striking a stretched cord with a soft hammer, at a definite point near the end of the cord, so quickly that the cord and hammer remain in contact about the six-hundredth part of a second, and that the observed phenomena could not be produced by any other of the imagined vibrating systems. Then he concludes that the observed sound was probably produced by the stretched cord of a piano. He will have detected the true system, by first imagining every possible system, by computing the frequencies and corresponding intensities due to each hypothetical system, and by then comparing computation and observation.

For a second example, suppose we ring, for our imagined observer, a bell of a certain form, and that he notes the frequencies 200, 475, 845 and 1295 in one second; in which, also, he finds that the vibration 845 so predominates as to give its pitch to the compound tone. Our observer will not be able to refer this sound to any stretched cord, or to any organ-pipe or other wind instrument; for all these are limited to frequencies contained in the series 200, 400, 600, 800. A uniform metallic bar, suspended and struck like the triangle of an orchestra, will give frequencies not contained in this list, but they will be 200, 550, 1080, and 2670, instead of 200, 475, 845 and 1295. But if our observer has adequate powers he will imagine a hemispherical bowl of suitable dimensions, and will, in imagination, add mass and rigidity in suitable places, until, in time, he will have devised a system whose computed vibrations agree in frequency, and in distribution of energy, with those of the invisible sounding body. Then he would conclude that the observed sound was due to a bell of the form assumed in the successful computation.

This illustration sketches, imperfectly, I fear, the laborious method by which we may learn the structure of a vibrating system from a study of the vibrations produced by it. When we attempt to use this method in order to learn something about the structure of molecules and atoms, our powers of imagination and our mathematical skill are none too much. We know but little which can suggest plausible hypotheses. The facts which are to be explained have been but recently reduced to order. Accordingly, little has been actually accomplished. But there are some few examples of the use of this method of studying the structure of molecules and atoms.

In one such example the structure imagined consisted of a system of concentric spherical shells, each connected with the adjacent shells by springs. This complicated structure admits of relatively simple computation, and was taken because it fairly well represents a rather simple imagined structure, for which, however, computation is difficult. But it was found that the results computed on this hypothesis gave little promise of agreement with facts.

This was a dynamical hypothesis; it suggested, not only vibrations, but the forces which were to produce them. A second example suggests certain possible motions, but not the forces which might produce the hypothetical motions; it is not dynamic, but kinetic.

As we know, many of the lines in the spectra of the elements are double. For instance, when a volatile compound of sodium is brought into a colorless gas flame, this is colored yellow. When we examine this yellow flame with a spectroscope of sufficient power, we see that there are two frequencies, differing from each other by only one part in a thousand. Now it is probable that these two frequencies are due to the vibrations of one and the same body. There are many illustrations of the fact that a given body may perform two different vibrations whose frequencies differ but slightly. For instance, if we suspend a ball by means of a cord and let it oscillate as a pendulum it is well known that a swing of six feet takes a little more time than a swing of three feet. Suppose, then, that we let our ball swing six feet north and south, and also three feet east and west at the same time; the two motions may be combined so that the ball moves in an ellipse—an ellipse whose longer axis is north and south. If the longer and the shorter swing had precisely the same frequency, the axis of the ellipse would continue in this direction; but since the frequencies differ, the ellipse slowly revolves. Conversely, from the revolution of an ellipse, we should infer a difference of frequency in the two component vibrations. So it is suggested that the two slightly different frequencies in the light sent out by ignited sodium are due to an elliptic motion in the molecule in which the elliptic orb slowly revolves; this suggestion has not yet been carried so far as to specify any hypothetical cause for the revolution of the ellipse.

These two examples, both due to eminent English physicists, may serve to illustrate the method by which, if I am not mistaken, we are not unlikely to learn much as to the structure of molecules and atoms. We must not expect rapid progress. Even comparatively simple hypotheses may require, for their due examination, the invention of new mathematical methods. And useful hypotheses are rare: like the finding of buried treasures, they are not to be counted on. But, since Prout's hypothesis has rendered us its final service, new hypotheses must be devised, competent to guide us further on our way. Let us hope that, before this city again honors our Association with its invitation to meet here, American chemists and physicists may have had some honorable share in such new advance.

EDWARD W. MORLEY.

CLEVELAND, O.

PAST AND PRESENT TENDENCIES IN ENGINEERING EDUCATION.*

THE present status of engineering education in the United States is the result of a rapid evolution which has occurred in consequence of opinion as to the aims and methods of education in general. These changes of opinion, whether on the part of the public or on the part of educators, together with the resulting practice, may be called tendencies. All progress that has occurred is due to the pressure of such views or tendencies; hence a brief retrospect of the past and contemplation of the present may be of assistance in helping us to decide upon the most advantageous plans for the future.

Thirty years ago public opinion looked with distrust upon technical education. Its scientific basis and utilitarian aims were regarded as on a far lower plane than the well-tried methods of that venerable classical education whose purpose was to discipline and polish the mind. What wonderful changes of opinion have resulted, how the engineering education has increased and flourished, how it has influenced the old methods, and how it has gained a high place in public estimation are well known to all. The formation of this Society in 1893, its remarkable growth, and the profitable discussions contained in the three volumes of its transactions, show clearly that technical education constitutes one of the important mental and material lines of progress of the nineteenth century.

Engineering courses of study a quarter of a century ago were scientific rather than technical. It was recognized that the principles and facts of science were likely to be useful in the everyday work of life and particularly in the design and construction of machinery and structures. Hence mathematics was taught more thoroughly and with greater regard to practical applications, chemistry and physics were exemplified by laboratory work, drawing was introduced, and surveying was taught by actual field practice. Although engineering practice was rarely discussed in those early schools, and although questions of economic construction were but seldom brought to the attention of students, yet the scientific spirit that prevailed was most

*Presidential Address before the Society for the Promotion of Engineering Education at the meeting in Buffalo, N. Y., August 20, 1896.

praiseworthy and its influence has been far reaching.

This scientific education notably differed from the old classical education in two important respects: first, the principles of science were regarded as principles of truth whose study was ennobling because it attempted to solve the mystery of the universe; and second, the laws of the forces of nature were recognized as important to be understood in order to advance the prosperity and happiness of man. The former point of view led to the introduction of experimental work, it being recognized that the truth of nature's laws could be verified by experience alone; the latter point of view led to the application of these laws in industrial and technical experimentation. Gradually the latter tendency became far stronger than the former and thus the scientific school developed into the engineering college.

The very great value of laboratory experiments, and of all the so-called practical work of the engineering school of to-day, is granted by all. Principles and laws which otherwise may be but indistinct mental propositions are by experimentation rendered realities of nature. The student thus discovers and sees the laws of mechanics, and is inspired with the true scientific spirit of investigation. It should not, however, be forgotton that if such practical work be carried beyond the extent necessary to illustrate principles it may become a source of danger. The student of average ability may pass a pleasant hour in using apparatus to perform experiments which have been carefully laid out for him, and yet gain therefrom little mental advantage. Especially is this true when the work assumes the form of manual training, which, however, useful in itself, is properly considered by many as of too little value to occupy a place in the curriculum of an engineering college.

The tendency toward the multiplication of engineering courses of study has been a strong one, especially on the part of the public. This has resulted in a specialization that, as a rule, has not been of the highest advantage to students. In some institutions this has gone so far that the student of civil engineering learns nothing of boilers and machines, while the student of mechanical engineering learns nothing of surveying or bridges. The graduate is thus too often apt to lack that broad foundation upon which alone he can hope to build a successful career.

The development of the scientific school into the engineering college has been characterized throughout by one element of the happiest nature, that of hard work and thoroughness of study. The numerous topics to be covered in a limited time, their close interrelation, and the utilitarian point of view, have required many hours per week and earnest work by each student in preparation for each exercise. The discipline of hard and thorough work is one whose influence can be scarcely overestimated as a training for the duties of life, and in every university it is found that the activity and earnestness of the neighboring students is a source of constant stimulus to those of other departments. Thus scientific and engineering education has tended to elevate the standard and improve the methods of all educational work.

The length of the course of study in engineering colleges has generally been four years, and whatever tendencies have existed towards a five-years' course have now for the most part disappeared. With higher requirements for admission, particularly in English and in modern languages, a reduction of the length of the course to three years may possibly be ventured in the future, particularly if the long summer vacation be utilized for some of the practical work, as indeed is now the case in several institutions.

There has been and now is a strong tendency toward a reduction in the length of the college year. While formerly forty or forty-two weeks were regarded as essential, the process has gone on until now some colleges have but thirty or thirty-two weeks, a reduction of nearly twenty-five per cent. having been effected in twenty-five years. Undoubtedly the long vacation is utilized to great advantage by the majority of students in actual work, yet the fact remains that it is not good business economy to allow the buildings and plant of a college to lie idle for so large a part of the year. It is perhaps possible that in the future the summer schools may be so developed that the work will be practically continuous throughout the year, thus giving to students the option of completing the course either in three or four years.

The report of the committee on requirements for admission, which will be presented later in the session, sets forth many facts which show the tendencies now existing. Almost without exception a higher standard is demanded, both that students may enter with better mental training and that more time may be available in the course for technical subjects. While the general line of advance is toward an increase in mathematics and in modern languages, there is also found, particularly in the central states, a demand for broader training in science. It has already been pointed out that our early engineering schools were strong in scientific training, and that the tendency has been to replace this by industrial applications. If the requirements for admission can be extended to include the elements of chemistry and physics, with some botany or zoology, the engineering student will enter with broader views, a keener power of observation and a scientific spirit that will greatly increase his chances for success in technical studies.

The general increase in requirements for admission tends to raise the average age of the student. It is now usually the case, owing to the greater length of time needed in preparatory work, that the average age of the classical student is one year higher than that of the engineering student; or the former has had one more year of training than the latter. One more year of training means much as an element for success; one more year in age means an increase in judgment which is of the highest importance for a proper appreciation of the work of the course. The older men in a class usually do the best if not the most brilliant work, and after graduation their progress is the most satisfactory. It thus appears that all tendencies that raise the age of entrance are most important ones and deserve hearty encouragement.

Having now considered some of the general elements and tendencies in engineering education it will be well to take up the program of studies, especially in regard to those subjects that are common to all technical courses. The three volumes of the Transactions of this Society contain many carefully prepared papers and interesting discussions which enter into questions of detail concerning nearly all topics in the curriculum. Here, however, can only be noted briefly the main lines of development and the indications for future progress.

Mathematics is undoubtedly the most important subject in all courses of engineering study, and it has been demanded for years that it be taught with great thoroughness. This demand has been not more completely in the independent engineering colleges than in the engineering courses of the universities. Much, however, remains to be done in this direction, and probably it cannot be satisfactorily accomplished until a change in method has been effected. The fundamental element in the change of method must be, it seems to me, in a partial abolition of the formal logic of the text-books and an introduction of historical and utilitarian ideas. Mathematics is a tool to be studied for its uses, rather than for its logic or for discipline that it can give; hence let its applications be inculcated frequently and not be systematically kept out of view. If the student gains the impression that his mathematical exercises are merely intended to train the mind his interest and his progress will usually be slow. If, however, he learns what mathematics has done in the past, how it joins with mechanics to explain the motions of the distant planets as well as to advance the material prosperity of man, there arises an interest and a zeal that helps him to overcome all difficulties.

The great advantage of numerical exercises in all branches of pure and applied mathematics, and the deplorable lack of good preparation in arithmetic, have been expressed by many educators. In numerical computations the average engineering student is weak in spite of the numerous exercises in his practical work. To remedy this defect better instruction in arithmetic is demanded in the common and high schools, while in engineering colleges the teachers of mathematics should constantly introduce numerical work and insist that it be done with a precision corresponding with the accuracy of the data.

Next in importance to mathematics comes mechanics, the science that teaches the laws of force and motion. In most institutions the rational is separated from the applied mechanics and often taught by the mathematical department. Probably less improvement has resulted in the teaching of rational mechanics during the past quarter of a century than in any other subject. That mechanics is an experimental science whose laws are founded on observation and experience is often forgotten, and the formal logic of the text-books tends to give students the impression that it is a subsidiary branch of mathematics. The most interesting history of the development of the science is rarely brought to the attention of classes, and altogether it appears that the present methods and results are capable of great improvement.

It should not be overlooked, however, that in recent years the so-called absolute system of units has been introduced into mechanics and is now generally taught in connection with physics. Here the pound or the kilogram is the unit of mass, while the unit of force is the poundal or the dyne. Although this system possesses nothing that is truely absolute, it has certain theoretical advantages that have commended its use, notwithstanding that no practical way of measuring poundals has been devised except by the action of the force of gravity on the pound. Engineers have continued to employ the pound weight as the unit of force, and the calculations of the physicist must be translated into the units of the engineer before they can be understood. The student of rational mechanics thus has the difficulty at the very outset of two systems of units, and great care should be taken that each be thoroughly understood and the relations between them be clearly appreciated by application to many numerical problems. In view of these and other difficulties and of the novelty of the subject in general, it appears that some engineering colleges do not give to rational mechanics as much time as its importance demands.

Physics in some colleges is taught by a course of five or six exercises per week, extending over a year, while in others the elements are required for admission and the regular course is correspondingly abridged. The marvelous development of electrical theory and practice has naturally tended to make this the most important topic in the course, sometimes indeed to a material abridgment of mechanics, acoustics, thermodynamics and optics. Considering how great is the importance of each branch of physics and the advances that are made every year in new directions, it may also be concluded that more time can be profitably given both to theory and to experimental work. Physics is a fundamental subject whose principles and results are of constant application in every walk of life, and a student who thoroughly covers a well arranged course has gained a mental discipline and a scientific habit of mind that will be of greater value than the technical details of a purely engineering specialty.

Undoubtedly the most powerful tendency in engineeeing education has been in the direction of the development of those special technical subjects which may be grouped under the name of Construction and Design. In civil engineering this has led to plans for railroad, water supply and bridge construction ; in mechanical engineering to engine and machine design; in mining engineering to projects for mine plants, and in electrical engineering to the design of dynamos and motors. These courses have been demanded by the public and by the students themselves, and have been often elaborated to an extent beyond the best judgment of teachers of engineering. To the extension of such courses there is no limit, but it is a question whether the process has not already gone too far. For instance, it would not be difficult to arrange a course of twenty or thirty exercises on water pipes in which should be discussed all the methods of manufacture and processes of laying cast-iron, wrought-iron lap-welded, steel-riveted and wooden mains, together with a comparison of their relative economies under different conditions in different parts of the country. These lectures, however, would plainly be of such a technical nature that the advantage to the student would be slight; they would give valuable information, but little training.

In all courses in construction and design the practical limit seems to be reached when the exercises are of such a nature as to give more information and little scientific training. The aim of all education, and of engineering education in particular, should be to render the student conscious of his mental power and sure of applying it with scientific accuracy so as to secure economy of construction. Fundamental principles are hence more important than the details of a trade, and all exercises in design should be arranged so that the student may think for himself rather than blindly copy the best practice of the best engineers.

The subject of applied mechanics, which occupies an intermediate place between rational mechanics and the work in design, has been so differentiated that the mechanics of materials is now almost the only topic common to all engineering courses. The strongest line of development has here been in the introduction of testing machines and in the making of commercial tests. This work is of high value, although it may be doubted if the use of one or two large testing machines is as advantageous as that of many smaller ones which are designed especially to illustrate principles. The student of the present day enjoys, however, advantages that were unknown a quarter of a century ago, and the marked progress in applied mechanics from both the scientific and technical point of view is a source of congratulation.

English and modern languages are generally called culture subjects, and it is well known that of all the topics in the engineering course these are the ones in which students have the least interest. The great importance to an engineer of being able to clearly and correctly write his own language can scarcely be overestimated. Further it may be said that no engineer can hope to attain eminence unless he can read German and French literature. These opinions have long been held, and furthermore it has been recognized that engineering students and graduates are often lacking in that general culture which the world demands as one of the conditions of success. Great improvements have been made in the methods of teaching English and modern languages, and probably still greater ones are yet to result. In the ideal engineering colleges of the future perhaps these subjects will be required for admission, as is now done at least by one institution, but at present they must generally be taught. The main line of improvement to secure better results will be, it seems to me, in partially abandoning the idea of culture and placing the instruction upon a more utilitarian basis. If English be regarded as a means to an end instead of linguistic drill; if the aim of teaching French and German be to read fluently the language of to-day instead of laboriously to decipher the meaning of the poets of centuries ago, true zeal on the part of the student will arise and a truer culture will result.

At the close of the college course the student presents a thesis showing his ability to apply the principles and rules of engineering in the investigation or design of a special problem. The tendency has been strong to abandon subjects which involve mere description or compilation, and to insist upon those that will require the student to exercise his own powers. Thus the value of the work to the student has been greatly increased, and the theses of each class are a source of stimulus to the following ones. Although the view held by some that theses should be monographs setting forth important conclusions of original investigations is one that can not in general be realized, it is a gratification to note that each year a few theses are produced which are sufficiently valuable to warrant immediate publication.

The formation of engineering clubs among students for the discussion of the details of professional work is one of the most important tendencies of recent years. No exercise is so valuable to a student as one entirely originated and performed by himself, and the preparation of a paper which is to be presented to and criticised by his fellows ranks highest of all among such exercises. Recently there has been forced upon my notice a remarkable activity in the three engineering clubs of a certain engineering college, more than fifty papers having been read discussed during the year by a total of about three hundred and fifty students, besides a number of others read before the mathematical club. In meetings of this kind the scientific and economic questions under discussion in the engineering journals receive a detailed attention which the professor in the class room often finds it impossible to give, while the advantage to students in expressing themselves in debate is very great.

Occasional lectures to classes by practicing engineers have been introduced in many institutions during the past decade, and with uniformly good results. In engineering education there is no conflict between theory and practice, and every professor cordially welcomes distinguished engineers to explain their great structures and achievements to his classes. It is an inspiration to students to see and hear those men who have so successfully applied sound science to economic construction, and whose influence has been uniformly to elevate the standard of the profession.

After four years of work the engineering student receives his degree and is ready to commence the actual work of life. What the letters are that designate the degree is a matter of small importance. Moreover, if we examine the lists of the alumni who graduated ten or fifteen years ago, the conviction arises that their particular course of engineering study has not been an absolute factor in determining their actual lines of engineering work. It is found that graduates in civil engineering are engaged in mining, in machinery and in electricity, and that graduates in other courses are employed upon work in which they received no especial technical instruction. Thus it appears also that the particular course of engineering study is not so important a matter as students and the public generally suppose. In fact, a young man thoroughly grounded in fundamental principles and well trained how to apply them has almost an equal chance for success in all branches of engineering practice.

Looking now over the field of tendency thus briefly outlined it is seen that there has been ever present a powerful impulse towards specialization, to which, indeed, nearly all others have been subordinated. This has demanded a higher standard of admission, great thoroughness in all fundamental subjects, and a rigid adherence to scientific methods. Engineering education has had an active part and healthy growth; it now enjoys the respect and confidence of the public, and its future is sure to be more influential than its past. It is not specialization that has caused its success, but rather the methods which specialization has demanded. Those methods have resulted in imparting to students zeal and fidelity, a love of hard work, a veneration for the truths of science, and a consciousness of being able to attack and overcome difficulties; these elements of character are, indeed, the foundation of success in life.

Looking now forward into the future it is seen that in our efforts for the promotion of engineering education a wide field for work still lies open. The student should enter the engineering college with a broader training and a more mature judgment. The present methods of instruction are to be rendered more thorough and more scientific. In particular the fundamental subjects of mathematics, physics and mechanics are to be given a wider scope, while the languages and the humanities are to be so taught as to furnish that broad, general culture needed by every educated man. In general let it be kept in mind that education is more important than engineering, for the number of men who can follow the active practice of the profession will always be limited. Hence let it be the object of engineering education to influence the world in those elements of character that the true engineer possesses, so that every graduate may enter upon the duties of life with a spirit of zeal and integrity, with a firm reliance upon scientific laws and methods, and with a courage to do his work so as best to conduce to the highest welfare of his race and his country.

MANSFIELD MERRIMAN.
LEHIGH UNIVERSITY.

AN OZARK SOIL.

CENTRALLY located on the Ozark Plateau, in the southwestern portion of the State of Missouri, there is a tract of very hilly country, underlain by Lower Carboniferous limestones and noted for its exceedingly stony soil. It comprises a portion of the counties of Stone and Barry, and is bounded on the north and west by the gently undulating plateau country commonly known as the 'crest of the Ozarks;' on the south and southeast by the escarpment of the Lower Carboniferous strata which bounds the broad basin-like valley of White river, and on the northeast by the outcrop of the Ozark Series. This small geographic district is characterized by ridges which are from 200 to 300 feet in height, yet so narrow that often two ridges and two valleys are required to make a mile. It is to the soil which covers these steep narrow ridges that I wish to call attention.

Our district being without the limits of the glaciated areas possesses a soil which has been in process of formation during many periods. It has never been disturbed by either marine or lacustrine agencies, and consequently, is but the residual material accumulated on the surface of the limestone rock after the decay of higher strata. These strata consisted of the coarsely crystalline, crinoidal Burlington limestone and abounded in layers of white chert.

The surface stratum of the soil which we are now considering is a layer of angular white chert gravel. The pieces vary in size from very small to a cubic foot, but sizes of a cubic inch to ten cubic inches predominate. Where the ridges are narrow the surface is so completely covered with this broken chert that the true soil cannot be seen, and in the spring, when the brown oak leaves and dried prairie grass are burned off, the hills look like hugh piles of broken rock. On the steeper hillsides the chert layer, which is here a true talus, is often several feet in thickness, and no attempt is made to reach the underlying soil for the purpose of cultivation. But on the flat-topped ridges, the plow passes under the superficial chert into a rich black soil, which is six to eight inches in thickness and remarkably fertile. This soil layer is nearly free from large fragments of chert, although very small particles abound and aid in giving the soil a very loose texture. The black color is, of course, derived from the decay of vegetation, and the carbonaceous matter accumulates more rapidly where the overlying chert layer is thickest. In fact, the existence of a black soil in this latitude is probably largely due to the presence of the chert.

Several years ago a 'cyclone,' in passing across the hill tops in the vicinity of Rancho Springs, in Stone county, prostrated the timber in narrow belts. The fallen oaks have upturned the soil, producing fine sections through it. Under the dark soil layer we find a light yellow clay, at first nearly free from chert, but which, at the depth of two feet, contains such a large percentage of large chert fragments that it requires the use of the pick in excavating it. This yellow sub-soil is a stiff clay and, when puddled with water and plastered into the 'chinking' between the logs of the simple country houses, makes an excellent substitute for mortar. When plowed into, rained upon and dried, it hardens on the surface as though frozen, so that to walk over a plowed field when it is in this condition makes no impression on it. Yet it contains the elements of fertility and in time will weather into a good soil.

The yellow subsoil clay grades imperceptibly downward into a bed of closely packed but invariably fragmental chert. At three feet from the surface of the soil, less than 10% of the material is clay, occupying the narrow crevices among the chert. At this depth also the yellow clay changes rather abruptly to a similar fine-grained stiff clay of a bright brick-red color. From here to the surface of the limestone rock, which may be 10 or 20 feet from the surface of the soil, the mass is composed almost exclusively of the fragmental chert. What clay there may be among it is always of the bright red variety.

Now it is to the characteristic feature of the subsoil clay, viz., its color, that I wish to call special attention. This, as we have just seen, differentiates naturally into an upper yellow variety and a lower red variety. The line of demarcation between them is not sharp, and bears no definite relation to the main body of the chert. For when the ridges are broad, and the subsoil clay over the chert bed thickens, the surface of the clay rises into the subsoil stratum, leaving quite a thick bed of not very stony red clay over the main body of the chert. In short, as the line of demarcation persists in following a given depth under the surface, which is about three feet, it is evident that the difference in color is due to a modification of the red clay by some action either atmospheric or aqueous. Now, red clay is the natural residual product of the decaying limestone. Red is, also, the color most generally represented in the mud of the caves. Indeed, there is no macroscopic difference between the red cave earth and the clay on the limestone rocks outside. They are due to the same general cause and constitute the same formation. But the upper three feet of the residual clay on the ridges has been converted into a yellow clay. The same effect has been observed and recorded, by numerous writers, in other unglaciated districts, but in this it is perhaps more prominent than in others. The cause appears to have been not the action of the atmosphere, which is incapable of destroying and removing the red oxide of iron, but the solution and removal of a large part of the iron salt, by percolating water containing acids generated by the decay of the vegetable matter contained in and on the soil.

The writer, believing that certain colors are, to some extent, characteristic of the products of certain periods and certain climates, wishes to propound the following questions:

1. If a residual clay were to form, in the absence of vegetation, at the present time in the Ozarks, would it be yellow immediately or would it first pass through a stage of red color?

2. Did the pre-glacial residual material, in certain districts of the upper Mississippi basin, as, for instance, over the Galena and Niagara limestones of northwestern Illinois, have a yellow stratum over the ordinary red, as in the present subsoil of Stone county, Missouri? (The remains of the pre-glacial residua yet seen by the writer in northwestern Illinois indicate only a red subsoil.)

3. Is it not possible, indeed probable, that the red clay in southwest Missouri represents some ancient period, while the modification of its upper three feet into a yellow clay is peculiarly the result of a more recent period?

The writer does not intend to answer these questions, but in conclusion will state one fact, which bears strongly on the last and may be found to be a key to its solution. In some long-past period the streams in Stone county laid down a flood-plain of of gravelly clay and silt of a prevailingly bright red color. Obviously, the material came from the soil and subsoil clay of the surrounding ridges. During a later period the same streams laid down a flood-plain of a light brown and yellow color. Obviously, the material came from practically the same position as during the earlier period. For an explanation of the strong contrast between the two fluvial formations we must look to the surface portion of the residua on the ridges. If we read the evidence aright it indicates that, subsequent to the formation of the first river deposit, a change of climate converted the previously red surface portion of the residual clay into a yellow clay, before the advent of the period during which the later formation was deposited.

Oscar H. Hershey.

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CURRENT NOTES ON ANTHROPOLOGY.

SOCIAL ORGANIZATION OF THE INCAN GOVERNMENT.

Under the title, 'Die sociale Verfassung des Inkareichs' (Dietz, Stuttgart), Dr. Heinrich Cunow, already known by an able treatise on the Australian aborigines, presents an analysis of the government and sociology of the Peruvians before the advent of the Spaniards. It is written from a careful comparison of the best early authorities and in the spirit of modern sociological science. The subject, therefore, is presented in a widely different light from that offered in Prescott's History. The foundation of the Peruvian government was an agrarian communism derived from the rights of the primitive gentes, very much as was the case not only in other parts of America, but, as the author observes, among the ancient Aryans as well. This explanation he develops in a highly satisfactory manner.

The claim, however, which Mr. Cunow puts forward in his preface, that he is the first to make these facts clear, is, doubtless unwittingly, unjust to a worthy American student, Dr. Gustav Brühl, who in his learned volume, 'Die Culturvölker Alt-Amerikas,' Chap. XVII. (Cincinnati, 1887), traces with entire clearness the Peruvian organization to the same source as does Cunow. It is to be hoped that in a future edition the latter will make proper acknowledgment of this.

THE INTERNATIONAL CONGRESS OF AMERICANISTS.

Mr. E. de Olivarria y Ferrari has issued at Mexico the 'Cronica del Undesimo Congreso Internacional de Americanistas' (pp. 183), giving a narrative of the proceedings of the Congress, its meetings and excursions (not abstracts of papers). The outlines were reported to Science at the time by Mr. Halsted. The present volume proves still further how courteous and kindly was the reception accorded to the Congress by the authorities and citizens of Mexico.

That meeting, however, was not a regular, but an extra session. The Congress meets only once in two years, and at the last regular meeting, in Stockholm, 1894, it was agreed to convene next in Holland, probably at the Hague. This is still the intention, and the last number of the 'Internationales Archiv für Ethnographie' contains an announcement to that effect. The precise date will be determined later. The volume of proceedings at Stockholm has not yet been issued. The Compte-rendus of the Congress, now numbering many volumes, the first of which was published in 1875, contain numerous articles of value to the student of the archæology and languages of America.

WORD-COUPLING LANGUAGES.

Sometimes a single linguistic procedure serves as a valuable trait by which to group linguistic stocks and measure their relative development. Such is the plan of uniting words one to another, so as to form compounds. This has been studied by several writers, and lately by Dr. H. C. Müller, of Leyden, in a monograph, 'Beiträge zur Lehre der Wortzusammensetzung' (pp. 59). While mainly devoted to the Aryan group, he has the breadth of mind, rare among Aryan specialists, to remember that all tongues are not built on Aryan models, and therefore calls under consideration the Ural-Altaic, Australian, and even, *mirabile dictu*, the American languages, for purposes of comparison. In this particular field the last mentioned offer peculiarly abundant topics of study in their synthetic and incorporative character, to which the author alludes, but perceives that the field is too vast to be surveyed in a few pages.

In some groups of tongues, as the Sinitic, word-coupling cannot be said to exist in the sense of the *dvandva* of the Sanskrit grammarians; under certain restrictions, its presence and development lend flexibility, accuracy and poetic power to a tongue, and thus serves as a criterion of linguistic evolution. This and other suggestive thoughts will be found in the essay.

D. G. Brinton.

University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS.

MEMBERSHIP OF THE INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.

An editorial in the *London Saturday Review*, August 1, 1896, makes the following comment upon the address of M. Berthelot, as President of the International Congress of Applied Chemistry, recently in session in Paris. It is of interest in this country, not only as showing the present attitude of thinking Englishmen in regard to the encouragement of research, but because the reproaches which the English editor showers upon his own country are at least equally applicable in the United States, perhaps more so:

"He was addressing the generals of this new army of science, who, in the rivalries of their nations, count for more than hosts of armed men. England, to defend her vast and scattered interests, attempts to keep her navy equal to the combined navies of any two foreign powers. How in this scientific review did she compare? The figures are so startling and so omnious that we give them all: from Austria, 157; from Germany, 102; from Belgium, 53; from Russia, 37; from Peru, 35; from Portugal, 25; from Brazil, 25; from Mauritius, 24; from Holland, 23; from the United States, 20; from Spain, 19; from Switzerland, 13; from Egypt, 12; from Italy, 10; from England and from Greece, 8; from Roumania, 7; from Cuba, Mexico and the Argentine, 4; from Denmark and Turkey, 1. Repeat it, ponder it! From England, 8; from Austria, 157; from Germany, 102. We will warrant that the Rev. Dr. Lunn got more Englishmen to attend his Swiss Conference on Arbitration! The worst of it is that we have little doubt but that the numbers represent fairly the relative interests in technical chemistry in the different countries, especially if allowance be made for convenience of access to Paris, the place of conference. For the present we cannot enter at length into the causes and possible remedies for this national folly. But we may point out that vast sums are annually wasted on chemistry in England. The Science and Art authorities at South Kensington, and the Technical Instruction authorities of the County Councils, spend largely upon chemical subjects. But, for the most part, the money is spent upon teaching of chemistry, not upon chemical research. It may be a valuable addition to national character that a large number of children be taught the elements of water and the composition of coal gas. But it is an indisputable fact that ninety per cent. of these children do not proceed beyond the luxury of superfluous elementary knowledge; and that of the remaining ten, at least nine become themselves elementary teachers. Teaching is a trade in England; research is not; and, until the endowment of research is recognized as a million times more important than the diffusion of cheap knowledge, England will continue on the downward path."

'SQUIRTING' IRON AND STEEL AND OTHER METALS.

ONE of the most remarkable and unexpected developments in the recent progress of manufactures of metal is described by Mr. Nursey in a paper recently presented, at the Spring Meeting, to the Iron and Steel Institute of Great Britain. This is a process of 'squirting' bars of all the metals in a manner similar in principle to the old and familiar process of manufacture of lead pipe. It is the invention of Mr. Alexander Dick, long known as a practical metallurgist, and especially in the work of introduction of various valuable alloys.

Mr. Dick has discovered a way to make possible the production of all sections of metal bars from the simple round wire to the most complex designs, such as are quite impossible to roll successfully, by raising the metal to be thus formed to a high temperature, and thus to reduce it to the plastic state and then forcing it from a reservoir through properly formed dies under hydraulic pressure. His claim is that it is commercially practicable to form bars of all such sections by 'extrusion under pressure at high temperatures.' The temperature usually adopted by him is approximately 1000° F.

After a long and costly series of experiments, the following system of construction of the apparatus has been found to meet the requirements of the case successfully: A series of concentric cylinders of tungsten steel are placed one within another, separated by an intermediate space of about $\frac{3}{4}$ of an inch; which space is filled with compressed non-conducting material. This 'container' is mounted on trunnions and fitted with a worm-gear arrangement for swinging it in the vertical plane, like a Bessemer Converter. The die plates are made of tungsten steel, and their orifices are given the form of the proposed section of the bar to be made. They are carried in a holder which permits their convenient introduction and removal for substitution of one form for another. Before the operation begins, the 'container' is set vertically to receive the charge, and the dies and holder are heated, also, to prevent chilling. Once charged, the container is turned into the horizontal position, and the plunger of a hydraulic press, working under about two tons per square inch pressure, is forced into the container, driving the plastic metal out through the die, from which the bar issues of the desired sectional shape.

The preliminary heating is effected by gas-burners, and the operation of the apparatus keeps up its temperature to the required point until its working hours are over. The apparatus in use at the works of Mr. Dick, the Delta Metal Co., London, has a cylinder of about two feet external diameter and an inner liner five or six inches. The product is about fifty charges per day, and the cost of operation is claimed to be small, the wages of two men and a boy. The metal so produced is claimed to have greatly increased strength, as compared with that made by simple casting, in the usual manner, precisely as 'Whitworth steel' is improved by pressure. Common yellow brass gains about 24 per cent. in tenacity. 'Delta metal' bars thus made are reported to have a tenacity of 48 tons per square inch as against its former strength, 32 tons, and to exhibit a ductility of 32.5 per cent. as against 20 per cent.

Only the copper-tin-zinc alloys and similar metals have, as yet, been treated; but the inventor proposes ultimately to employ the process in the manufacture of iron and steel bars of difficult sections.

THE SANITARY VALUE OF SUNLIGHT.

At the Annual Congress of the British Institute of Public Health, which was held at Glasgow, from July 23d to July 29th, Professor Ramsay, of University College, London, in his address as President of the Chemistry and Engineering Section, dwelt on the sanitary value of sunlight. According to the report in the *British Medical Journal*, he said that the most common evidence of the activity of the violet and ultra-violet rays is sunburn, which is probably due to the effort of the surface cells to protect themselves against these rays by secreting a pigment which can absorb them, and the peeling which accompanies severe sunburn is merely the shedding of such dead cells as have been unable sufficiently to protect themselves. The Röntgen rays are particularly apt to cause the worst kind of sunburn, in one case causing the finger nails of a hand which had been repeatedly subjected to them to come off. Professor Ramsay drew attention to the well-known researches of Professor Marshall Ward, in which he found the violet and ultra-violet rays of the sun, or even of electric light, to be capable of disinfecting the bacilli of typhoid and anthrax. The same subject has now been investigated from the chemical side by Dr. Arthur Richardson. Dr. Richardson determined the circumstances which caused the fading of certain water colors when exposed to light, and examined the action of light on carbon compounds and urine. He found that the effective agent in bringing about the changes which he observed is peroxide of hydrogen. When certain organic materials, such as carbolic acid, and some alcohols, or oxalic acid, are exposed in a damp state to sunlight, hydrogen peroxide is produced. Two quantities of fresh urine were tested for hydrogen peroxide; none was found. One was then exposed for six days to sunlight; the other was kept in the shade. The exposed sample was clear and was found to contain peroxide, while the portion kept in darkness swarmed with bacteria, had grown foul and contained no peroxide. Even after 23 days' exposure to sunlight the one showed no putrefactive change, while the other was entirely putrefied. Similar experiment was made where one sample was shaded with ruby glass, decomposition and absence of peroxide ensuing, while the portion exposed to sunshine was quite unaltered in appearance. Some of the sunned samples, after they had developed a considerable quantity of peroxide, were kept in the shade, but immediately developed fungoid growths, and the peroxide disappeared. Further experiment showed that the presence of oxygen was necessary for the formation of peroxide in urine. From these results, coupled with those of Dr. Edward Frankland on the development of bacteria at various depths below water, Professor Ramsay regards it as proved that the action of violet and ultra-violet light on organic matter may lead in many cases to the formation of peroxide of hydrogen; that peroxide passes on a portion of its oxygen to the organic matter, thus becoming water and destroying or changing the organic matter; that such changes are destructive to the minute organisms contained in rivers, and generally to animal life, unless the organism is capable of secreting some pigment which excludes violet and ultra-violet light; and that certainly typhoid and anthrax, and probably also other zymotic disease, would be prevented if it were possible to subject the source of infection to sunlight in the presence of moisture.

GENERAL.

JOSEPH DWIGHT WHITNEY, professor of geology in Harvard University, died at noon on August 19th, aged 76 years.

ALBERT NELSON PRENTISS, who since the foundation of Cornell University, in 1868, had occupied the chair of botany, arboriculture and horticulture, died at Ithaca, on August 14th.

FOLLOWING closely on the death of Sir Joseph Prestwich comes the news of the death of Alexander Henry Green, also professor of geology at Oxford. Prof. Green was a student of Cambridge and a fellow of Caius College. He was for many years attached to the geological survey of England and Wales, and later became professor at Leeds, being appointed to the professorship of Oxford in 1888. He died on August 20th, at the age of sixty-four.

THE most recent advices indicate that not only in the north of Japan, but also in Norway and Russia, observations of the recent solar eclipse were made impossible by clouds.

A FIRE broke out on August 18th in the building of the Industrial Exhibition in Montpellier, France, which not only cost considerable injury to the exhibits, but also spread to the university buildings, the damage to the latter being estimated at 600,000 francs.

ACCORDING to the provisions of the will of the late George W. Wales, the Boston Museum of Fine Arts, after the death of his widow, will get $30,000, besides his collection of pottery and glass, and his books on pottery, engraving, glass, lace, painting, architecture and fine arts in general.

DR. A. BALDACCI has undertaken, during the present year, a botanical investigation of northern Epirus, especially the district of Konitza.

DR. NANSEN has contributed to the London *Chronicle* a detailed account of his adventurous exploration, which has been cabled to this country and read by everyone in the daily papers. He states that during the drift of the Fram northward he made careful series of scientific observations, meteorological, magnetic, astronomical and biological, soundings, deep-sea temperatures, examinations for the salinity of the sea water, etc. The sea was not more than ninety fathoms deep south of 79 degrees north, where the depth suddenly increased and was from 1,600 to 1,900 fathoms north of that latitude. This will necessarily upset all previous theories based on a shallow polar basin. The sea bottom was remarbably devoid of organic matter.

DR. HERMANN KRUTZSCH, lately professor of physics and meteorology at the University in Tharandt, died on July 28th, at the age of 77. We also note the death of Dr. L. C. Wiener, professor of mathematics in the High School of Karlsruhe, at the age of 70.

MR. WILFRED WARD, who was Huxley's neighbor at Eastbourne during the latter years of his life, has contributed to *The Nineteenth Century* an interesting account of conversations with Huxley. He is reported to have said: "One thing which weighs with me against pessimism, and tells for a benevolent Author of the universe, is my enjoyment of scenery and music. I do not see how they can have helped in the struggle for existence. They are gratuitous gifts."

THE Editor of *The Astronomical Journal* announces that a few copies of the *Astronomische Nachrichten*, Vols. 100–140 inclusive, forty-one volumes in all, may be obtained from him for $75.00, which is much less than the regular price.

Prof. A. A. Tichomirow has been appointed director of the zoological museum of the University of Moscow, in place of the late Prof. Bogdanov.

The biological station at Plön was closed during the month of July, and has during this period been thoroughly renovated. It is open during August, a month especially favorable for a study of the fauna of the lake. The charge is 10 M. a week for the use of a table.

The committee appointed by the Kazan Physico, Mathematical Society to collect funds for the Lobatchefsky memorial have received 9072 roubles ($7165). *Nature* states that a circular issued by Prof. Vassilief contains the information that the fund has been utilized in the following manner: A capital sum of 6000 roubles has been used to found a prize of 500 roubles to be awarded every three years for a geometrical work, and especially one on non-Euclidian geometry, printed in Russian, French, German, English, Italian or Latin. The first prize will be awarded on November 3, 1897 (the centenary of Lobatchefsky's birth took place on November 3, 1893), and mathematicians competing for it must send in their works not later than November 3d (October 22d). The sum remaining after the foundation of this prize has been devoted to the erection of a bust of Lobatchefsky, in front of Kazan University. The bust will be inaugurated on September 13th of this year, and it is hoped that as many foreign men of science as are able will be present to witness the ceremony.

There will be held at Turin in 1898 a National Exposition at which special arrangements will be made for meetings on medicine and hygiene.

Dr. Geo. Bruce Halsted, professor of mathematics in the University of Texas, is spending the summer in Austro-Hungary and Russia, where he is engaged in mathematical research. His address is Kazan, Russia.

The British Commissioners for the Exhibition of 1851 have made twenty appointments to science research scholarships, for the year 1896, on the recommendation of the authorities of the universities and colleges in which this right is vested. The scholarships are of the value of £150 a year, and are ordinarily tenable for two years in any institution approved 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.

The University of the Pacific, at its last commencement, conferred the honorary degree of Doctor of Science upon Prof. Edward S. Holden, Director of the Lick Observatory.

Henry C. Ford, President of the Pennsylvania State Fish Commission, died at Philadelphia on the night of August 17th, at the age of sixty.

Since the outbreak of cholera in Egypt this year to August 15th there have been 14,755 deaths.

The agricultural experiment station of the University of Wyoming has issued a first report on the flora of Wyoming by Prof. Aven Nelson, botanist of the station. There are enumerated from the material in the herbarium 1,118 species and varieties of phanerogams representing 393 genera, and 170 more have been reported by other observers. Though the northeast and southwest floras are quite distinct from each other and from those portions of the State which have been the most carefully examined, 1,295 species and varieties have thus far been reported from the State, as compared with 1,460 from Nebraska and 1309 from West Virginia, two of the States that have been most carefully worked over.

The 119th part of the *Flora Brasiliensis*, containing Orchidaceæ III., by A. Cogniaux, has been published in Leipzig. The cost of this extensive work, which was begun in 1840, now amounts to nearly $1,000.

The last number of the *Transactions of the American Institute of Electrical Engineers* contains a report on standards of light by a subcommittee of the Institute consisting of Edward L. Nichols, Clayton H. Sharp and Charles P. Mathews. The committee concludes that of all standards thus far used candles are the least reliable. It seems likely that many of the difficulties that are unavoidable with flame standards may be overcome by the adoption of a standard consisting of some surface electrically heated to a standard temperature. The definition of the degree of incandescence of such a surface appears at the present almost insuperable, but the committee is at work upon a method for the measurement of the temperatures of incandescent carbon, which may lead to results looking towards the solution of the problem. It also has in progress experiments looking to the production of a light standard in which not only the burning material, but also the atmosphere, shall be of known and definite chemical composition.

PROF. E. B. TITCHENER, of Cornell University, will translate into English Wundt's *Physiologische Psychologie* and, in coöperation with Mr. W. B. Pillsbury, Külpe's *Einleitung in der Philosophie*. Miss Julia H. Gulliver, of Rockford College, will translate Wundt's *Ethik*. WUNDT'S *Lectures on Human and Animal Psychology* and Külpe's *Outlines of Psychology* have already been translated into English by Prof. Titchener, the former in coöperation with Prof. Creighton, and his *Introduction to Psychology* is being translated by Dr. Judd. Consequently, after a too long delay, we shall have adequate English versions of Wundt's contributions to psychology, including those of one of his most prominent pupils, Prof. Külpe.

THE Chicago Academy of Sciences gave, from July 15th to August 15th, a free course of lectures by twenty-five different lecturers, the subjects included being Anatomy, Climatology, Optics, Geology, Astronomy, Physics of Electricity, Botany, Zoology, Entomology, Comparative Anatomy, Mental Science, Biology, Physiology, Malacology, Physical Geography, Surgical Anatomy, Physics of Optics, Bacteriology, Ornithology, Scientific Nursing, Latin, German, Anthropology, Chemistry, Surgical Philosophy, Medical Chemistry, Hygiene and Meteorology. Meteorology was demonstrated at the Auditorium Tower every Saturday afternoon from 2 to 4 o'clock by Prof. E. B. Garriott.

THERE has been established in Berlin a People's Society for Natural Science, the chief object of which is to offer scientific lectures that will be interesting to those having no technical knowledge of the subject. The first lecture before the Society was given by Dr. Förster, Director of the Royal Observatory, and was entitled 'Conditions and beginnings of life on the earth.'

A CASE reported in *The British Medical Journal* may be of interest to American as well as English municipal authorities. The executors of the late Mr. T. H. Smith, of Moseley, near Birmingham, claimed, on behalf of his widow and six children, the sum of £10,000 damages from the King's Norton Rural District Council for negligence, which, it was alleged, caused the death of Mr. Smith from typhoid fever. It was stated that a ventilating shaft communicating with a chimney in the house of the deceased allowed sewer gas to be conveyed into the rooms. In 1891 the Council undertook to disconnect the shaft, but after Mr. Smith's death inquiry was made, with the result, it was alleged that a defect was found to exist which, still permitted the escape of sewer gas into the house. The jury gave a verdict for the plaintiff, with £3,500 damages.

WE learn from the New York *Evening Post* that, beginning with August 28th, the usual series of horticultural schools under the direction of the professors at Cornell will be conducted throughout western New York. Twenty-six schools have been definitely arranged for, to be in the charge of three distinct sets of teachers, having at their heads respectively Prof. L. H. Bailey, who travelled 15,000 miles back and forth through the State in carrying out this work last year; George T. Powell, of Ghent, and Prof. E. G. Lodeman.

UNIVERSITY AND EDUCATIONAL NEWS.

THE University of Pennsylvania will proceed at once with the erection of a new building for the department of dentistry, to cost $120,000.

GROUND has been broken for the new library at Princeton University. The building is to be 200 x 180 feet in ground measurements, and will be four stories high. The estimated cost is $598.000.

THE London University Bill, which it was hoped to pass through Parliament before its adjournment, has been abandoned, owing to the opposition of a few members of the House of Commons who wish to introduce a Church of England 'Test' for the professorships in Kings College.

Col. W. C. Breckinridge, of San Antonio, has given $30,000 to the University of Texas to be used for a dormitory and confectory for the women students of the medical department.

Dr. A. C. Abbott has been appointed to succeed Dr. Billings, who has resigned the chair of hygiene in the University of Pennsylvania.

Dr. Edwin F. Northrup, of Syracuse, N. Y., has been elected associate professor of physics in the University of Texas. Dr. Northrup is a graduate of Amherst College, was later a graduate student at Cornell University, and a fellow for two years at Johns Hopkins University.

Mr. B. M. Duggar has been appointed assistant in cryptogamic botany in Cornell University.

Prof. Thompson has resigned from the chair of ophthalmology in Jefferson Medical College and will be succeeded by Dr. de Schweinitz.

Dr. Burney Yeo has been appointed by the Council of King's College professor of the principles and practice of medicine in succession to Dr. Lionel Beale, and Dr. John Curnow has been appointed to the chair of clinical medicine in succession to the late Sir George Johnson.

Dr. C. v. Ehrenfels, of Munich, has been appointed assistant professor of philosophy in the University of Prague, and Prof. R. Anschütz, of Bonn, has been appointed acting director of the Chemical Institute of the University.

DISCUSSION AND CORRESPONDENCE.

A PROTEST AGAINST QUADRINOMIALISM.

In the present days when systematists are continually confronted with puzzles in nomenclature, which owe their origin mainly to the inadequate descriptions and careless methods of the older naturalists, it seems of the greatest importance for us to consider carefully any new practices that may be proposed by writers of today, and to call attention to their good or bad points before they are adopted by others.

A case in point will be found in papers by Dr. C. Hart Merriam, in 'North American Fauna,' Nos. 10 and 11. This is practically the proposition to introduce 'quadrinomials' into our nomenclature. Trinomialism, the use of 'subspecies,' has of late years become almost universal among zoologists in this country, and its advantages are well known. Dr. Merriam has always been a strong advocate of trinomialism, but in the papers just referred to he goes a step further and describes 'subspecies' of 'subspecies,' which is practically quadrinomialism, though he so writes the names as to use only three words.

For instance, *Blarina brevicauda*, is the common short-tailed shrew of the northeastern States. In the Southern States it merges into a smaller subspecies known as *Blarina brevicauda carolinensis*. In tropical Florida still another subspecies is found which Dr. Merriam names *peninsulæ*. This, according to our established usage would stand as *Blarina brevicauda peninsulæ*, but Dr. Merriam writes it *Blarina carolinensis peninsulæ* (N. A. Fauna, No. 10, p. 14).

It will be noticed that *carolinensis* is thus treated as the 'species' of which *peninsulæ* is made a subspecies, while on the preceding page *carolinensis* is itself treated as a subspecies of *brevicauda*.

In other words, the author prefers to unite in the trinomial name the two forms which are geographically contiguous and to omit the fourth name, *brevicauda*, for the sake of brevity. This is of course nothing more nor less than quadrinomialism.

There is no doubt but that quadrinomials or any form of polynomials may be employed under the same rules that now govern us in the use of binomials and trinomials, but the question arises, are they desirable or useful? Decidedly not. Trinomials serve a useful purpose in the designation of geographical races, which while quite distinct in their extremes are connected by a perfect series of intergrades. No other satisfactory method of designation has ever been suggested for these. But here let us draw the line. We cannot express the whole relationship of a species in its name, and if we could the name would become useless as such; and when it comes to dropping out a portion of it we only tend to confusion. Do we not lose just as much by omitting *brevicauda* in the instance quoted as by inserting *carolinensis*?

Moreover the adoption of such a practice will necessitate the rearrangement of most of our existing trinomial nomenclature, and in such cases as the Song Sparrows or Horned Larks among our birds it will be no small matter to decide which of the numerous subspecies shall be relegated to 'sub-subspecies' and in which instances the species name shall be omitted.

Furthermore, is not an author who uses quadrinomials, expressed or implied, placing himself in the same category with Brisson and other post-Linnean authors who were more or less polynomial? And when we ignore their works entirely, what right have we to recognize more recent writers who are not consistently binomial?

In conclusion it seems to me a matter of serious regret, when the A. O. U. Code of Nomenclature has practically become the standard for American zoologists and botanists, to see a member of the A. O. U. Committee on Nomenclature breaking away from the Code and proposing such innovations as the above. Is not such individual action directly opposed to the ultimate stability of our nomenclature?

WITMER STONE.

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, August 3, 1896.

IMPOSSIBLE VOLCANOES.

TO THE EDITOR OF SCIENCE: I wish to echo the protest expressed by J. Paul Goode in a recent issue of SCIENCE, against the illustrations of impossible icebergs, with which our text-books are filled, and ask that impossible volcanoes be put in the same category.

The picture which has done service in geographies for many years as a representation of Popocatapetl is about as severe a libel on a respectable volcano as one could well imagine. A tall cross, such as no traveller in Mexico ever saw, and luxuriant palms such as never grow at the altitude from which Popocatapetl can be seen, make up a tropical foreground beyond which a symmetrical, snow-capped cone with a slope of from 40° to 50° rises to an impossible height and extends to an impossible magnitude.

All this is untrue, and it would seem, considering the number of excellent photographs of the volcano extant, unnecessary. Besides, it tends to perpetuate a common misconception as to the slopes and heights of mountains which it is time to correct. Many of the pictures of mountains appear rather to record the feelings of the artist after he has climbed to their summit than to represent their actual profile.

It ought to be generally understood that the average slope of a mountain of any kind can rarely be more than 35° and is usually much less. During a recent visit to Popocatapetl, I measured its slope from several points of view, and found it never more than 30°. In making a sketch of the volcano, however, I found that I labored under the optical delusion which leads one to exaggerate the steepness of mountain slopes, and which probably accounts for their usual faulty representation. The slope as I represented it on the paper, with what I thought to be a fair degree of accuracy, proved on holding the paper between my eyes and the volcano to be far too steep. It was only after several trials that I could give it the requisite flatness.

On relief maps vertical exaggeration is excusable and without doubt necessary, but it can hardly be said to be in text-book illustrations. Natural scenery is sufficiently imposing not to need to be made attractive by exaggeration, while correct illustrations strengthen the pupil's confidence in the truth of what he is taught.

I append a view of Popocatapetl as it is represented in a modern geography in common use in our schools, and, for comparison, a profile drawn from a photograph of the volcano as it appears from the valley of Puebla.

Oliver C. Farrington.

Field Columbian Museum, Chicago, Ill.

ON THE NOTATION OF TERRESTRIAL MAGNETIC QUANTITIES.

At the International Meteorological Congress to be held in Paris, a number of questions of special interest to magneticians have been proposed for discussion, among which is the following: The same notation should generally be employed, H for horizontal force, X for the northern component, Y for the western component, Z for the vertical force, and V for the potential. As the need of some uniform notation has been made apparent to me in connection with the journal *Terrestrial Magnetism*, I have been paying this matter some attention with the view of obtaining a concise and logical system for adoption in this journal.

The principle upon which I proceed is to take the first letter of a word designating a particular quantity, if at the same time it conforms with typographic requirements, such, for example, as declination, which is common to several languages. In this way I have thus far obtained the following: D for declination, I for inclination, H for horizontal component of force, V for vertical component, F for total force.

Upon examination it will be found that these letters stand for words derived in almost all cases originally from the Greek and Latin languages and, with but insignificant variations in spelling, common to several of the main modern languages. The Germans will be asked to yield a point with regard to F,* but this, as will be seen below, will be made up to them in the adoption of G for magnetic potential. V, taken from the Latin *vis* or I from *intensitas*, or D from the Greek word δύναμις, would not do for force, as they are already taken. Nor would T from *totus* or P from πᾶς answer, since the former is frequently used for time of vibration, and so in fact is the letter P, which stands besides for the first deflection coefficient. As I hope to be able to find satisfactory notation for all the principal magnetic quantities, I am keeping this matter constantly in mind in adopting any particular letter. The English and French have *force*, and I have, therefore, adopted F for total force. As it is frequently the custom to designate angular quantities by Greek letters, I should have preferred, had it been possible, to adopt δ and ι instead of D and I, but the Greek ι is a very unsatisfactory letter from a typographical standpoint. Moreover, if found desirable later on, the small letters d and i or δ and ι can be reserved for the variations on the mean of day and on the mean of year respectively.

I think it very much to be deplored if Z, as above proposed, be universally adopted to designate the vertical force. It should not be forgotten that the Gaussian mode of resolving the magnetic force into northerly component (X), westerly component (Y) and vertical component (Z) applies to a *local* system of coordinates, not to a fixed system, as the layman might naturally suppose, a fact which is even apparently forgotten at times by magneticians. The mean values of these components for a complete circuit of the earth along a parallel of latitude can, in consequence, no more be *physically* interpreted than the mean H, for example. I am therefore opposed to adopting a letter for the vertical force which in no way gives evidence of the exact quantity for which it stands. V, on the other hand, is logically connected with H and at the same time implies that the direction of the quantity that it symbolizes is *local*, the direction of the vertical or plumb line varying from point to point.

For the same reasons I am not in favor of adopting X for northerly component and Y for westerly component. Let authors choose this method of notation if they prefer it, but in a

*The initial letter of the German word *Kraft* is frequently used to designate the moment of inertia and hence will not answer for force.

system suggested for universal adoption it would seem to me that N and W would more satisfactorily meet the requirements, clearly indicating to the eye as they do the local character of the system of coordinates employed.

As a letter to designate the earth's magnetic potential, I believe none more fitting could be adopted than G after Gauss, the author of this function. Gauss himself used V, but this letter is not sufficiently characteristic; it is used to designate many other functions in mathematical physics; and there would, moreover, be a conflict in our system, since V seems the most logical letter to designate the vertical force.

L. A. Bauer.

Linden, Md., August 10, 1896.

SCIENTIFIC LITERATURE.

Memoirs of Frederick A. P. Barnard, D. D., LL. D., L. H. D., D. C. L., Tenth President of Columbia College. By John Fulton. Columbia University Press. Macmillan & Co. 1896.

When a person has been for nearly sixty years deeply interested in the problems of education, and has himself contributed largely to their solution, his biography necessarily reads like the history of the progress of this science during that period. The life under review is no exception, and indeed his lively reminiscences of his own early school days carry the beginning of our period back to the time when our century was scarcely a baker's dozen years old.

Born May 5, 1809, at Sheffield, Mass., of old Puritan stock, Frederick Augustus Porter Barnard was a thorough New Englander. He has given a very vivid description of the isolation of the little village among the hills and its peculiar institutions, especially the 'meeting house' and all its associations. He says of this early period of his life, which he afterwards came to consider all important in the education of a child: "I believe that if there is anything good in me it must be owing to that loving maternal solicitude which gently swayed me toward the right, at a time when the bending of the twig sufficed to give its permanent inclination to the full grown tree." Soon after he could walk he was sent to the village school, and at four attended a 'grammar school.' At six he commenced the humanities with the village parson and was an interested reader of Shakespeare's comedies; with his mother he made the acquaintance of Cowper, Goldsmith, Addison, Burke and others. At the same time his ingenuity produced kites, windmills, waterwheels and the like, which were the objects of the envious admiration of his playmates. At the age of nine he went away to the Saratoga Academy, where along with much classics he learned the printer's trade, an incident which undoubtedly was the beginning of that interest in journalism which resulted later in so much editorial work. When only twelve he was sent to the Stockbridge Academy to prepare for Yale, where he entered three years later (1824), the youngest member of his class. One will be amply repaid for reading his lively and often amusing accounts of his life at the preparatory school, and especially his description of contemporary life at Yale. Graduated second in his class in 1828, he was appointed teacher in the Hartford Grammar School. These two years of life in Hartford prior to his appointment at Yale were full of new experiences and ventures, especially as an author and an editor, and at this early date he evinced that liking and aptness for newspaper controversy that stood him in such good stead in his after life.

When Barnard was appointed to teach at Yale it had been the custom for each tutor to take his share of the entering class and teach them all the branches during their first three years. As an undergraduate he had seen the weakness of this method, and his first act at Yale was to persuade the faculty to permit the division for the first three classes by subjects instead of by numbers, thus starting a much needed change. After one year of service he was so troubled by increasing deafness that he resigned from Yale and threw himself heartily into the instruction of the deaf mutes at the Hartford Institution. Removing in 1832 to the similar institution in New York city, he labored zealously and happily until his call to the University of Alabama early in 1838.

During the sixteen years of his stay at Tuskaloosa, Barnard began the campaign for good discipline and a correct curriculum, which only ceased when he resigned the Presidency of Columbia in 1888. He was specially occupied with the teaching of chemistry, natural philosophy, or mathematics, but made time for some outside scientific work, as, for example, the commission to establish the boundary between Alabama and Florida. His chief energies, however, were devoted to the old problems of discipline and curriculum and many letters, editorials and reports attest his activity as well as his great power in this field of discussion. Incidentally he frequently took occasion to inveigh against secession, and in vain endeavored to cultivate devotion to the Union, especially in his famous Tuskaloosa oration July 4, 1851.

In 1846 he was married to Margaret McMurray, a young woman of English parentage, who was ever to him a loving and devoted helpmate, and to her affectionate zeal is chiefly due this collection of memories. After his death, April 27, 1889, she made arrangements to publish his life, but when only two chapters had been written she suddenly died, leaving the editor uninstructed in details and unprovided with many important letters.

In 1854 Barnard was called to the chair of mathematics and natural philosophy in the University of Mississippi, at Oxford. During his first year he also gave full courses in chemistry, astronomy and civil engineering. He was soon after elected Chancellor (President) of the University, in which office he labored still more zealously and effectively for good discipline and for the true university. This period is especially noteworthy as witnessing his change of views with reference to the relative importance of 'mental discipline' studies like the classics and of the 'useful' studies like science.

While chancellor he was on one occasion charged with 'unsoundness' on the slave question, a charge of which he was acquitted by unanimous vote of the trustees. Even though we must give full weight to the trying conditions amidst which he was placed, still we must admit that in this instance he lacked that supreme element of courage which would have boldly proclaimed the abhorrence of that institution which his earlier and later utterances show that he must have felt. Instead of this he allowed appearances to exculpate him, without any open declaration that would contravene his secret convictions. This weakness was emphasized by the publication, after his return to Washington, of a most rabid attack upon slavery in his 'Letter of a Refugee.'

At the final outbreak of the war he resigned the Chancellorship and left Oxford in 1862, eventually reaching Washington, where he was occupied with several pieces of scientific work until his appointment, in 1864, as President of Columbia College, in the City of New York.

The twenty-four years of his Presidency of Columbia were years of hard work, with many discouragements, but much success, and closing with the college in a position from which it could and did suddenly rise to the rank of a University of the first class. During this time he labored for the true university and argued as forcibly for an optional course, and for the advantages of the exact sciences, as he had previously insisted upon an inflexible devotion to the classics at Tuskaloosa. He seems actually to have changed his opinions upon this subject, but was not willing to admit it, striving to ascribe the needed change of course entirely to changed conditions. Indeed his love of science is well proved by his generous bequest to Columbia of a library fund of $50,000, from the income of which the Barnard medal ($200) is given every five years, and a $10,000 science fellowship fund.

Latterly, he urged the admission of women to the privileges of the college and university, and Barnard College is at once the result and the reward of his activity in this field.

Although a little prolix in places, and the introduction of quotations sometimes results in repetition, still these memoirs may be read with pleasure and profit by all who are interested in the progress of this country during the last three-quarters of a century. A brief but interesting history of Columbia College is introduced, taken largely from Dean Van Amringe's more elaborate sketch.

Barnard appears to have been a man of considerable power, rather dogmatic and somewhat dictatorial, but usually supported by good reasons. In fact it seems doubtful whether his strength lay so much in the inherent correctness of his ideas, as in the uniform clearness and force with which he propounded and defended them. He was a born advocate, and if he had been able to follow his chosen profession of law he would undoubtedly have become famous. W. HALLOCK.

COLUMBIA UNIVERSITY.

The Legend of Perseus; A Study of Tradition in Story, Custom and Belief. By EDWARD SIDNEY HARTLAND, F.S.A. Vol. I. The Supernatural Birth. London, David Nutt.

Mr. Hartland believes that the classical myth of Perseus belongs to a group of folk tales ranking among the foremost in interest for the student of the evolution of human thought and human institutions. The first three chapters are devoted to an account of the story as given by the poets and historians of antiquity, and in modern folk-lore ; the remaining chapters trace the supernatural birth in Märchen, Sagas and practical superstitions. The legend consists of three leading trains of incident, viz.:

1. The Birth, including the prophecy, etc.
2. The Quest of the Gorgon's Head, including the jealousy of Polydectes, etc.
3. The Rescue of Andromeda, including the fight with the monster, etc.

It is considered that the modern tales have come down from classical antiquity in the countries in which they are now found, but they are subject to variations. After the Danæ type we have a type in which the wife of a poor fisherman eats the head of a fish—the king of the fishes—and becomes the mother of three boys. In this group the plot consists of four incidents, distinguishable as :

1. The supernatural Birth,
2. The Life-token,
3. The Dragon-slaying, and
4. The Medusa-witch.

After this group there still remain a large number of variants, wherein one or more of the incidents are wanting or may be represented by a mere relic. Some of these the author recognizes as probably derived by degradation from one or other of the earlier versions; of some he is constrained to say that they are in a state of decay; and in some the reader can hardly see any resemblance at all to the legend of Perseus. Yet the connection may be said to be made out, through the tracing of the gradations of change.

The stories of supernatural birth are very numerous, and may be said to have a currency as wide as the world. The usual agency is, that a woman eats some part of a mysterious fish; but in India it is fruit that she eats, an apple or an orange, or two grains of wheat, or soma seeds; or she swallows a potent drug. Conception in other cases has been by the wind or by the rays of the sun. The author has been very industrious in collecting stories and very discriminating in their classification; he gives more than twenty pages of authorities whom he has consulted; and as a student of folklore, working on approved lines, he has performed his task well.

The question, however, occurs, whether this laborious hunting up of stories is a very profitable business? Many of the modern folk-tales may be interesting stories for the nursery ; and it is as well, once for all, to know their relations or resemblance to the legend of Perseus; but what was the meaning of the Perseus legend itself? We are not persuaded of the 'anthropological' explanation, according to which 'the original belief is intimately bound up with the savage theory of the universe.' The Greeks had ceased to be savages when they came to believe in Zeus, and framed the story of Perseus. The Greek mythology had an astronomical basis, and not an anthropological ; Perseus and Andromeda are still constellations in the heavens ; and Zeus is there too, though unrecognized. Besides, it hardly seems consistent to trace the folk tales of savages to the Greek myths and then seek the origin of the myths in the irrational fancies of savages. The study of folk tales, in their multiplication, variation and decay, is analogous to the study of Scripture MSS. with their hundreds of various readings. The revisers of the Bible found that the three oldest manuscripts were of more value than all the hundreds of later copies ; and the student of the legend of Perseus will find the parallel Babylonian legend of Gilgames more to his purpose than a bushel of modern folk-lore.

GEO. ST. CLAIR.

SCIENTIFIC JOURNALS.

TERRESTRIAL MAGNETISM, JULY.

A Summary of the Results of the Recent Magnetic Survey of Great Britain and Ireland Conducted by Professors Rücker and Thorpe: By A. W. Rücker.

The writer divides his article into three parts. Part I: *On the Accuracy of the Delineation of the Terrestrial Isomagnetic Lines.* Complete observations were made at 882 places in the British Isles, thus averaging one station to every 139 square miles of land area. With the exception of the recent magnetic survey of Holland by Dr. Rijckevorsel, where the stations averaged one to about every 39 square miles, this survey of Rücker's and Thorpe's is the most detailed one thus far made. A first survey embracing 205 stations was made for the mean epoch 1886, and a second one covering 667 stations for the epoch 1891. In no previous case have *two* such detailed surveys for the same region been made within so short an interval of time. They they therefore present a good opportunity for testing the accuracy with which the positions of the terrestrial isomagnetics can be inferred from the observations. The conclusion is reached that the accuracy of the calculated values is about equal to the probable error of an observation (declination $\pm 0.'6$, dip $\pm 0.'4$, horizontal intensity in C. G. S. units ± 0.00006).

Part II: *On the Accuracy of the Determination of the Local Disturbing Magnetic Forces.* The main object of so elaborate a survey was to study local magnetic disturbances. For this purpose the northerly, the westerly and the vertical components of the earth's magnetic force were determined from the observed elements, declination, dip and horizontal intensity. The differences between these quantities and those calculated from the formulæ for the isomagnetics gave the corresponding components of the disturbing force. When these were plotted, and lines called respectively *ridge* and *valley* lines were drawn through the loci of maximum and minimum vertical disturbing force, it was found that, with few exceptions, the horizontal disturbing forces were directed to the ridge lines. Eight such regions were detected in the 1886 survey and again revealed in the later survey. The range of the magnitude of the vertical disturbing force at places where the surface is comprised of sedimentory rocks is about 0.00600 C. G. S. units. On granite and gneiss the range is doubled, and in the neighborhood of basalt it may be enormously increased. One of the ridge lines could be traced without difficulty for 170 miles and more. Disturbances of a secondary order were also revealed.

Part III: *On the Relation between the Magnetic and the Geological Constitution of Great Britain and Ireland.* The most probable causes of the disturbing forces are electrical earth currents and magnetic rocks, or both of these combined. Rücker is led to the belief that the presence of magnetic rocks is the more potent cause. The article is illustrated by maps and concludes with a summary of the results with regard to the relationship between geological and magnetic features.

Die magnetischen Störungen der Yahre 1890–5, nach den Aufzeichnungen des Magnetographen in Potsdam: By G. Lüdeling.

This is an investigation of the magnetic perturbations for the interval 1890–95, as revealed by the self-registering instruments at the Royal Magnetic Observatory, Potsdam. According to the tabular and cartographic presentation, there is a characteristic increase in the number of disturbances towards evening and decided decrease at noon. The equinoctial months are the most disturbed, and in these the diurnal distribution of disturbances is most pronounced, a double maximum showing itself most decidedly. The annual distribution as determined from this six-year series shows as yet no pronounced parallelism with the distribution of sun spots over the same period. There is, however, a nearly perfect concordance in both the diurnal and in the annual period of magnetic disturbance and of polar lights.

A letter to the editor by Prof. Hellmann of Berlin, with regard to an old work containing magnetic declinations, notes by the editor and reviews of Paulsen's papers 'On the Nature and the Origin of the Aurora Borealis,' of Carlheim-Gyllensköld's 'Determination of the Magnetic Elements in Sweden and of Weyer's Researches,' 'On the Magnetic Declination and its Secular Variation,' conclude the number.

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SCIENCE

FRIDAY, SEPTEMBER 4, 1896.

CONTENTS:

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

THE BUFFALO MEETING.

THE meeting last week was one of the smallest in the recent history of the Association, but it was of unusual interest and importance. The address of the retiring president, which we have already published, was from a master hand, and the meeting was presided over by one of the great men of science of the world. The scientific work of the sections was as a rule good, and in several cases, especially in chemistry, in geology and in botany, was excellent. We must count on another comparatively small meeting at Detroit next year, but we believe that the outlook has never during the present decade been more hopeful for the Association.

The American Association for the Advancement of Science has two serious difficulties with which it must contend. One of these is the scattering of American men of science over a wide territory; the other is the increased specialization in science

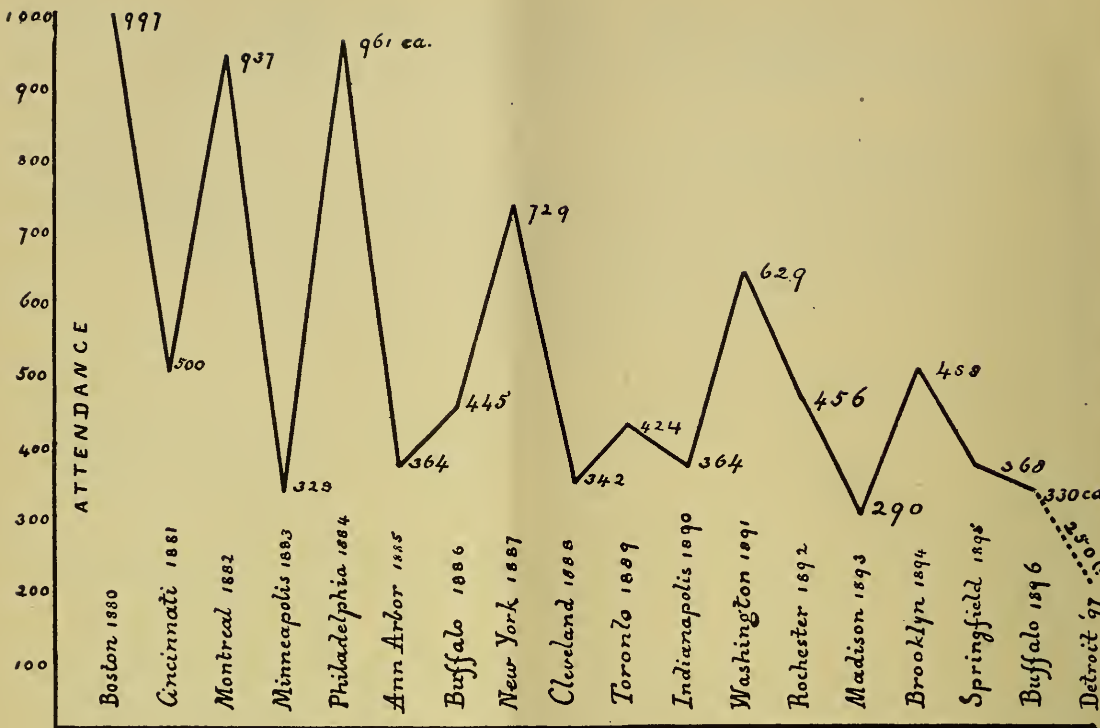

Fig 1.

and the special societies which have sprung up in consequence. Yet these two difficulties are the strongest arguments that can be urged for the necessity of the Association. The fact that men of science are so widely separated, and have no established center where they are likely to come in contact with each other, makes the annual meetings of the Association essential. The fact that great specialization in science is needful makes it peculiarly important for the sciences to be kept in touch. The sciences are but members of science, which is an organic body. As Aristotle has said, "a hand cut off from the rest of the body is no longer a hand."

The dispersion of American men of science is inevitable, and is indeed favorable to the advancement and diffusion of science. We can but appeal to all to promote the common welfare by attending the annual meetings even at a great sacrifice of time and money, and try to make the meetings so valuable that none can afford to be absent. In the case of the special societies arrangements can be made, and are being made, by which they will not weaken, but strengthen, the Association. If part of the time of the meeting be given to these societies, subsections being organized to make specialization as complete as may be desirable, and the rest of the time be given to joint meetings of several sections and of the entire Association for the discussion of questions of common interest and great importance, all the objects of the Association will be accomplished.

It must be accepted as a fact that the attendance at the meetings (as shown in the accompanying curve) after reaching its maximum from 1880 to 1884 has steadily declined. It is also true that with some noteworthy exceptions, leaders in science have in recent years very generally absented themselves from the meetings. We think this is from no lack of interest in the aims of the Association, but from inertia and habit. It is true in psychology as well as in physics that a body at rest will remain at rest until moved by some external force. Fortunately when once in motion it will continue to move in a straight line. The time has come to apply the force.

The election of Prof. Wolcott Gibbs as president of the Association, and men such as Dr. G. Brown Goode as vice-presidents for some of the Sections, was a courageous act, the value of which cannot be overestimated. A majority of the nominating committee believed that present conditions offered an opportunity for further courageous action of much importance. It was recommended that the Association meet next year at Toronto to welcome the British Association to American territory and to join with them in the scientific work of their sections. The Toronto committee sent a delegate to Buffalo with a cordial invitation, and we could have welcomed the British Association through a retiring president and a president-elect equal in accomplishment to any delegate from Great Britain. The following year will be the fiftieth anniversary of the foundation of the Association, and in Boston or New York, with the same officers, we might have held a meeting far surpassing any in the history of the Association.

The recommendation of the nominating committee was not accepted in the general session. The question was nicely balanced, and there was room for difference of opinion among those interested in the welfare of the Association. It seems, however, evident that the Association should be a true democracy. Having chosen its delegates, their deliberative action should not be reversed by inconsiderate impulse. As Huxley has said, "there may be wisdom in a multitude of counselors, but it is usually in one or two of them.' Folly is also likely to be concentrated in one or two of a crowd, and unfortunately folly is more contagious than wisdom. Whatever may have been the merits of the present question when it was before the nominating committee, the action of the general session has given a warning that should be heeded.

If a meeting apart from the British Association were to be held, Detroit seems to be the best place, and it was of course desirable to choose a time not conflicting with that of the meeting of the British Association. The curve of attendance demonstrates that the meetings at Cincinnati, Minneapolis, Ann Arbor, Cleveland, Indianapolis and Madison have always been stepping stones in a downward path, and we fear that a meeting at Detroit, beginning on August 9th, will be no exception. For this very reason we must use our best efforts to make the Detroit meeting creditable, and begin at once to plan for a notable meeting in Boston or New York on the occasion of our fiftieth anniversary.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: FORTY-FIFTH MEETING, BUFFALO, AUGUST 24–29, 1896.

The fourth Buffalo meeting of the American Association for the Advancement of Science, began on Saturday, August 24th, 1896, with the meeting of the Council at noon, in the Iroquois Hotel, with rather more than usual of that body present. The first general session of the Association was held at 10 o'clock Monday, and the last at 8 o'clock on Friday evening.

On Tuesday evening a reception was given to the Association by the ladies of Buffalo in the rooms of the Twentieth Century Club. The Buffalo Club extended the privileges of its house to all members during the week. Thursday afternoon, August 27th, the Geologists were entertained at the Idlewood Club, at the mouth of 18-Mile Creek, a noted fossil collecting ground. On Friday, August 28th, the Botanists were taken ten miles up the Canadian lake shore to Point Abino, where the Section was the guests of the Point Abino Association. The grand trip of the session was a general complimentary excursion for the Association to Niagara Falls, on Saturday, August 29th.

The new arrangement as to time seems to have been generally satisfactory, and is decidedly advantageous in permitting the sections to have sessions for four full days without interruption. The attendance this year was not large, owing doubtless to the economy-provoking condition of political affairs. The registration was 330. 110 new members were elected and 83 members were elected fellows. Horatio Hale, of Clinton, Ont., upon nomination by Section H, was made a life fellow, and Wolcott Gibbs, Professor Emeritus in Harvard University, was elected an honorary fellow. Four foreign associates were elected: Victor Gutzu, of Bucharest, Roumania, sent by his government to investigate petroleum products; Seiryo Mine, of Japan, sent by his government to investigate long distance transmission of electrical power; Miss Mary Foster, member of the Geological Society of London, and J. Bishop Tingle, of Aberdeen, Scotland.

Most of the officers of the Association were present. Vice-President Wm. E. Story, chairman of Section A, was detained by sickness in his family; the untimely death of Capt. John G. Bourke created a vacancy in the secretaryship of Section H, as did the journey to Greenland of Prof. A. C. Gill in that of Section E. Alex. Macfarlane, of South Bethlehem, Pa., was elected vice-president and chairman of Section A; Wm. North Rice and Geo. H. Perkins were elected secretaries of Sections E and H respectively.

The first session was called to order by the retiring president, Edward W. Morley, of Cleveland, who introduced the president-elect, Edw. D. Cope, of Philadelphia, who called upon Bishop Charles H. Fowler, D. D., to pronounce the invocation. The Association was welcomed by a brief address by Mayor Jewett, on behalf of the city, and by Dr. Roswell Park, President of the Buffalo Society of Natural Sciences, on behalf of that body. President Cope responded to the welcome and took occasion to speak of the characteristics of a scientific career. In the afternoon the eight addresses of the vice-presidents were delivered. These will be published in this Journal. In the evening the address of the retiring president (published in the last number of this Journal) was given before a large audience.

A communication regarding the metric system was referred to the Chairman of the Committee on Standards of Measurement, President T. C. Mendenhall. Later that committee presented the following report which was adopted:

Resolved, That the A. A. A. S. is now, as it always has been, earnestly in favor of reform in weights and measures, and it urges upon the Congress of the

United States the desirability of further legislation looking to the early adoption of the metric system.

Upon the subject of electrical standards the committee presented the following report which was adopted :

In view of the absence of any properly constructed and authenticated standards of electrical measurement prepared under the law of 1894, this committee recommends that it be authorized to construct such standards, and to pay in part the necessary expenses incident to this work, that the sum of $50 be placed at the disposal of the committee from current funds of the Association in possession of the treasurer ; it being understood that any standards thus constructed or material so acquired shall remain the property of the A. A. A. S., until otherwise disposed of by the Council.

A communication from the Joint Commission of the Scientific Societies of Washington regarding the creation of the office of Director-in-Chief of the scientific divisions of the United States Department of Agriculture was referred to a committee which later presented the following report, adopted unanimously:

Your Committee has carefully considered the communication from the Joint Commission referred to, and has consulted sundry other papers sent on from Washington by persons interested in the movement in question. That there has been in Washington a movement towards the creation of such an office is probably familiar to all the members of the Council. The Committee is informed that a circular letter from the Secretary of Agriculture has been sent to many of the members of the Council, and an editorial in SCIENCE has probably familiarized others with the matter. The Department of Agriculture has further been in correspondence with many scientific organizations in the country which could be regularly reached, and all have expressed themselves as favoring the plan.

In brief, the plan is the outgrowth of the unsatisfactory condition of affairs which has existed in the Department of Agriculture for some years, in fact since the great development of its scientific work which has taken place within the last decade. The officer having immediate supervision of the scientific divisions is the Assistant Secretary of Agriculture. This office is filled by Presidential appointment for a term of four years, and it has been found by experience that it takes the person appointed to fill this office about one year to familiarize himself with the details of the work, and that no sooner does he become thoroughly acquainted with the conditions than his term of office expires and a new man is appointed. Further, there is no certainty that the appointee to to fill the office of Assistant Secretary of Agriculture will in every case be a man of broad scientific opinions and able to satisfactorily supervise the work of the scientific divisions.

The great necessity for the existence of an officer of broad attainments, whose term of office would not be limited, and who could act in an advisory and controlling manner, becomes at once apparent. There are at present in the Department two large Bureaus, namely, The Weather Bureau and the Bureau of Animal Industry, and eight divisions engaged in purely scientific work. Of the two thousand men employed in the Agricultural Department, nine hundred and ninety-three are engaged chiefly in scientific and technical work. And of the $2,400,000 appropriated annually, $1,700,000 is appropriated for work of this class.

In view of the evident desirability of legislation in the direction indicated, an amendment to the appropriation bill was introduced in the United States Senate, May 13, 1896, and was referred to the Committee on Agriculture and Forestry. It received a favorable report from the Committee, but no action was taken by the Senate on account of the approaching close of the session. It is hoped that favorable action may be reached during the next session of Congress, and to this end it is proposed to submit to Congress the opinions of prominent individuals and scientific organizations. The proposition has been warmly approved by the following persons and organizations: President Gilman and the Scientific Faculty of Johns Hopkins University. President Dwight and the Scientific Faculty of Yale. Seventeen members of the Scientific Faculty of the University of Michigan. President Elliott and Prof. Shaler, of Harvard. Presidents Schurman, of Cornell; Low, of Columbia; Warren, of Boston; Walker, of the Massachusetts Institute of Technology; Hall, of Clark; Canfield, of Ohio; MacLean, of Nebraska; Chaplin, of Washington (St. Louis), and many other heads of colleges, directors of agricultural experiment stations, members of scientific faculties, various academies of science and scientific societies, the Joint Commission of the Scientific Societies of Washington, Mr. Theodore Roosevelt, and other gentlemen identified with the cause of Civil Service Reform.

In view, therefore, of the obvious good to the cause of science which will result from this proposed legislation, and in view of the practically unanimous endorsement which it has received from prominent educators and men of science throughout the country, and in further view of the fact, which is none the less true although it has not been publicly mentioned, that this movement is in the direction of the coordination of scientific work under the general government, it seems to your Committee that the American Association for the Advancement of Science can unhesitatingly approve.

Your Committee, therefore, recommends that the Council recommend to the Association the adoption of the following resolution:

Resolved, That the American Association for the Advancement of Science heartily approves the proposition to create the office of Director-in-Chief of Scientific Bureaus and Investigations in the Department of Agriculture, to be filled by a broadly educated and experienced scientific man, provided that such appointment shall be made only on the nomination of the National Academy of Science, the legally constituted adviser of the Government in matters relating to science.

L. O. Howard,
Committee.

A communication with reference to the proposed vivisection laws was referred to a committee which presented the following report, which was unanimously adopted:

The American Association for the Advancement of Science, at its annual meeting held at Buffalo, August 24th to 28th, 1896, desires to present to the Congress of the United States its protest against legislation on the subject of vivisection. The membership of this Association is composed of experts and authorities and persons interested in different branches of science, in all numbering nearly two thousand. These members come from all parts of the country and represent many diverse interests.

Whereas, This Association was organized for the purpose of advancing science, of diffusing scientific information and exciting widespread interest on the part of the public in scientific progress; therefore, be it

Resolved, That this Association deprecates any legislation on the part of the government which would tend in the slightest degree to discourage the advancement of science, more especially biological, chemical and medical science, at this time when greater results are promised than ever before in the history of the world. And

Whereas, The health and welfare of men and animals are vitally affected by the results of animal experiments, and such experiments have effected a saving of many millions of dollars in animal property, and are the basis of our knowledge of hygiene and preventive medicine, and, in part, of surgery; therefore, be it

Resolved, That while deprecating cruelty and needless vivisection experiments in the public schools, this Association believes that those who are trained in biological research are the ones who are best able to decide as to the wisdom and utility of animal experimentation and deems that the legislation contemplated by Senate Bill 1552 would be unwise and would tend to retard the increase of knowledge of the means of mitigation of the sufferings of men and animals.

Edward D. Cope,
L. O. Howard,
Committee.

A communication asking that some steps be taken by the Association to secure the study of the white race in America was referred to Section H, with a request that a committee be nominated to consider the matter. The section reported the following names and the committee was so constituted: D. G. Brinton, J. McK. Cattell, W. W. Newell, W J McGee, Franz Boas.

A resolution regarding the proper designation of the vice-presidents was referred to a committee consisting of T. C. Mendenhall, F. P. Whitman and L. O. Howard, and upon their recommendation the Council instructed the permanent secretary to use the term *vice-president* in official publications in expressing the relation of the presiding officer of any section to the Association, and the term *chairman* in expressing his relation to the section, the term vice-president preceding the name and chairman following it when both relatious are to be expressed. When referred to they are to be called vice-presidents *for* the sections, not *of* the sections.

The Committee on Grants recommended the following which were authorized by the Council: To the Marine Biological Laboratory, Woods Holl, Mass., for a table (appointment to be made by the vice-presidents for Sections F and G and the director of the laboratory), $100; to Francis E. Phillips for investigations on the properties of natural gas, $50; to L. A. Bauer for investigations on terrestrial magnetism in connection with the magnetic survey of Maryland, $50.

At the request of the National Educational Association a committee was appointed to cooperate with committees from the N. E. A., with a view to unifying the requirements in science in secondary schools. The committee named by the Council consists of Profs. R. S. Tarr, H. S. Carhart, A. S. Packard, C. F. Mabery and C. E. Bessey.

Upon the recommendation of Section F, Prof. A. S. Packard was appointed a member of the American Advisory Board on Zoological Names.

Upon the recommendation of Section E, the following were named as delegates to the International Geological Congress at St. Petersburg in 1897, with power to fill any vacancy by a majority vote: E. D. Cope, James Hall, B. K. Emerson, W. N. Rice, C. D. Walcott.

A communication from the American committee upon the proposed monument to Pasteur in Paris was read to the Association, with the statement that the funds of the Association did not warrant an appropriation. The next day the permanent secretary received a check for $100 from the generous patron of the Association, Mrs. Esther Herrmann, requesting that it be sent as the gift of the A. A. A. S. The treasurer was authorized to receive and transmit other gifts in the same way.

The officers of Section C were authorized to confer with those of the American Chemical Society in arranging the program of the next meeting. It is understood that the first two days of the meeting will be officially the meeting of the American Chemical Society, but that opportunity will be given for the proper organization of the section and the vice-president's address. The courtesy of reading papers before Section C is to be extended to members of the A. C. S. and *vice versa*. Similar arrangements were authorized between Section E and the Geological Society of America.

The Committee on the Policy of the Association has been active in considering steps for its further invigoration. Changes in the form and matter of the volume of proceedings, the relation of the affiliated societies, and a number of constitutional amendments permitting greater flexibility in transacting business and arranging for meetings were under consideration by the Council on recommendation by this committee, and it seems likely that some important advances will be made in the near future.

The place of meeting for 1897 and the relation of the Association to the Toronto meeting of the British Association was found a difficult problem. The invitations for 1897 from Indianapolis, Nashville, Columbus, Detroit, Minneapolis, Seattle, San Francisco, Denver and Toronto were all early placed in the hands of a sub-committee consisting of Professors Carhart, Mendenhall and Galbraith for consideration. Representatives of both Nashville and Toronto were present. This committee reported to the Nominating Committee, which debated the question for two hours, finally determining by about a two-thirds majority upon the following recommendation, which was presented to the Association:

> The Committee recommend that the meeting for 1897 be only a formal meeting, that it be held in Toronto on August 17th of that year, and that the Association join in welcoming the British Association for the Advancement of Science to the continent of America.

The recommendation was vigorously opposed and after a two hours' debate was amended so as to require the meeting for 1897 to be a regular meeting, the time and place of which was left to the discretion of the Council.

The officers elected for the next meeting are:

PRESIDENT.

WOLCOTT GIBBS, of Newport, R. I.

VICE-PRESIDENTS.

A. Mathematics and Astronomy—W. W. BEMAN, of Ann Arbor, Mich.

B. Physics—Carl Barus, of Providence, R. I.

C. Chemistry—W. P. Mason, of Troy, N. Y.

D. Mechanical Science and Engineering—John Galbraith, of Toronto, Canada.

E. Geology and Geography—I. C. White, of Morgantown, W. Va.

F. Zoology—G. Brown Goode, of Washington, D. C.

G. Botany—George F. Atkinson, of Ithaca, N. Y.

H. Anthropology—W J McGee, of Washington, D. C.

I. Social and Economic Science—Richard T. Colburn, of Elizabeth, N. J.

PERMANENT SECRETARY.

F. W. Putnam, of Cambridge, Mass. (Office, Salem, Mass.)

GENERAL SECRETARY.

Asaph Hall, Jr., of Ann Arbor, Mich.

SECRETARY OF THE COUNCIL.

D. S. Kellicott, of Columbus, Ohio.

SECRETARIES OF THE SECTIONS.

A. Mathematics and Astronomy—James McMahon, of Ithaca, N. Y.

B. Physics—Frederick Bedell, of Ithaca, N. Y.

C. Chemistry—P. C. Freer, of Ann Arbor, Mich.

D. Mechanical Science and Engineering—John J. Flather, of LaFayette, Ind.

E. Geology and Geography—C. H. Smyth, Jr., of Clinton, N. Y.

F. Zoology—C. C. Nutting, of Iowa City, Iowa.

G. Botany—F. C. Newcombe, of Ann Arbor, Mich.

H. Anthropology—Harlan I. Smith, of New York, N. Y.

I. Social and Economic Science—Archibald Blue, of Toronto, Canada.

TREASURER.

R. S. Woodward, of New York, N. Y.

Charles R. Barnes,
General Secretary.

Madison, Wis.

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*BOTANICAL GARDENS.**

ORIGIN AND DEVELOPMENT.

The cultivation of plants within small areas for their healing qualities by the monks of the middle ages appears to have been the beginning of the modern botanical garden, although these mediæval gardens doubtless took their origin from others of greater antiquity. Botanical gardens were thus primarily formed for purely utilitarian purposes, although the æsthetic study of planting and of flowers must doubtless have appealed to their owners and visitors. Their function as aids in scientific teaching and research, the one which at present furnishes the dominating reason for their existence, did not develop much, if at all, before the 16th century, and prior to the middle of the 17th century a considerable number existed in Europe, in which this function was recognized to a greater or less degree, of which those at Bologna, Montpellier, Leyden, Paris and Upsala were, perhaps, the most noteworthy. The ornamental and decorative taste for planting had meanwhile been slowly gaining ground, as well as the desire to cultivate rare or unusual species, and during the 18th century attained a high degree of development. Many persons of wealth and influence fostered this taste and became, through the employment of men skilled in botany and horticulture, generous patrons of science. The world was searched for new and rare plants, which were brought home to Europe for cultivation, and many sumptuous volumes, describing and delineating them, were published, mainly through the same patronage. The older gardens were essentially private institutions, but as the rights of the people became more and more recognized, many existing establishments and an increasing number of newly founded ones became, to a greater or less extent, open to the public, either through an admittance fee or without charge. The four main elements of the modern botanical garden have thus been brought into it successively :

1. The utilitarian or economic.
2. The æsthetic.

* Vice-Presidential address before Section G, American Association for the Advancement of Science, Buffalo, N. Y., August 24, 1896.

3. The scientific or biologic.
4. The philanthropic.

These four elements have been given different degrees of prominence, depending mainly upon local conditions, some gardens being essentially æsthetic, some mainly scientific, while in our public parks we find the philanthropic function as the underlying feature, usually accompanied by more or less of the æsthetic and scientific.

The Economic Element.—In the broadest extension of this department of a botanical garden there might be included, to advantage, facilities for the display and investigation of all plants directly or indirectly useful to man, and their products. This conception would include forestry, pharmacognosy, agriculture, pomology, pathology and organic chemistry, and, in case the management regards bacteria as plants, bacteriology.

The display of the plants may be effected by growing such of them as will exist without protection in the locality in a plot, more or less individualized, commonly known as the Economic Garden, while those too tender for cultivation in the open are grown in the greenhouses, either in a separate house or section, or scattered through the several houses or sections, in the temperatures best adapted to their growth. The display of plant products, best accompanied by mounted specimens of the species yielding them, by photographs and by plates, is accomplished by the Economic Museum, where these are arranged in glass or glass-fronted cases, suitably classified and labeled. It is believed that the most useful results are obtained by arranging this museum by the products themselves, and thus not in biologic sequence, but by bringing together all drugs, all fibres, all woods, all resins; where the same product is used in more than one industry the exhibit may be duplicated, more or less modified, without disadvantage.

The investigation of economic plants and their products is accomplished through the Scientific Department, and few valuable results can be reached unless the scientific equipment is well developed. The two departments must work conjointly, both on account of the necessity of knowing just what species is under investigation, its structure, distribution and literature, and in order that the most approved and exact methods may be used in the research. Any idea that the scientific element can be dispensed with in connection with economic studies is palpably untenable.

Teaching and research in agriculture, pomology and plant pathology are so well organized in America, through our National Department of Agriculture and our numerous agricultural colleges and schools, that there is no great necessity for providing elaborate equipments for those branches in botanical gardens. But in case the endowment of a garden were sufficiently large to enable them to be successfully prosecuted, in addition to more necessary work, there can be no doubt that important additions to knowledge would be obtained. On the other hand, no such liberal allowances have been made with us for forestry or pharmacognosy, and research and instruction in these sciences must prove of the greatest benefit to the country.

The Æsthetic Element.—The buildings, roads, paths and planting of a botanical garden should be constructed and arranged with reference to tasteful and decorative landscape effect. The possibilities of treatment will depend largely upon the topographical character of the area selected and the natural vegetation of the tract. The buildings required are: A fire-proof structure or structures for museum, herbarium, libraries, laboratories and offices; a glass house with compartments kept at several different temperatures for exhibition, propagation and experimentation, or several separate glass houses; and to these will usually be added dwelling houses for some of the officers, a stable and other minor buildings. The character, number and sizes of the buildings generally depend on financial considerations. In placing the structures intended for the visiting public, considerations of convenient access, satisfactory water supply and the distribution of crowds must be borne in mind, in connection with the landscape design. The planting should follow, as nearly as possible, a natural treatment, except immediately around the larger buildings and at the entrances, where considerable formality is desirable for architectural reasons. It is especially desirable that as much natural treatment as possible should be given to the areas devoted to systematic planting—herbaceous grounds, frutecetum, arboretum. The rectilinear arrangement of plant beds found in most of the older gardens has become abhorrent to landscape lovers, and the sequence of families desired can usually be quite as well obtained by means of curved-margined groups.

The cultivation of decorative plants, and especially the fostering of a taste for them, and the bringing of unusual or new species to attention and effecting their general introduction, are important functions of a botanical garden. For the accurate determination of these plants, information concerning their habits and structure, and suggestions regarding the conditions of their growth, the æsthetic side must rely on the scientific.

The Scientific or Biologic Element.—The important relations of the scientific department to the economic and æsthetic have already been alluded to. The library, herbarium, museums and laboratories are the sources whence exact information regarding the name, structure, habits, life-processes and products of plants are derived, and they are the more useful as they are the more complete and thoroughly equipped. It is practically impossible for any one library to have all the literature of botany and related sciences; any one herbarium to possess an authentic and complete representation of all species of plants, or any one museum to be thoroughly illustrative; absolute perfection along these lines cannot be obtained, but the more closely it is approximated the better the results. The research work of the scientific department should be organized along all lines of botanical inquiry, including taxonomy, morphology, anatomy, physiology and paleontology, and the laboratories should afford ample opportunities and equipment for their successful prosecution.

The arrangement of the areas devoted to systematic planting, and the proper labeling of the species grown, are important duties of the scientific department. The sequence of classes, orders and families is usually made to follow some 'botanical system.' It is highly desirable that this should be a system which indicates the natural relations of the families, as understood at the time the garden is laid out, and be elastic enough to admit of subsequent modification, as more exact information relative to those relationships is obtained. The weight of present opinion is overwhelmingly in favor of an arrangement from the more simple to the more complex, and this will apply not only to the systematic plantations, but to the systematic museum and the herbarium.

The scientific possibilities of a botanical garden are the greater if an organic or cooperative relationship exists between it and a university, thus affording ready facilities for information on other sciences.

The Philanthropic Element.—A botanical garden operates as a valuable philanthropic agency, both directly and indirectly. Its direct influence lies through its affording an orderly arranged institution for the instruction, information and recreation of the people, and it is more efficient for these purposes than a park, as it is more completely developed and liberally maintained. Its indirect, but equally important, philanthropic operation is through the discovery and dissemination of facts concerning plants and their products, obtained through the studies of the scientific staff and by others using the scientific equipment.

NUMBER AND DISTRIBUTION OF BOTANICAL GARDENS.

There are somewhat over 200 institutions denominated botanical gardens, but only a few of them meet the requirements of the foregoing sketch. Some are essentially pleasure parks, with the plants more or less labeled; most of them pay some attention to taxonomy and morphology; many to economic botany; while a small number are admirably equipped in all branches of the science.

I have drawn freely on Prof. Penhallow's first annual report of the Montreal Botanical Garden, published in 1886, for the following approximate statement of the number in different countries:

Algeria, 1.	Italy, 23.
Australia, 5.	Japan, 1.
Austro-Hungary, 13.	Java, 1.
Belgium, 5.	Malta, 1.
Brazil, 2.	Mauritius, 1.
Canada, 1.	Natal, 1.
Canary Islands, 1.	New Zealand, 1.
Cape of Good Hope, 3.	Norway, 1.
Ceylon, 1.	Peru, 1.
Chili, 1.	Philippine Islands, 1.
China, 1.	Portugal, 3.
Cochin China, 1.	Reunion, 1.
Denmark, 2.	Roumania, 2.
Ecuador, 1.	Russia, 16.
Egypt, 1.	Servia, 1.
France, 22.	Siberia, 1.
Germany, 36.	Spain, 2.
Great Britain and Ireland, 12.	Straits Settlements, 1.
Greece, 1.	Sweden, 6.
Guatemala, 1.	Switzerland, 4.
Guiana, 1.	Tasmania, 1.
Holland, 4.	United States, 10.
India, 7.	West Indies, 6.

NOTES ON SOME FOREIGN GARDENS.

1. Buitenzorg, Java. This is the largest botanical garden, occupying some 1100 acres, at altitudes from sea level to about 6000 feet. It was founded by the Dutch government in 1817, and has been well supported. Affording as it does highly favorable conditions for the growth of tropical and subtropical plants under natural conditions, it has yielded most important results, especially in taxonomy and plant physiology, many of which have been published in the ten large volumes of its 'Annales.'

2. The Royal Botanic Gardens at Kew are situated on the south bank of the Thames, about 6 miles west of Hyde Park Corner. They are reached by several railway routes, the time from Charing Cross being about 40 minutes, by steamer, and by omnibus lines. The present area of the gardens is about 260 acres, an addition having been made during the past year. These world-famed gardens originated in the exotic garden of Lord Capel, in 1759. In 1840 they were adopted as a national establishment and opened as a public park. The botanic garden proper occupies about 70 acres, and the remainder is given to arboretum and pleasure grounds. There are two main greenhouses: 1. The palm house, 362 feet long, the central dome rising 66 feet; 2. The temperate house, of which the central portion is 212 feet long, 137 feet broad, and about 60 feet high, flanked by wings which give a total length of about 580 feet, the whole covering between one and one-half acres of ground. There are also fourteen other houses, grouped in two ranges and more or less connected, given to special collections. There are three botanical museums: 1. Devoted to economic products; 2. to miscellaneous products; 3. to timbers. There is also a large museum hall given to the exhibition of floral paintings by the late Mari-

enne North. There is a small laboratory equipped for research in physiological botany. The herbarium and library occupy the old palace of the King of Hanover, near the main entrance to the garden, and they are the largest and most complete in the world. The herbaceous ground is planted in long parallel beds and contains several thousand species. The arboretum is thoroughly illustrative of all trees that will grow in the open at Kew, and the shrubs are, for the most part, cultivated in areas by themselves. There are numerous special features, such as the rock garden, the bamboo garden, and the American garden.

The research work of Kew is principally economic and taxonomic. Around it center the 24 botanical gardens and botanical stations of the British colonies, which are manned chiefly by men who have studied or worked at Kew. The principal publications at present emanating from Kew are:

1. The Kew Bulletin of Miscellaneous Information.
2. Hooker's Icones Plantarum.
3. The Continuation of Hooker's Flora of India.
4. The Continuation of the Flora of Tropical Africa.
5. Annual Reports.
6. The Index Kewensis.

The monographs and separate writings of its staff of scientific men are too numerous to review at this point.

3. The Royal Botanical Garden of Berlin is situated in the southwestern part of the city, but a project for moving it out into the country is now being seriously considered. The palm house reaches a height of about 90 feet, being the highest one yet constructed, and too high for satisfactory operation. The botanical museum is very extensive and has series of economic, systematic and archæological collections. The herbarium is one of the largest in the world. The systematic beds are arranged on a strictly modern sequence, and portions of the garden are devoted to plant geography and plant biology. The arboretum is not extensive. Among special features may be mentioned the alpine garden and the collections of Cacti. The garden is an institute of the University, where the principal laboratories are situated. There is also an institute of plant physiology with a small separate garden. The official publications of the Berlin Garden are the 'Notizblatt' and annual reports. A series of volumes of 'Jahrbücher' was issued some years ago. The publications of the garden staff are voluminous and cover all lines of botanical inquiry.

4. The long-established 'Jardin des Plantes,' the gardens of the Museum of Natural History at Paris, are situated in the heart of the city, fronting on the Seine. The conservatories are grouped near the main museum building, at one end of the grounds, are very large and contain a great variety of plants. The botanical library, laboratories, and the enormous herbarium are in a separate older building. The systematic beds are arranged in rows; owing to the limited size of the area devoted to them, they are much crowded, but contain a splendid assortment of species. But little space is given to trees; there are, however, some famous specimens. Many valuable contributions to the literature of botany along all its lines have emanated from this grand institution for over 100 years, published for the most part, in the 'Annales' and 'Archives' of the Museum of Natural History, and in the Bulletin of the Botanical Society of France.

5. The Botanical Garden of the University of Vienna was established about 1754 and is located in the heart of the city. There are here very important and extensive museums, herbaria and libraries, and one large fine greenhouse. The systematic

plantations occupy the larger portion of the tract, and special areas are devoted to the cultivation of medicinal and other economic plants, to an arboretum of native trees, and to groups illustrating plant geography. The garden and associated laboratories provide equipment for the prosecution of all lines of botanical research.

6. The Botanical Garden of Geneva was founded in 1817, and is situated in the heart of the city, near the University. There are two small greenhouses, a very large and important herbarium and library, and a small museum. The laboratories of the University are extensive and well equipped, affording capital facilities for work along all lines of botanical investigation. The De Candolle herbarium and library, and the Boissier herbarium and library, which are near by, afford, in connection with the collections of the garden, unsurpassed facilities for taxonomic study.

7. The Royal Botanic Garden of Edinburgh covers about 60 acres, of which about one-half was added to the older portion some 12 years ago; there are possibilities of still further enlargement. The main greenhouses have a frontage of about 200 feet, the palm house rising some 70 feet, and there are six small special houses. The botanical museum, lecture room and laboratories are in one building, the large herbarium and library in another. The systematic plantations of herbaceous species are extensive, the rock garden being an especially strong feature. The development of arboretum and frutccetum in the newer portion of the tract has made good progress. The institution is in intimate relationship with the University, nearly all the instruction in botany being given at the garden. The research work has been extensive, along taxonomic, morphologic and physiologic lines.

8. The Royal Botanic Garden of Dublin, situated at Glasnevin, just without the city, was founded through the influence of the Honorable and Honorable Dublin Society, in 1790, was for many years supported by this Society with the aid of government grants, and was transferred to the Science and Art Department in 1877. It includes about 40 acres of undulating land, bounded to the north by the small river Tolka. There are eight greenhouses, most of them rather old, but containing a valuable collection. There is a small botanical museum and herbarium. The systematic herbaceous plantations are irregularly shaped beds, arranged in a somewhat radial manner. The arboretum and frutecetum occupy about one-half of the area.

9. The Brussels Botanical Garden lies in the heart of the city and embraces not more than ten acres of land, of which about one-half is given to arboretum. The greenhouses are large but old. There is a very extensive herbarium and library. The systematic beds are arranged as quadrants of a circle, separated by concentric and radial paths. Special areas are devoted to ornamental and economic plants. Owing to the restricted size of the area available a very dense grouping of plants is necessitated. The research work accomplished here has been mainly taxonomic. The Botanical Society of Belgium has its headquarters at the garden.

10. The Imperial Botanical Garden at St. Petersburg is in close affiliation with the Academy of Sciences and the University. There is here a famous herbarium, a large botanical library and museum, and commodious and well-stocked greenhouses. The garden publishes 'Acta,' and many researches prosecuted there are printed in the Bulletin and Memoirs of the Imperial Academy.

11. The Royal Botanic Garden of Trinidad, situated at Port of Spain, was established in 1818, and now occupies about sixty-three acres, with some outlying plantations.

There is a vast collection of tropical plants in cultivation, an extensive botanical library and herbarium and a small laboratory. The garden publishes 'Annual Reports' and 'Bulletin,' dealing especially with topics of economic application.

12. The Botanical Department of Jamaica, West Indies, operates extensive gardens at Kingston, smaller ones at Castleton, and the several large Cinchona plantations. The scientific collections and library are valuable. The department publishes 'Annual Reports' and 'Bulletin,' especially devoted to economic botany.

13. McGill University, at Montreal, Quebec, carries on a small botanical garden in connection with its laboratories. The Montreal Botanic Garden, begun in 1885 on about seventy-five acres of ground in Mount Royal Park, was soon abandoned, owing to political complications.

14. Among other foreign gardens of which mention must be made, and of which a description would be interesting if our time allowed, are those at Munich, Würzburg, Tübingen, Stockholm, Copenhagen, Upsala, Zurich, Calcutta and Oxford.

BOTANICAL GARDENS IN THE UNITED STATES.

The first botanical garden established in America was begun by John Bartram in Philadelphia, in 1728. In it he placed a considerable number of plants obtained in the course of his extensive travels. The plot still remains, including the family homestead, somewhat modified, and it is a pleasure to know that it will be preserved as public ground.

Andre Michaux, in the latter part of the last century, planted gardens at Charleston, S. C., and New Durham, N. J., but they were essentially nurseries from which he sent seeds and plants to Europe.

In the year 1801 Dr. David Hosack, then professor of botany and materia medica in Columbia College, purchased twenty acres of ground in New York city, and called it the Elgin Botanic Garden; in this tract he accumulated, with great labor during the next ten years, a very large and valuable collection of plants. The institution was transferred to the State of New York, through an act of the Legislature, in 1810, and was then known as the Botanic Garden of the State of New York. It was subsequently granted to Columbia College. Funds for its maintenance were not provided, however, and it was ultimately abandoned. Two catalogues of its plants were issued by Dr. Hosack, one in 1806, and another in 1811. The condition of botanical gardens in America at that time is indicated by the following note in Dr. Hosack's catalogue of 1806:

"I learn, with pleasure, that a Botanic Garden is proposed to be established near Boston, and connected with the University of Cambridge. The Legislature of Massachusetts, with a munificence which does them honor, have granted, for this purpose, a tract of land, the value of which is estimated at thirty thousand dollars; and several individuals have evinced their liberality and love of science by voluntary subscriptions, to the amount of fifteen thousand dollars, towards the establishment and support of that institution. Another is also begun at Charleston, S. C., and a third is contemplated in New Jersey, in connection with the College of Princeton."

In the year 1824 there was published at Lexington, Ky., the 'First Catalogues and Circulars of the Botanical Garden of Transylvania University at Lexington, Ky., for the year 1824,' by W. H. Richardson, M. D., President of the Board of Managers, and C. S. Rafinesque, Ph.D., Secretary. This rare pamphlet, which is not recorded in Dr. Call's very complete life and writings of Rafinesque, is of 24 pages, and is printed alternately in English and French. It is essentially an appeal for plants and material for the garden, and a list of species that it could furnish to kindred institutions. This garden was evidently short-lived, inasmuch as in Rafinesque's 'Neogenyton' of the following year, 1825, he remarks, "I mean, therefore, to indicate and propose in this small essay, many of the numerous new genera of plants detected or ascertained, some of which were indicated last year, 1824, in the Catalogue of the botanical garden which I have tried in vain to establish in Lexington."

The principal gardens at present operated and in course of development in the United States are as follows :

1. The Botanic Garden of Harvard University, at Cambridge, Mass., founded in 1805. There are about seven acres of land under cultivation, a small greenhouse, and a famous herbarium and library from which have flowed during the past 40 years voluminous and invaluable contributions to taxonomy and morphology, especially of North American plants. There is also a small morphologic laboratory. The main laboratories and museums connected with the institution are situated in other of the Harvard buildings, a short distance away. The system of garden, libraries, museum, laboratories and herbaria operated by Harvard College is one of the most complete in existence. It is hard to say, indeed, in what respect it is not ideal, except in the rather wide distance separating the several elements and the small amount of land available for planting.

2. The Arnold Arboretum of Harvard University, at Jamaica Plain, Mass., was founded through a bequest of $100,000, made about 1870, by Mr. James Arnold, of Providence, R. I., to three trustees, to be used for the improvement of agriculture or horticulture. The trustees wisely determined to devote it to forestry and dendrology, and effected cooperative agreements with Harvard College and the City of Boston, which have now given us the greatest tree museum in existence, freely open to the visiting public. The planted area is about 160 acres, and will be materially increased in size. A small museum, library and herbarium building has been erected near the main entrance. The great *Silva of North America* and the journal *Garden and Forest* are noteworthy publications from this noble institution.

3. The Botanic Gardens of the United States Department of Agriculture, at Washington, have an extensive range of greenhouses and a large tract of land under cultivation. The herbarium of the department, now deposited with the United States National Museum, is very large and is at present increasing more rapidly than any other in America. There is a somewhat effective working library, which greatly needs material enlargement, and several poorly located and equipped laboratories, in which a vast amount of important investigation is being accomplished, under very unfavorable conditions, which urgently demand improvement. Publications include : Bulletin of the Botanical Division, Bulletin of the Division of Forestry, Bulletin of the Division of Plant Pathology and Physiology, Contributions from the United States National Herbarium, Year-book of the United States Department of Agriculture, and circulars of the several divisions.

4. The Missouri Botanical Garden, at St. Louis, Mo., was established in 1889, through the provisions of the will of Mr. Henry Shaw, who for over thirty years previously had been bringing together material for it on the land about his residence, which was known as Shaw's Garden. There were in all some 670 acres devised to the institution under the will of the generous and philanthropic founder, and from the income yielded by much of this land, not nearly all the area being required for garden purposes, the institution derives its large main-

tenance fund which will certainly be greatly increased as the land becomes more valuable, and will supply an income sufficient to operate the institution in the most effective manner. There are several greenhouses, a very large and valuable herbarium and library, while the laboratories of the Shaw School of Botany, at Washington University, are in close relationship to the garden. Much important research, principally taxonomic, has been prosecuted. Publications consist of seven volumes of Annual Reports, and nine 'Contributions from the Shaw School of Botany.'

5. The Botanical Garden of the Michigan Agricultural College was begun in 1877. There are now about three acres under high cultivation, exclusive of the arboretum and decorative grounds, which together cover several acres. There are several small greenhouses, an herbarium of about 60,000 specimens, a good botanical library and extensive, well equipped laboratories.

6. The University of California, at Berkeley, has a botanical garden of several acres, established some years ago, in which a large number of plants are grown. It furnishes a valuable adjunct to the work of the botanical department, which has well appointed laboratories, a working library and a large herbarium.

7. The University of Pennsylvania has recently established a garden of about three acres in the immediate vicinity of its building, in Philadelphia, and has many species under cultivation. The extensive and well appointed laboratories of its School of Biology, good library facilities and a small herbarium afford capital opportunity for research, especially in physiology and morphology.

8. Smith College, at Northampton, Mass., has also recently established a botanical garden, on the campus.

9. The Buffalo Botanical Garden, in South Park, Buffalo, N. Y., was commenced in 1893, and has since made rapid and encouraging progress. A small range of greenhouses has been built and others are planned. A beginning has been made in accumulating a library and herbarium, and much permanent planting has been accomplished.

10. The New York Botanical Garden. The establishment of the New York Botanical Garden was authorized by the Legislature in 1891, and the enabling act was amended in 1894. The enterprise was inaugurated and the legislation procured by a committee of the Torrey Botanical Club, appointed in 1889. The Act of Incorporation provided that when the corporation created should have raised or secured by subscription a sum not less than $250,000.00 the Commissioners of Public Parks were authorized to set apart and appropriate a portion of one of the public parks, not exceeding 250 acres, and the Board of Estimate and Apportionment was authorized to issue bonds, aggregating the sum of $500,000.00, for the construction and equipment, within the grounds, of the necessary buildings. The subscription of $250,000.00 required by the Act of Incorporation was completed in June 1895, and the Commissioners of Public Parks, in the following month, formally appropriated 250 acres of the northern part of Bronx Park for the purposes of the Garden. Since that time the preparation of plans for the development of the tract has been steadily progressing, including designs for the museum building and a large horticultural house. This planning is still in progress, in charge of a commission of architects, engineers, gardeners and botanists, who will complete their work within a short time, and be ready to submit a complete scheme to the Board of Managers during the coming autumn. Meanwhile, much preliminary work has been accomplished in clearing the ground, in grading, in the planting of borders, in the establishment of an extensive

nursery, and in the accumulation of herbarium, museum and library material. Through a cooperative agreement entered into with Columbia University, the herbarium and botanical library of the University will be deposited with the Garden, and most of the research and graduate work of the University in botany will be carried on in the Museum Building.

The endowment fund has been materially increased, and about 430 persons have become annual members of the Garden, contributing ten dollars a year each to its support. The publication of a Bulletin has been commenced by the issue, in April, of the first number of Volume I.

N. L. BRITTON.

NEW YORK BOTANICAL GARDEN.

PHILIP LUTLEY SCLATER.

PHILIP LUTLEY SCLATER, Secretary of the Zoological Society of London, is one of the best known of zoologists. Few men now living have contributed so much as he to systematic ornithology, and none have done so much in the identification and description of new forms from the Western Continent.

His work has been largely in connection with the luxuriant fauna of Neotropical America, little known at the time when he began his researches. Nearly every year since he began work, in 1853, his correspondents in tropical America have laid at his feet new wealth in the form of collections from regions hitherto unexplored.

He has characterized 1,067 new species (245 in collaboration with Osbert Salvin) and 135 new genera (25 with Salvin), as well as two new families of American birds.

Mr. Robert Ridgway writes:

"The name of Sclater is so much a part of Neotropical ornithology that any knowledge of the latter without equal familiarity with the former would be impossible. Certainly no other name occurs so frequently nor ranks more highly in the literature pertaining to the birds of tropical America. Covering a period of more than forty years of unceasing activity, chiefly devoted to this, his favorite geographical field, the importance of Mr. Sclater's contributions to the ornithology of the Neotropical region can hardly be over-estimated. Other ornithologists, it is true, have rendered important services so far as portions of America are concerned, as Salvin for Mexico and Central America, and Lawrence for the same area and the West Indies, while the former has been associated with Sclater in the preparation of various monographic papers, the 'Nomenclator Avium Neotropicalium' and other works; but only Sclater has covered impartially the Neotropical region as a whole.

"Mr. Sclater's treatment of ornithological subjects is concise and conservative—more so, frequently, than some of us would wish it to be. Some of us on this side of the Atlantic differ with him in nomenclatural matters and regarding the status and discrimination of subspecies or geographical races; but in these respects his methods are those of a particular school, which we are pleased to call the 'old,' and which few, if any, of his countrymen have forsaken. We fondly hope, however, that the conservatism of our English brethren may sometime yield to the sound principles upon which the so-called 'American' schools have based their 'innovations,' and the complete harmony of methods between ornithologists of the two countries, so much to be desired, be thereby established.

"Sclater," writes Merriam, "is a good type of the industrious, systematic natuarlist. His official and personal energy brought him a wealth of new material. This he described in an endless series of papers on new species and new genera. Then, as additional specimens and additional species came in, he promptly published more comprehensive treatises in the form of synopses of genera or larger assemblages. And later, when still ampler material cast new light on the subject, he, in numerous instances, revised the same groups over again, correcting early errors, adding new species and bringing the history of the groups down to date. These synopses and monographic revisions are the most important and useful of Sclater's contributions to science. Their number is amazing. In addition to all these, his 'Nomenclator Avium Neotropicalium' and 'Argentine Ornithology' have come to be indispensable to the student of South American birds. And finally, as a fitting climax to this remarkable series, he has lived to erect his own monument in the admirable volumes he has contributed to the British Museum's 'Catalogue of Birds.'

"He has written many important papers concerning mammals, illustrated by colored plates of high merit. Among the more useful of these are articles on the deer, rhinoceroses and African monkeys. He is now publishing, in connection with Mr. Oldfield Thomas, a magnificently illustrated work, entitled 'The Book of Antelopes,' the second volume of which is already well advanced."

Remarkable as have been his industry and his accuracy in diagnosis and description, his energy and skill as an organizer have been equally noteworthy. But for him many regions now well known to the ornithologist would doubtless still remain unexplored.

His labors have also resulted in extensive additions to our knowledge of the geographical distribution of vertebrates. Not only has he worked out many local faunas, but his generalizations upon the distribution of life and the division of the globe into zoogeographical regions have had great influence. He was one of the pioneers in this field of investigation, and his writings upon the subject have always been full of suggestion and have stimulated many others to engage in similar inquiry. His views as to the geographical distribution of birds are undoubtedly more widely accepted throughout the world than those of any other authority, and though, with increasing knowledge, modifications in the scheme proposed by him long ago will doubtless become more and more numerous, his studies of geographical distribution will always be considered as of fundamental importance, and the terms which he suggested for the principal divisions of the earth's surface will doubtless remain in ordinary use.

For more than thirty years the chief executive officer of the most wealthy and vigorous zoological society in the world, his influence upon the progress of natural history exploration has been very great, and his relations with American naturalists have always been cordial and cooperative.

Notwithstanding the great bulk of his technical publications, he has for four decades been prominent in the social activities of scientific London and a noteworthy figure in the midst of every important scientific gathering.

A complete analytical bibliography of his writings, including nearly 1,300 titles, will soon be published as one of the bulletins of the U. S. National Museum. This will make available to American naturalists all the results of the work of this eminent scholar, who has done for the ornithology of Central and South America what Nuttall, Wilson, Audubon, Baird, Ridgway, Allen, Merriam and their associates have done for that of the northern continent.

Philip Lutley Sclater was born November 4, 1829, at 'Tangier Park,' in Hampshire, the residence of his father, William Lutley Sclater, Esq., and his boyhood was passed chiefly at 'Hoddington House,' another estate in the same county belonging to his father, who died there in 1885 at the age of ninety-seven.

In beautiful Hampshire, not far from the home of Gilbert White at Selborne, he acquired, early in life, a love for outdoor life and a taste for the study of birds.

At the age of ten he was sent to a well-known school at Twyford, near Winchester. In 1842 he went to Winchester College, and in 1845 was elected scholar of Corpus Christi College, Oxford. Being at that time under sixteen years of age, he was not called into residence at the University until Easter, 1846.

At Oxford his attention was given principally to mathematics, though his spare time was occupied by the study of birds and of the excellent series of natural history books then in the Radcliffe Library.

Hugh E. Strickland, the well-known ornithologist, who was at that time resident in Oxford as reader in geology, became interested in young Sclater and took him under his protection. At Strickland's chambers he met John Gould, shortly after his return from his great journey to Australia.

From Strickland he received his first instruction in scientific ornithology. He began his collection of bird skins at Oxford, making British skins for himself and buying foreign species at a shilling apiece, whenever he could get to London for a run among the bird shops.

After taking his degree he remained at his college in Oxford for two years, devoting his time principally to natural history. He also gave much attention to modern languages, studying with masters at home and always visiting the Continent in vacation time, and thus soon made himself familiar with French, German and Italian.

At this period of life he was often in Paris, where he made the acquaintance of the great ornithologist, Prince Charles Bonaparte, at whose house, until his death in 1858, he was a frequent visitor.

In 1851 he entered himself for the bar. In 1855 was admitted fellow of Corpus Christi College, and having in the previous June completed his legal education and been called to the bar by the Honorable Society of Lincoln's Inn, he went the Western Circuit for several years.

In 1856 he made his first journey across the Atlantic, in company with the Rev. George Hext, a fellow collegian. Leaving England in July, they went by New York up the Hudson to Saratoga, and there attended the meeting of the American Association for the Advancement of Science. After that they went to Niagara, and thence through the Great Lakes to Superior City, at the extreme end of Lake Superior. Here they engaged two Canadian 'voyageurs' and traveled on foot through the backwoods to the upper waters of St. Croix River. This they descended in a birch-bark canoe to the Mississippi. Mr. Sclater subsequently published an account of this journey in the third volume of 'Illustrated Travels.'

Returning by steamboat and railway to Philadelphia, he spent a month in that city studying the splendid collection of birds belonging to the Academy of Natural Sciences, where he had the pleasure of the company of John Cassin, Joseph Leidy, John Le Conte and other then well-known members of that institution. He returned to England shortly before Christmas, 1856.

For some years after this he lived in London, practicing occasionally at the bar, but always at work on natural history. He was a constant attendant at the meetings of the Zoological Society, of which he was elected, in 1850, a life member, and in 1857 a member of the Council.

In January, 1859, he made a short excursion to Tunis and eastern Algeria, in company with Mr. E. C. Taylor and two other friends. They visited the breeding places of the vultures and kites in the interior and gathered many bird skins, returning to London at the end of March.

At this time Mr. D. W. Mitchell, secretary of the Zoological Society, was about to vacate his post in order to take charge of the newly instituted Jardin d'Acclimatation in Paris. For this position Mr. Sclater was selected by Owen and Yarrell, then influential members of the Council. He was formally elected to it April 30, 1859, and has been reelected annually ever since.

He found it necessary to devote himself entirely for three years to the reorganization of the affairs of the Society. The 'Proceedings' and 'Transactions' were at that time several years in arrears—they were brought up to date; the 'Garden Guide,' which was out of print, was rewritten; the large staff at the gardens was rearranged and divided into departments under the superintendent, and various other reforms were introduced.

For thirty-five years his life has been almost entirely spent in work connected with natural history.

In 1874, when his brother accepted office in Mr. Disraeli's administration as President of the Local Government Board, Mr. Sclater became his private secretary, a position which he occupied for two years. But when subsequently offered a place in the civil service he declined it, because he could not make up his mind to give up his dearly loved work in natural history.

His most engrossing duties have been in connection with the Zoological Society of London, to which, as principal executive officer, he has, of course, devoted most of his time. It is conceded by all that its affairs have prospered well under his direction. The number of Fellows of the Society, in 1859 about 1,700, has increased to over 3,000. The income of the Society, which in 1858 was a little over £14,000, is now seldom under £25,000. Besides this, nearly all of the principal buildings in the Society's gardens have been rebuilt during the past thirty-five years and fitted up with every sort of modern convenience for animals. The old office building (No. 11 Hanover square) has been sold and a larger and more convenient one (No. 3 Hanover square) bought in the same vicinity. A debt of £12,000 to the Society's bankers, originally secured upon its house, has been paid off, and this property is now the property of the Society without any sort of incumbrance.

The first floor of the Society's house is devoted to the accommodation of a large and very valuable zoological library, under the care of a librarian and his assistant, and is the constant resort of the working zoologists of the metropolis. This library has been almost entirely accumulated since 1859.

The publications of the Society, consisting of Proceedings, Transactions, Lists of Animals (of which eight editions have been published), the 'Garden Guide' and 'Zoological Record,' are all issued from this office, with almost unfailing regularity. The scientific meetings of the Society are held here during the eight months of the scientific session, and an abstract of their proceedings is always printed and issued within a week after each meeting has taken place.

Mr. Sclater was selected by the British Ornithologists' Union as the first editor of *The Ibis*, in 1859. He finished the first series in 1864. Professor Newton took his place as editor of the second series, and Mr. Salvin as editor of the third. In 1877 he was associated with Mr. Salvin as joint editor of the fourth series, and in 1883 commenced the editorship of the fifth series, with Mr. Howard Saunders as coeditor. When the fifth series was completed, in 1888, he became sole editor of the sixth, which he finished in 1894. In 1895, having again obtained the assistance of Mr. Howard Saunders, he commenced work on the seventh series, of which two volumes are already complete.

When the British Ornithologists' Club was established, in 1892, he joined heartily in the movement inaugurated by Dr. R. Bowdler Sharpe, and has usually had the honor of occupying the chair at its meetings and of delivering an inaugural address at the commencement of each session.

With the British Association for the Advancement of Science he has had a long connection, having become a member in 1847 at the second Oxford meeting, and having attended its meetings with few exceptions ever since. For several years he was secretary of Section D, and at the Bristol meeting in 1875 he was president of that section and delivered an address 'On the Present State of our Knowledge of Geographical Zoology.' In 1876 he was elected one of the two general secretaries of the Association, together with Sir Douglas Galton, and served in that capacity for five years, thereby becoming an *ex officio* member of the Council, at the meetings of which he is a constant attendant.

Ever since the scientific journal *Nature* was started by Professor Lockyer—in 1869—he has been a frequent contributor to that most important periodical.

In 1886 he began the transfer of his private collection of American bird skins to the British Museum. This collection contained 8,824 specimens, representing 3,158 species, belonging to the orders Passeres, Picariæ and Psittaci. It may be remarked that when he began his collection at Oxford, in 1847, he intended to collect birds of every kind and from all parts of the world, but after a few years resolved to confine his attention particularly to the ornithology of South and Central America and to collect only in the orders just mentioned, which were at that time generally less known than the others and of which the specimens are of a more manageable size for the private collector. At the time of the beginning of this transfer, which was only completed in 1890, he agreed to prepare some of the volumes of the British Museum 'Catalogue of Birds,' relating to the groups to which he had paid special attention. In accordance with this arrangement, by the expenditure of fully two years of his leisure time for each volume, he prepared the eleventh volume in 1886, the fourteenth in 1888, the fifteenth in 1890, and half of the nineteenth in 1891.

When the *Challenger* expedition started around the world, in 1873, at the request of his friend, the late Sir Wyville Thomson, he agreed to work out all the birds. Soon after the return of the expedition, in 1877, the specimens of birds collected were placed in his hands, and with the assistance of his ornithological friends were speedily reported upon in a series of papers contributed to the Zoological Society's 'Proceedings.' The whole of these papers were reprinted with additions and illustrations, and now form part of the second volume of the 'Zoology' of the *Challenger* expedition.

Geography, being very closely connected with zoology, has always commanded Mr. Sclater's hearty interest. He became a life member of the Royal Geographical Society in 1880, and has attended its meetings regularly ever since. He has also served two years on the Council, and is a member of the Geographical Club. He has assisted in promoting many researches in foreign parts, chiefly, however, with a view to obtaining collections of natural history from strange places. Among these may be especially mentioned Sir H. H. Johnston's expedition to Kilima-Njaro in 1884 and Professor Balfour's visit to Socotra in 1880. He also took a leading part in sending out naturalists to Kerguelens Land and Rodriguez, along with the transit-of-Venus expeditions of 1774–75, and in many other similar efforts to explore little-known parts of the earth's surface. At the present time he is serving on two committees of this kind—one for the investigation of the fauna and flora of the Lesser Antilles and the other for the further exploration of the fauna and flora of the Lesser Antilles and the other for the further exploration of the fauna of the Hawaiian Islands. In both of these countries collectors are actively at work.

In 1884 he took advantage of the opportunity of the visit of the British Association to Montreal to cross the Atlantic a second time, and after the meeting to visit the United States. He was not in good health at that period and did little, if anything, in the way of zoology. But he had the pleasure of seeing several of his former friends, especially Lawrence and Baird, and of making the personal acquaintance of Mr. Ridgway, Mr. Allen, Mr. Brewster, Dr. Merriam and many other naturalists.

In 1887, after a continuous residence of more than twenty-five years in London, he gave up his residence in Elvaston Place, where so many American naturalists visiting England have received a hearty welcome. He has since lived in Hampshire, at his country house, 'Odiham Priory,' about forty miles from town, taking a house for his family in London for three or four months at the beginning of each year. In summer he constantly visits the Continent, making excursions to see the various zoological gardens and museums.

One of his closest friends was the late Prof. Huxley, long a member of the Council of the Zoological Society, where he was one of Mr. Sclater's most constant supporters. Prof. Huxley, it may be said, was the chief advocate of the project of employing an anatomist at the Society's gardens, and invented the title 'prosector' for the new office. A. H. Garrod who became prosector in 1871, and W. A. Forbes, who succeeded him in 1879—both talented and promising young naturalists—were dear friends of Sclater, and the unfortunate death of Forbes during the excursion to the Niger in 1883 was a most severe blow to him. Notable among his other friends was Charles Darwin, who frequently visited him in his office, bringing long lists of memoranda for conference.

Mr. Sclater married, in 1862, Jane Anne Eliza Hunter Blair, daughter of the late Sir David Hunter Blair, baronet, of 'Blairquhan,' in Ayrshire. He has five children, of whom four are sons. The eldest, William Lutley Sclater, has inherited his father's tastes; he was for four years an assistant in the Indian Museum in Calcutta, and after a short term of service as science master at Eton College was appointed director of the South African Museum at Cape Town, a position which he now occupies.

The second son, Capt. Bertram Lutley Sclater, is an officer in the Royal Engineers, and is now on duty in British East Africa, constructing a road to Uganda from the coast.

The third son, Lieut. Guy Lutley Sclater, an officer in the Royal Navy, is a specialist in torpedo work; while the youngest, Arthur Lutley Sclater, is a tea planter in Ceylon.

Mr. Sclater received the degree of doctor of philosophy, honoris causa, from the University of Bonn in 1860, and in 1861 was elected a fellow of the Royal Society, on the Council of which he has twice served.

At the age of sixty-seven he is still in full mental vigor, and adding each year a number of papers to his already remarkable list. May this useful career be continued for many years to come.

G. Brown Goode.

ON THE FLOATING OF METALS AND GLASS ON WATER AND OTHER LIQUIDS.

During the progress of a research on the surface tension of liquids, and on the tension of films, I observed that rings of aluminum, made of wires of various diameters, floated on water when these rings were *chemically clean.* A ring 62 millimeters in diameter, made of aluminum rod 3.6 millimeters ($\frac{1}{7}$ inch) in thickness and weighing 5.6 grams floats on water; sometimes for several minutes, sometimes for several hours; the duration of flotation depending on conditions to be stated in a subsequent publication.

I naturally thought that these remarkable phenomena were peculiar to aluminum, because in all the works on physics I have read it is stated that to float a metal on water it is necessary that its surface should previously be greased. (See the latest treatise on physics, by Violle; Vol. I., pt. 2, p. 679.) I found, however, that all metals from platinum of a density of 22 to magnesium of a density of 1.7 float on water when their surfaces are chemically clean.

Rings were made of aluminum, iron, tin, copper, brass and German silver. The wire of these rings is one millimeter thick and the rings are about 50 millimeters in diameter. The axis of the wire of a ring is in a plane; in other words, the rings are flat. Each of these rings has soldered to it a thin wire along a diamter and raised above the plane of the ring. On this wire is cemented a platform of thin metal. These rings are highly polished and are chemically clean.

On loading one of these floating rings, by gradually adding weights on its platform, the ring sinks deeper and deeper below the general surface of the water, till, finally, it breaks through the depresssed surface. On the form of this depressed surface (which I have plotted) depends the amount of weight per centimeter of circumference of the ring, required for the ring to break through the surface of the water. This weight, in the cases of the rings mentioned, is, on the average, 0.155 grams per centimeter, or about double the surface tension of water; because tangents to the depressed surface of the water, at the point where the rupture occurs, are vertical.

In the present stage of the research I am inclined to hold the opinion that the flotation of metals and of glass depends on a film of air which is condensed on their surfaces. The following experiments seem to sustain this opinion. If a ring made of platinum wire $\frac{4}{10}$ millimeter thick, which readily floats on water, is heated to redness and as soon as cold is placed on water it sinks. Also, when withdrawn from the water and wiped dry it again sinks when placed on the water; but after the same dried ring remains about a quarter of an hour exposed to the air then it will float. If the platinum ring, after having been heated to redness, remains in the air about a half hour and then is placed on the water it floats.

Glass behaves in a similar manner to platinum. If a rod of glass, recently drawn out in a spirit flame and just cold, is placed on water it sinks. After a freshly made rod has remained exposed to the air about a quarter of an hour it will float. If a recently made glass rod which has just sunk in water be withdrawn, wiped dry and exposed to the air for a quarter of a hour, it will float. The glass rods used in these experiments are one millimeter thick and four to five centimeters long.

Under certain conditions the ratio of the weights required to make a platinum ring break through the surface of water and through the surface of another liquid is the ratio of the surface tension of water and that of the liquid. This ratio is 1 : 1.09 in the case of water and a solution of chloride of sodium of density 1.2. Taking .077 as the surface tension of water we have 1 : 1.09 = .077 : .0839. Platinum is used for such experiments because it is chemically inert to nearly all liquids.

Under certain conditions the ration of the weights required to make a platinnm ring bread through the surface of water and through the surface of another liquid is the ratio of the surface tension of water and that of the liquid. This ratio is 1 : 1.09 in the case of water and a solution of chloride of sodium of density 1.2. Taking .077 as the surface tension of water we have 1 : 1.09 = .077 : .0849. Platinum is used for such experiments because it is not oxidizable and is chemically inert to nearly all liquids.

The relation that the experiments mentioned in this article have to the surface tension of water and other liquids, and to the change of surface tension on the exposure of a liquid to the air, will be discussed in a paper containing a fuller account of facts and theory than can be given in this notice.

ALFRED M. MAYER.

MAPLEWOOD, N. J., August 21, 1896.

A GALL-MAKING COCCID IN AMERICA.

THE numerous and extraordinary galls formed by Coccidæ in Australia have long excited the interest of entomologists, but so far no gall-making coccid has been described from America. It was, therefore, with the greatest surprise and pleasure that I detected some galls produced by a coccid, on the leaves of *Quercus wrightii* at Pinos Altos, New Mexico, on July 8th. The galls were quite abundant and are situated on the midrib on the under side of the leaf, at or near the base; their shape is something like that of a hazel-nut, but flatter on one side, with the midrib continued to form a ridge, terminating in a more or less pointed apical crest. Frequently two galls will be combined in one, in which case there are two pointed crests. On the upper side of the leaf is observed a narrow slit, opening into the cavity of the gall. The cavity of the gall is low-conical and is filled by the dark-colored female coccid.

The coccid, aside from the fact of its forming a gall, is extremely interesting. It belongs to the Idiococcinæ, a group of sixteen known species, all confined to Australia, except one in the Sandwich Islands and one in Japan. It is closely allied to the Australian forms, the larva being very like that of *Crocidocysta*, lately described by Rübsaamen, while the adult resembles certain species of Maskell's genus *Sphærococcus*. It represents, however, a new genus, which I call *Olliffiella*, in memory of Mr. Sidney Olliff, whose lamented death occurred just as he was about to publish on the gall-making coccids of Australia. The genus *Olliffiella* will be known by its adult female having very small but perfectly distinct and well-formed legs and antennæ; the antennæ resembling those of *Coccus*, six-jointed, the joints after the third successively shorter; the femora very stout, semi-circular in outline, the tarsi distinctly two-jointed (a rare but not unique character in coccids), the four digitules all filiform, with small round knobs; the skin of the dorsal surface is thickly beset with glands, mostly double or figure-of-eight. The larva after being treated with potash is reddish-purple, with the legs, antennæ and spines pale yellowish. There are rows of blunt dorsal spines, as in various Coccinæ. The anal ring has distinct but very small bristles; the antennæ are six-jointed, joints 1, 3 and 6 equal in length and longest, 2, 4 and 5 equal and shortest. The caudal setæ are fairly long. The species may be termed *Olliffiella cristicola*, n. sp. At some later date it is intended to give a detailed and illustrated account of it.

T. D. A. Cockerell.

Mesilla, N. M., August 3, 1896.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

The fourth annual meeting of this Society was held at Buffalo, N. Y., on August 20, 21, 22. Five sessions were held and twenty-one papers were read and discussed. On August 22d there was an excursion to Niagara Falls and Lewiston, under the auspices of the Engineer's Society of Western New York. The following were the officers of the meeting: President, Mansfield Merriman, of Lehigh University; Secretary, C. Frank Allen, of Massachusetts Institute of Technology; Treasurer, J. J. Flather, of Purdue University. The opening address of President Merriman was published in the last issue of Science.

This report of the Committee on Requirements for Admission to Engineering Colleges was presented by the Chairman, Prof. Marvin. This report gives in full the data from both engineering colleges and preparatory schools, collected by the committee during the two years of its labors, as also a careful analysis of the same with conclusions and recommendations. It was advised that a qualitative uniformity seemed desirable in regard to subjects for admission, and a list of such subjects was presented. The reports will be printed in full and opinions thereon be requested from the 350 institutions which have furnished the data.

'A Quarter Century of Progress in Engineering Education,' by Prof. Robert Fletcher, of the Thayer School of Civil Engineering, was a historical paper which especially set forth the influence of engineering education upon other education, upon the profession of engineering and upon the technical press.

'The Study of Modern Languages in Engineering Courses,' by Dr. T. M. Drown, President of Lehigh University, recommended that after one year of study instruction in technical reading should be given by teachers of engineering, the aim being to accomplish an important practical end in the shortest possible time. After one year of such instruction the author had found that students could read technical books and journals with ease and confidence.

'Biology for Civil Engineers,' by G. C. Whipple, of the Boston Water Works, set forth the advantages of instruction in biology to sanitary engineers. It was thought that this is not less an age of electricity than it is an age of bacteria, and itw as maintained that better sanitation would result from thorough fundamental instruction of the laws governing matter in the living state.

The following are the titles of the other papers read at the meeting:

'Agreement on Definitions of Engineering Terms,' by Thomas Grey, of Rose Polytechnic Institute.

'Seminar Methods as Applied to Engineering Subjects,' by F. P. Spalding, of Cornell University.

'An Experiment in the Conduct of Field Practice,' by F. O. Marvin, of University of Kansas.

'Methods of Teaching Perspective to Engineering Students,' by H. S. Jacoby, of Cornell University.

'A Course of Study in Naval Architecture,' by C. H. Peabody, of Massachusetts Institute of Technology.

'The Elective System in Engineering Colleges,' by M. E. Wadsworth, Director of the Michigan Mining School.

'The Desirability of Lectures to Undergraduates on the Ethics of Engineering,' by C. C. Brown, Civil Engineer.

'Quantity versus Quality in Smaller Colleges,' by Albert Kingsbury, of New Hampshire College of Agriculture and Mechanic Arts.

'The Conservation of Government Energy in Promoting Education and Research,' by C. W. Hall, of University of Minnesota.

'The Hale Engineering Experiment Station Bill,' by W. S. Aldrich, of University of West Virginia.

'Uniformity of Symbols for Engineering Text-Books,' by I. O. Baker, of University of Illinois, being a report of progress of a committee on this subject.

'Is not Too Much Time Given to Merely Manual Work in the Shops?' by W. H. Schuerman, of Vanderbilt University.

'How to Divide Subjects for Original Investigation among Different Colleges,' by C. H. Benjamin, of Case School of Applied Science.

'Credit for Shop Experience in Entrance Examinations,' by W. T. Magruder, of Vanderbilt University.

'A Course of Study in Municipal and Sanitary Engineering,' by A. N. Talbot, of University of Illinois.

'Engineering Education in Japan,' by J. A. L. Waddell, Civil Engineer.

'Modelling as an Aid to Teaching Machine Design,' by G. W. Bissell, of Iowa Agricultural College.

About 25 new members were elected, thus making the total membership over 200, about 85 engineering colleges being represented. Among the guests present was Mr. Surijo Mine, Electrical Engineer to the Japanese government. The number of members in attendance was about 50, and many interesting discussions upon the papers were held. On the motion of Dr.

T. C. Mendenhall, the Society adopted a resolution advocating the passage of a law by Congress for the adoption of the metric system of weights and measures.

The following officers were elected for the ensuing year: President, H. T. Eddy, of University of Minnesota. Vice-Presidents, J. Galbraith, of Toronto School of Practical Science, and J. M. Ordway, of Tulane University. Secretary, C. Frank Allen, of Massachusetts Institute of Technology. Treasurer, J. J. Flather, of Purdue University. Councillors, T. C. Mendenhall, of Worcester Polytechine Institute; Robert Fletcher, of Thayer School of Civil Engineering; A. Beardsley, of Swarthmore College; M. E. Wadsworth, of Michigan Mining School; W. H. Schuerman, of Vanderbilt University, and Wm. Kent, Editor of *Engineering News*.

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*THIRTEENTH GENERAL SESSION OF THE AMERICAN CHEMICAL SOCIETY.**

The president, Dr. Chas. B. Dudley, called the meeting to order. He spoke of the large program and proceeded at once to call upon the committee of arrangements.

Dr. Miller introduced Dr. Roswell Park, president of the Buffalo Society of Natural Science, who gave the address of welcome. After making the visitors feel at home, he made a plea to those who were interested in physiological chemistry to produce a substance which should have a germicidal property, so far as the deleterious germs were concerned, and yet not be toxic to the living tissue. With such a substance we could saturate our systems and live secure from the attacks of the deleterious germs. The president replied to Dr. Park's address. After thanking him for his kind welcome, he spoke of the advancement of chemistry in the last few years, and the benefits to be derived from chemists' being united in a society. The reading of papers was then proceeded with. Among the most interesting of the papers read was that of Prof. Kennicott, 'The Inspection and Sanitary Analysis of Ice.' This paper was discussed at length.

* Buffalo, N. Y., August 21 and 22, 1896.

The following is a list of the papers read:

Composition of American Kaolins (*25m.*). Charles F. Mabery and Otis F. Klooz.

Composition of Certain Mineral Waters in Northwestern Pennsylvania (*15m.*). A. E. Robinson and Charles F. Mabery.

Mercuric Chlor-thiocyanate (*5m.*). Charles H. Herty and J. G. Smith.

Zinconium Oxalates (*10m.*). F. P. Venable and Charles Baskerville.

Rutheno-cyanides (*m.*). James Lewis Howe.

The Inspection and Sanitary Analysis of Ice (*20m.*). Cass L. Kennicott.

The Reduction of Concentrated Sulphuric Acid by Copper (*8m.*). Charles Baskerville.

Some Analytical Methods Involving the Use of Hydrogen Di-oxide (*15m.*). B. B. Ross.

Notes on the Preparation of Glucinum (*10m.*). Edward Hart.

Aluminum Analysis (*30m.*). James Otis Handy.

An Analytical Investigation of the Hydrolysis of Starch by Acids (*30m.*). George W. Rolfe and George Defren.

The Effect of an Excess of Reagent in the Precipitation of Barium Sulphate (*15m.*). C. W. Foulk.

Estimation of Thoria: Chemical Analysis of Monazite Sand (*15m.*). Charles Glazer.

Determination of Reducing Sugars in Terms of Cupric Oxide (*30m.*). George Defren.

Acidity of Milk increased by Boracic Acid (*5m.*). E. H. Farrington.

Accuracy of Chemical Analysis (*15m.*). Frederic P. Dewey.

Some Extensions of the Plaster of Paris Method in Blowpipe Analysis (*15m.*). W. W. Andrews.

Device for Rapidly Measuring and Discharging a Definite Amount of Liquid (*5m.*). Edward L. Smith.

Table of Factors (*5m.*). E. H. Miller.

A Modified Form of the Ebullioscope (*10m.*). H. W. Wiley.

A New Form of Potash Bulb (*5m.*). M. Gomberg. Communicated by A. B. Prescott.

Morphine in Putrefactive Tissue (*15m.*). H. T. Smith. Communicated by A. B. Prescott.

The Signification of Soil Analysis (*10m.*). H. W. Wiley.

A Complete Analysis of Phytolacca decandra (*5m.*). G. B. Frankforter and Francis Romaley.

The Crystallized Salts of Phytolacca decandra. G. B. Frankforter and Francis Romaley.

The By-products formed in the Conversion of Narcoline into Narceine (*5m.*). G. B. Frankforter.

Notes on the Determination of Phosphorus in Steel and Cast Iron (*25m.*). GEO. AUCHY.

The Development of Smokeless Powder (*10m.*). C. E. MUNROE.

The afternoons were spent in visiting the several manufactories in the city and vicinity. After transacting the necessary business the session adjourned. The winter meeting will be held at Troy, N. Y.

LILIENTHAL, THE AVIATOR.

THE death of Otto Lilienthal, the aviator, and the fatal accidents which have been so common of late among balloonists, are likely to check somewhat the work of experimentation in aërial navigation; but it is not probable that it will put a stop to research in this seductive though dangerous field. Necessarily involving experiment at the speed of a railway train, and at considerable heights above the ground, aviation is especially hazardous. Herr Lilienthal, whose death is reported to have occurred August 11th, through the breaking down of his apparatus when at the full height of his flight from the hill at Rhinow, is perhaps the greatest loss that the cause of aviation could at this time experience.

He was the most successful and one of the most enthusiastic of all the many inventors who have entered upon this field of work. He was in the prime of his life, forty-seven years of age, and had already accomplished enough to convince himself and many careful observers of the possibility of artificial flight, once the motor could be found to supplement his apparatus of support. He was a steam-engine builder, and familiar with the available motors, and was confident that only patience, perseverance and skilful engineering were required to insure complete success. A firm believer in aviation, as distinguished from ballooning, he had accomplished so much in the construction of the apparatus of flight, and had succeeded so far in actual, soaring flight that his confidence seemed well justified.

The machine employed was a system of aëroplanes forming wings and a tail; the wings being given a certain curvature, always observed in the wings of birds and which Lilienthal found to be essential to best effect. The material was 'balloon muslin,' impregnated with collodion to make it impervious to air, and stretched upon frames of split osier, and fitted with great care and skill. He was, at the time of his death, experimenting upon carbonic acid and other motors. The weight of his apparatus was from 33 to 55 pounds, as lately constructed (15 to 25 kilos); its area of supporting surface, 10 to 20 square meters. The spread of wing was usually about 23 feet (7 meters). With this machine, Lilienthal insisted that the art of flying might be acquired, or at least that of soaring flight, as readily as that of riding a bicycle. He made thousands of flights without serious accident, and was confident that comparatively little danger was to be anticipated if the method were cautiously learned. His experience indicated, he considered, that the exercise is on a par in this respect with bicycling, for though the latter sport gives rise to daily, and sometimes fatal, accidents, it is rightly commended and encouraged. His experiments confirmed, as he has stated, the deductions of Langley relative to the 'internal work of the air.'

Lilienthal was a frequent contributor to the German technical journals, and wrote a small work detailing his experiments and the methods of construction and operation of his machines.* Expecting to secure some pecuniary advantage, in time, from his inventions, he patented them in this country as well as in Europe.

R. H. THURSTON.
CORNELL UNIVERSITY.

*Der *Vogelflug als Grundlage der Fliegekunst*, Berlin, 1889.

CURRENT NOTES ON ANTHROPOLOGY.

THE QUESTION OF THE TOLTECS.

In a recent note (Science, July 24) I referred to Dr. Valentini's opinion that the ancient Toltecs belonged to the Mayan stock. This view is advocated also by Mr. E. P. Dieseldorf in an article entitled "Who Were the Toltecs?" in the Bastian-Festschrift, and by Dr. Förstemann in Globus, Vol. 70, No. 3.

The theory of the latter is that at a remote period the Mayan stock occupied North America to about N. Lat. 23°, and extended perhaps to the island of Cuba. They had developed a moderate degree of culture when the Aztecan tribes invaded their domain from the north and west. Tula and Cholula were Mayan settlements, and when they succumbed to Aztecan inroads they dowered their conquerors with a part of their superior culture, notably their mythology. In later times the Mayans were driven southward, the only fragment who managed to remain being the Huastecas of the Rio Panuco. This hypothesis, it is claimed, explains the marvelous legends of the Toltec empire, and also the similarities of culture between the two stocks. Mr. Dieseldorf is so convinced of this that he is sure if we drove a tunnel through the pyramid of Cholula we should reach the primitive Mayan temple which is buried beneath it.

CLASSIFICATION OF PRIMITIVE IMPLEMENTS.

General culture development is measured by progress in the arts, and for that reason archæologists devote such close attention to the historic development of these. Prehistoric archæology is divided into periods marked by the introduction or discovery of improved methods and materials. Mr. Joseph D. McGuire in the *American Anthropologist* for July proposes a scheme, in some respects novel, for the classification and development of primitive implements. It is five-fold in scope, considering the natural material, the most obvious use to which it would be put, the primitive tool which this would suggest, and then the special and complex tools which would result.

The scheme thus presented is ingenious, well stated and, from our view point, satisfactory. If natural man did not follow it he must have been a fool. Unfortunately, it is almost sure that he was a fool, and that he repeatedly overlooked the most obvious improvements to his condition which were directly under his nose. Perhaps some later dwellers upon earth do the same. Indeed, the tendency is so radical in the race that it is safer to take the facts alone for our guides, and to hold, at least at present, that if there are no polished stones in palæolithic sites early men were stupid enough not to 'catch on' to polishing.

THE RUINS OF COPAN.

It is generally known that for several years past the Peabody Museum of Harvard has been prosecuting excavations in the extensive ruins at Copan, Honduras. A preliminary report has just been published by the Museum which gives an outline of the work accomplished, and that in view. It is a handsome, large quarto, with numerous illustrations, a map and plans. Further special reports will follow on particular localities.

No one can examine the fifty pages of this publication without being profoundly impressed with the size, bold planning and artistic finishing, which these ancient and unknown architects gave to their constructions. The ornamentation was recklessly profuse, and the cubic mass of materials moved something surprising. The art motives at times are much beyond what we are accustomed to see in native American work, as, for example, the head of the 'singing girl' represented on plate IX.

This publication should stimulate friends of American archæology to contribute liberally to this enterprise, as it abundantly shows that the soil of our own continent offers problems in reference to ancient civilization every whit as interesting as those existing in the valley of the Nile or on the banks of the Euphrates.

D. G. Brinton.

University of Pennsylvania.

CURRENT NOTES ON PHYSIOGRAPHY.

GULF STREAM AND LABRADOR CURRENT.

Prof. Wm. Libbey, Jr., of Princeton, presented to the Sixth (London) International Geographical Congress, an abstract of the results obtained from serial temperature soundings along the boundary of the Gulf Stream and the Labrador current, made under his direction by the U. S. Fish Commission southward from the New England coast (Lat. 41° to 39°) between Block Island and Nantucket, in the summer months of 1889 to 1892. Surface and deep currents are separately discussed. The former are found to fluctuate with weather changes; the most intimate relation appearing between surface winds and the surface termination of isothermal lines (isothermobaths) on vertical north-south sections. The surface currents are continually swayed laterally, or hurried or retarded by the winds. Smaller and slower shifts of the deeper currents are found; while these effects are not yet definitely correlated with their causes, it is believed that they may be the cumulative results of varying surface impulses. Twenty-one sections are appended, shaded in red and blue to represent differences of temperature. Unfortunately they are without sufficient indication of place, depth or date.

PREGLACIAL EROSION CYCLES IN ILLINOIS.

O. H. Hershey discusses the physiographic development of northwestern Illinois on the basis of personal observations, comparing his results with those found by others elsewhere (Amer. Geol., Aug. 1896). He regards the general upland as a peneplain of Tertiary erosion. It is surmounted by low monadnocks, locally known as 'mounds,' 200 feet or more in local relief; the accordant summits of these eminences are tentatively taken to indicate an almost destroyed ancient peneplain, probably to be correlated with the peneplain of Cretaceous erosion elsewhere recognized. The uplands are interrupted by broad-floored valleys, and these in turn are trenched by narrow valleys, of late Tertiary and of Quaternary date respectively. The narrow valleys are more or less clogged with drift, concerning which several details are given. The drainage lines are interpreted as having been modified from ancient consequent courses by continually advancing adjustment to weak structures in successive early cycles; except that the Mississippi between Iowa and Illinois is thought to have first come into existence after the excavation of the broad-floored valleys in late Tertiary time. Taking 5 as the time needed for cutting the trenched valleys, 25 is given for the broad-floored valleys, 200 for the uplands, and more than 500 for the doubtful ancient peneplain of the monadnock tops; but all this is admittedly very rough. This essay is not only intrinsically valuable for its contents, but interesting as one of the few products of individual work in physiographic exploration; standing in this respect on the same plane with Taylor's studies of the ancient shore lines of our Great Lakes.

THE PIEDMONT PLATEAU OF VIRGINIA.

The eighth annual field meeting of the National Geographic Society at Monticello, Va., was the occasion of an address by McGee, on the Geographic History of the Piedmont Plateau (Nat. Geogr. Mag., Aug., 1896). The undulant and mountain-embossed plateau is described as the peneplained surface of a vast mass of inclined schists, with many dikes and veins, of which an unmeasured upper portion has been worn away; the peneplain being now uplifted and trenched by sharp-cut gorges, 100 to 300 feet deep. Monticello, and Carter mountain with which it is joined, are residual eminences surmounting the undulant peneplain. It is well pointed out that a peneplain like the Piedmont plateau is a better witness to the work of rain and rivers than even the Colorado canyon; for what has been only well begun in the canyon is carried almost to completion in the peneplain. Several historico-geographical essays followed McGee's physiographic address.

NOTES.

The North German heaths and moors, geographical inheritances of glacial action, are described with particular reference to their flora by Krause in Globus, lxx., 1896, Nos. 4, 5.

The origin of the Wind Gap in Blue Mountain, Pa., north of Easton, by the diversion of an ancient river to several subsequent branches of the Delaware and Lehigh, finds a recent advocate in F. B. Wright, of Oberlin (Amer. Geol., Aug., 1896).

An interesting flight of interpretation by O. H. Howarth (London Geogr. Journ., Aug., 1896) treats Popocatapetl and the neighboring volcanoes of the Mexican chain as subsidiary vents, marginal to and later than the Pedregal, a vast flood of uniform basaltic lava that stretches from the Ajusco cone over 200 miles westward nearly to Acapulco. The lava flood is referred to a quiet fissure eruption, while the scoriaceous cones, high as they tower above the Pedregal, are ascribed to explosive eruptions at points where the great body of hot lava encountered accumulations of water. Before the fissure eruption, the North American continent is believed to have ended with the Mexican plateaus.

A geological and a hypsometrical map of northern Venezuela by Sievers, with explanatory text, appears in Petermann's Mittheilungen, vi., vii., 1896.

The undersigned has recently published the following essays: The Seine, the Meuse and the Moselle (Nat. Geogr. Mag., June, July, 1896), in which the Meuse is shown to have lost certain branches to its neighbors on the west and east. The Outline of Cape Cod (Proc. Amer. Acad., Boston, 1896), in which the attempt is made to reconstruct the original outline of the terminal portion of the Cape. Large-scale Maps as Geographical Illustrations (Chicago Journ. Geol., May–June, 1896), advocating the introduction of detailed topographical maps in teaching geography, and describing several examples selected from the official surveys of Great Britain, France and Germany.

W. M. Davis.
Harvard University.

CURRENT NOTES ON METEOROLOGY.

WORK OF THE WEATHER BUREAU IN CONNECTION WITH OUR RIVERS.

Comparatively few persons know of the work our Weather Bureau is doing in connection with the rivers of the United States, and fewer still realize the importance of this work. Bulletin No. 17 of the Weather Bureau contains an account of the origin and development of the river and flood system of the Bureau, and of the work that is now being done in this division of the service. The object of this department is to facilitate commerce on navigable streams by publishing daily information as to water stages along the course of each river, and to issue warnings of coming floods. Observations of river stages were made by the United States Engineer Corps prior to 1873, in which year the Weather Bureau formally undertook the work of making daily observations of the height of the water in the principal rivers, these observations being telegraphed to other river stations and to Washington. Since that time each issue of the *Monthly Weather Review* has contained a summary of the water fluctuations and floods of the principal waterways of the country. The work has been very greatly extended during the last few years, and on January 1, 1896, the stations operated in connection with it were as follows: 135 special river stations equipped with standard river gauges; 44 rainfall stations, so distributed in the various catchment basins as to give, in connection with the regular stations of the Bureau, a fair approximation of the average rainfall over each watershed; 38 completely equipped meteorological stations where river measurements were made, and 22 Weather Bureau stations which were centers from which flood warnings and forecasts of expected changes in river level were issued. Since July 1, 1893, the immediate supervision of the river service and the predicting of river changes for their several districts has been delegated to the various local forecast officials. The importance of the flood forecasts can hardly be calculated, but as one example we note that the warnings of a flood on May 21 and 22, 1894, at Harrisburg, Pa., saved property and live stock of an estimated value of $60,000 to $70,000.

WINDS OF THE SOUTH ATLANTIC OFF THE COAST OF BRAZIL.

THE August *Pilot Chart of the North Atlantic Ocean* makes clear the January and July wind relations of the South Atlantic Ocean adjacent to the coast of Brazil, by means of two small charts and some explanatory text. The charts are compiled from returns made by volunteer observers of the Hydrographic Office during 1890–95, and show by wind-roses the percentages of the winds that may be expected from the different directions, and the chances of finding calms. The effects of the seasonal changes of pressure over South America are clearly seen. In July (winter) the S. E. Trades are carried southward to the 20th parallel, while in January (summer), owing to the presence of the continental area of low pressure over South America, the S. E. Trades are replaced north of Cape San Roque by N. and N. E. winds, these being the indraft on the eastern side of the low pressure area.

R. DEC. WARD.

HARVARD UNIVERSITY.

PSYCHOLOGICAL NOTES.

WITH the exception of the advancement of scientific research there is no subject more important to men of science than the adequate teaching of the sciences in our colleges and schools. The efforts now being made by the Natural Science Department of the National Educational Association to properly coordinate higher and secondary scientific education should be heartily supported, and those who have read in this JOURNAL the addresses by Profs. Bessey, Carhart, Freer, Jordan and Gage, at the recent meeting of the N. E. A., will understand what excellent leadership controls the movement. As a psychologist, interested in the development of the child, its senses and movememts, I wish to urge that scientific education begin with the kindergarten. There are but few things more pathetic than the ignorant zeal of the average kindergarten teacher. I have recently examined the catalogue of kindergarten supplies offered by the Milton Bradley Co., and find it simply abominable. Nearly everything seems especially devised to injure the eyesight and the nervous system of the child. The young child should be taught to concentrate the attention, to observe accurately and to make easily movements not requiring nice adjustments. The best thing he can do is to learn to classify things by their resemblances, to watch plants grow, to take care of animals, to learn the geography of the schoolhouse, to use tools, to weigh and measure on a large scale. These are the beginnings of science and are the best subjects for the kindergarten.

We begin to ruin the eyesight of children in the kindergarten and continue to persecute them until the end of the college course. Some time since I wished to find an edition of *Homer* for my own use, and after examining about twenty editions could not find one that I regarded as properly printed. If children are legally forced to attend the public schools, and their eyesight is injured by long sessions, badly printed books and badly lighted and ventilated rooms, could they not bring suit for damages against the State or district that has forcibly injured them? My own progressive myopia and accompanying headaches were caused by private schools, and I have no redress; but if some public spirited man of science would bring suit against the proper body, the result, whether damages were allowed or not, would be most useful.

What we need is a scientific study of the conditions of fatigue in reading, and a step in this direction is made by a research from the psychological laboratory of Columbia University by Dr. Griffing and Mr. Franz, to be published in the September number of *The Psychological Review*. Starting from a research of my own (*cf.* Science, O. S., Vol. VII., p. 128), on the legibility of the letters used in printing, the authors investigate the size and style of type, the color and quality of paper and the illumination. Type should not be less than 1.5 mm. in height; it should be leaded, and the illumination of the printed page should not be less than 100 candle-meters. Yet most school books are printed in small type, without leads, on poor or glazed paper, and the illumination in many school rooms is less than 2 candle-meters. I found the relative legibility of the small letters to be in the following order: d k m q h b p w u l j t v z r o f n a x y e i g c s. Thus some of the letters most frequently used are among the most illegible. The letters used in printing were developed from those used in writing, and these were evolved in accordance with the convenience of the writer, not for the advantage of the reader. Now that we write chiefly with the printing press, it is absurd to retain symbols whose legibility would be greatly improved by a slight modification.

It is often said that psychology has no practical applications, but another article will be found in the September number of *The Psychological Review* of general interest. Prof. Patrick and Dr. Gilbert, of the University of Iowa, have kept three observers awake during ninety consecutive hours. The anti-vivisection societies might expect to find enlarged usefulness in the psychological laboratory, but it happened that the observers suffered in no wise from the 'fast,' although dogs die if kept awake four or five days. Careful records were taken of the physical and mental condition of the observers during and after the enforced insomnia, and the results are of the greatest interest, scientifically and practically.

Dr. J. Paul Goode and Mr. Oliver C. Farrington have done well to call attention (Science, Vol. IV., p. 115 and p. 271) to absurdities in the illustrations of school books. I must, however, take exception to the view that mountains should be reproduced as they would be represented in a geometrical drawing or in a photograph. Mountains look higher than the angles they subtend, and should be represented as they look. Colors in a landscape are not what each would be apart from the rest. The Greeks knew very well that architecture should be psychological, not geometrical, and now that there is a science of psychology, architects and artists should study it. It is often said that since we have instantaneous photographs of animals in movement, these should be reproduced by the artist. But this is incorrect; art is concerned not with physics but with psychology.

J. MCKEEN CATTELL.
COLUMBIA UNIVERSITY.

SCIENTIFIC NOTES AND NEWS.

THE AMERICAN ASSOCIATION AND 'SCIENCE.'

THIS JOURNAL was established in 1883 by Mr. A. Graham Bell, who, in conjunction with Mr. Gardiner G. Hubbard, spent more than $80,000 in its support. The loss was so large and continuous that the generous donors were compelled to withdraw their aid, and publication was suspended early in 1894. At the Brooklyn meeting of the American Association for the Advancement of Science, in August, 1894, it was thought that the continuation of such a journal was so important for the advancement of science in America and for the welfare of the Association that an arrangement for cooperation between SCIENCE and the Association was effected and unanimouly adopted in the general session of the Association. The JOURNAL agreed to publish part of the papers read before the Association, and the Association appropriated on certain conditions $750 annually toward the support of the JOURNAL. In view of the moral and financial support of the Association, and by securing an editorial committee and a responsible editor who would serve without compensation, the JOURNAL was reorganized and the publication of a new series was begun in January, 1895.

The JOURNAL has had the generous support of the leading men of science in America. The general character of its contents may be judged from the following presidential addresses which it has been able to publish since the first of January of the present year:

President Morley, before the American Association for the Advancement of Science.

President Cope, before the Society of American Naturalists.

President Shaler, before the Geological Society of America.

President Dwight, before the Association of American Anatomists.

President Hill, before the American Mathematical Society.

President Gilbert, before the Geological Society of Washington.

President Dall, before the Philosophical Society of Washington.

President Rees, before the New York Academy of Sciences.

President James, before the Society for Psychical Research.

President Bowditch, before the Massachusetts State Medical Society.

President Bessey, before the Natural Science Department of the National Educational Association.

President Merriman, before the Society for the Promotion of Engineering Education.

President Trelease, before the Botanical Society of America (in press).

At the Springfield meeting of the Association the subsidy mentioned above was paid to SCIENCE, and the money has been spent in its enlargement. Unfortunately recent meetings of the Association have been small, and it was necessary to take the money from the invested funds of the Association. The meeting at Buffalo last week was even smaller than that at Springfield, and it was believed by friends of the JOURNAL and of the Association that it would be undesirable to use further for any purpose, however important, the invested funds of the Association. But it was hoped that enough members of the Association would subscribe to the JOURNAL to make up the amount of the subsidy promised at Brooklyn.

We have not hitherto mentioned the business affairs of the JOURNAL in its pages, but the editorial importance of its continued efficiency makes it desirable to do so on this occasion. SCIENCE will not be abandoned, even though its continuation may entail serious financial sacrifices on the part of a few. We venture, however, to ask those members of the Association who can to subscribe to the JOURNAL. Some of those who are already subscribers may be willing to make one or more additional subscriptions to be used in sending the JOURNAL to members of the Association who cannot themselves afford the subscription.

GENERAL.

THE Paris Academy of Sciences undertook, on the occasion of the Hundredth Anniversary of the death of Lavoisier in 1894, to erect a monument in his honor. An international subscription was opened, and the Academy has just published the subscriptions received up to August 1st of the present year. The names of the subscribers fill fifty pages, the sum so far collected being 47,553.30 fr. We note that the Academy is not without patriotism. Alsace is given the rank of one of the leading nations, being placed between France and Germany. It is a matter for great regret that only the small sum of 500 fr. has been subscribed in the United States, and of this one-fifth is from a zoologist, one-fifth from an electrician and one-tenth from an economist. The subscription is not yet closed, the French Minister of Public Instruction, the City of Paris, the Emperor of Russia and other individuals and institutions intending to assist. It is consequently not too late for subscriptions to be forwarded from America, and it is much to be hoped that the American Chemical Society will undertake to see that America is better represented than a country such as Servia on the final list.

The Critic, which early in the summer published a list of large gifts to American colleges, gives in its current issue from official sources a corresponding list of large gifts and bequests to libraries. The largest of these are as follows: New York Free Library, from members of the Astor family, about $1,650,000; from James Lennox, $735,000, in addition to books and land; from the Tilden estate, $2,000,000; John Crerar Library, of Chicago, from the founder, about $2,700,000; Newberry Library, of Chicago, from the founder, about $2,500,000; Carnegie Library, of Pittsburg, from the founder, $2,100,000; Enoch Pratt Free Library, of Baltimore, from the founder, about $1,080,000; Library Co., of Philadelphia, from the founder, Dr. Rush, about $1,060,000; President Low's gift of $1,000,000 for the Library of Columbia University is omitted from the list.

PROF. W. A. HERDMAN has contributed to *Nature* a further account of the arrangments for the approaching meeting of the British Association. Programs of the excursions arranged for four of the sections are given, and an article on the scientific work of the sections is promised for the following week. The Local Secretaries hope to secure Dr. Nansen's presence at the meeting. Before he sailed in the *Fram*, Nansen promised a Liverpool shipowner that he would visit him immediately on his return. He has now been reminded of that promise by telegram to Vardö.

THE American Social Science Association met at Saratoga, beginning on Monday evening, August 31st. The program is a strong one, demonstrating most clearly the needless weakness of Section 'I' of the American Association. Steps should be taken to secure, if possible, an affiliation between the Social Science Association and the American Association.

THE death is announced by cablegram of Nicolas Rudinger, professor of anatomy at Munich. He was sixty-four years of age. We also learn with regret of the death of Dr. H. E. Beyrich, professor of geology and paleontology, at Berlin.

ACCORDING to *Popular Astronomy*, Professor A. Hall, Jr., director of the observatory of the University of Michigan, has secured an extensive series of observations of Polaris for latitude variation. He is also engaged on the division errors of the meridian circle, as no examination of the errors has been made for a long time.

WE are glad to notice, in *Appleton's Popular Science Monthy* for September, the beginning of a series of articles on 'The Vivisection Question,' by Prof. C. F. Hodge, of Clark University. Prof. Hodge is, himself, making experiments on the lower animals which alone will probably alleviate more human and animal suffering than has been caused by all the vivisection experiments that have ever been made.

MR. SAMUEL H. RANCK, of the Enoch Pratt Free Library, Baltimore, calls our attention to articles in the students' journals of Franklin and Marshall College, advocating the use of metric units in college athletics. This is an excellent idea, as very few things would tend more quickly to familiarize the public with the units, and owing to the probable extension of international contests the students of our colleges might favorably consider the plan.

REFERENCE was recently made in these notes to the fact that the decimal system of numeration had its origin in man's having ten fingers. According to the *Revue Scientifique* the *Bibliographie générale de l'astronomie* calls attention to the fact that this was suggested by Aristotle (*Problemata*) and that there are languages in which five and hand are expressed by the same word. It is certainly unfortunate, so far as enumeration and measurement are concerned, that man did not originally have twelve fingers.

WE may reply to Mr. Josephson's letter (see page 315 below) that we have already published a large number of contributions regarding scientific bibliography and should be glad to have others of equal value. The JOURNAL is fortunate in having on its editorial committee Dr. G. Brown Goode, of the Smithsonian Institution, and Dr. John S. Billings, head of the New York Consolidated Libraries, both of whom are eminent authorities on the subject. Dr. Billings and Prof. Newcomb (also of the editorial committee) were the delegates from the American government to the recent Bibliographical Conference in London.

THE New York *Evening Post* states that Prof. C. W. Dodge, of the biological department of the University of Rochester, has asked the trustees to make an appropriation for the establishment of a biological laboratory at Hemlock Lake, a small lake thirty miles south of Rochester, from which it obtains its water supply. He proposes to make a complete biological survey of the lake and to utilize the services of the expert students in his department for the work.

ACCORDING to the *Electrical World* there were about 200 delegates present at the International Congress of Electricians which was opened in the Aula of the Geneva University, on Tuesday, August 4th. M. Turrettini presided and papers were read by Dr. Weitlishbach, on 'Telephonic Disturbances caused by Electric Traction;' by M. Hospitalier on 'Magnetic Units;' and by M. André Blondel on 'Photometric Units.' Among the subjects discussed was the question of transmission of power over long distances, and practical exhibitions of its transmission were made at the exposition.

THE War Department has sent to Paris for a set of the Bertillon instruments, and a thorough examination will be made into the system of identification with a view of introducing it into the United States army.

A MOUND has been explored at McKee's Rocks, near Pittsburg, by Mr. Thomas Harper and found to contain stone and bone implements and skeletons which are said to be of special interest and will be deposited in the Carnegie Museum.

SIBERIAN exiles are supposed to suffer peculiar hardships, but the St. Petersburg correspondent of *The Lancet* states that last year an old peasant named Ivan Kouzmin was reported to have traveled from Moscow to Kief at the age of 140. He was said to be in good health; he had formerly been a coachman to Count Sherемétief, but in 1840 was sent to Siberia, where he spent fifty-four years, returning in 1894. His is not the only instance in which a Siberian exile has survived to extreme old age. Two years ago there was said to have died in Samara one Lavrentii Efimof, who had attained the age of 150. According to the newspaper report of him he took part as a boy in the famous Pugatchef rebellion in the reign of Catherine the Great, and for his share in that outbreak spent thirty years of his life in Siberia.

IT is reported in the daily papers that a cave, said to be the largest in the world, has been discovered near Hudson, Mo. In the *Scientific American* of August 29th, Mr. H. C. Hovey gives an interesting description of the cave discovered by Mr. Pike Chapman in July of last year; this is one of a number of caves found in the vicinity of the Mammoth Cave and appears to be of considerable importance. It must be entered through the tip of a subterranean dome by means of ladders, and the lowest level of the cavern is 250 feet below the entrance. There are a number of fine domes, and passageways miles in extent. The effect is said to be very fine, as the crystals have not yet been injured by the smoke of lamps and fireballs.

American students will be interested in an article in *Science Progress* for August, on 'Petrology in America,' by Mr. Alfred Harker, of St. John's College, Cambridge. The author gives an account of the results of some thirty-seven investigations. The author writes:

"The material for study offered to the American geologist is rich in many respects, and perhaps in no branch richer than in petrology. The vast tracts of Tertiary lavas along and to the west of the Rocky Mountains, the peculiar igneous rocks on the east side of the great watershed, the varied series of lavas, tuffs, and intrusive masses in the Palæozoic and older formations of the Eastern States, the extensive areas of igneous and other crystalline rocks in the Lake Superior region, the Adirondacks, Canada, etc., all present many points of interest, and much valuable work has already been done in the description and study of these rocks. These results we owe in large part to the United States Geological Survey and that of Canada, and to various State surveys ; Minnesota, New York, Arkansas, Texas, etc. Besides this official work, systematic petrographic research has been carried on at several universities and colleges, such as Johns Hopkins, Columbia College, Yale, the University of California, and others."

Another paper of interest to American geologists in the same journal and also by a member of St. John's College, Mr. Philip Lake, is on 'The Work of the Portuguese Geological Survey.' The official *Communicaçõef da Direcção dos Trabalhos geologicos de Portugal* may be difficult reading for many (although a large part of the memoirs has also been published in French) and Mr. Lake's account of the recent work of the survey, which is of very considerable importance, is thus opportune.

M. Henri Moissan has reported to the Paris Academy that he has found, in disintegrated rocks from Brazil, microscopic diamonds, both black and transparent, and that they were in connection with graphite.

Students of primitive culture are inclined to attribute a wider and wider extension, as their knowledge of early conditions increases, to the matriarchal system of the family. Prof. E. B. Tylor, in the *Nineteenth Century*, reaches the conclusion that it has existed, in either a complete or a partial form, among about half of known peoples of the lower culture. Attention should be called in this connection to an important book on the subject by Mrs. Gamble, which was issued by Putnam two years ago. Prof. Tylor attributes the decadence of the custom to the spread of exogamy, which latter practice gave the tribes which adopted it an advantage on account of its cementing friendship and preventing fighting among larger and larger bodies of men. He mentions the curious fact that a Methodist missionary among the Maoris has lately been inculcating exogamy among his people with this same end, and with very good results. C. L. F.

At the recent International Psychological Congress at Munich, Mr. George M. Stratton, of the University of California, reported some interesting experiments on vision without inversion of the retinal image. An optical instrument with lenses appropriately arranged produced such an image, and at the same time excluded from the eyes all rays except those coming through these lenses. This instrument was worn on the eyes without intermission (except at night, when the eyes were blindfolded) from three o'clock in the afternoon of the first day until noon of the third day. The experience was somewhat as follows : all visual images seemed at first inverted and illusory. The things themselves were thought of as being, not where now seen, but where they would probably appear could normal vision be restored. Later, however, the present visual presentations seemed 'real.' Objects outside the field of vision began to be mentally represented in terms of the new abnormal vision ; they were pictured as they would appear if the present visual field were moved or widened to include them.

At the meeting of the Paris Academy of Science on August 17th, M. Weinek exhibited a further series of photographs of the moon, the negatives having been in part taken at the Lick Observatory and in part at the Observatory of Paris. The enlargement is such as to give a diameter to the entire disk of the moon of more than three meters and, as the photographs are 30x24 cm., there are a large number of separate sheets. The definition in these photographs is said to be admirable.

The ethics of quotation without assigning the source of the information are somewhat complex. We aim always to give credit to its source when we take a note from a journal that has in fact or apparently received the information at first hand. Our excellent contemporary, the *Revue Scientifique* does not seem to adopt this point of view, but finds Science of weekly use. In the current number it goes so far as to take from *Nature*, without credit, an account of Mr. Lindenkohl's observations on the Gulf Stream, (which *Nature* properly credited to Science), but states quite correctly (as quoted by *Nature* from this Journal), that this apparently original information *will* be published in a report of the U. S. Coast and Geodetic Survey.

In *Appleton's Popular Science Monthly* for September will be found an article by President David Starr Jordan, entitled 'The Sympsychograph,' the contents of which are even more extraordinary than its title. The writer of this note was at first under the impression that the article was intended as a parody on newspaper literature regarding X-rays and psychical research, but this will certainly not be the opinion of readers of the *Monthly*. President Jordan's first paragraph is as follows:

"The Astral Camera Club, of Alcalde, was organized in November, 1895, for purposes of scientific research through the medium of photography. The function of the club was the cooperative study of man's latent psychical powers, that these might be helpful in the conduct of life. No powers granted man should be neglected or allowed to waste in idleness. Just as the great physical force of electricity remained for centuries hidden and known only by casual and unimportant manifestations, so the great odic forces within man are still scantily revealed. The method of the club in Alcalde was to be that of the most rigid scientific research. It was to take up, one after another, the discoveries of our eager century as they were made known to the world through the medium of the daily newspaper. To these were to be added those suggestions which alert intuition and psychic practicality would naturally suggest. No hypothesis in science was to be rejected beforehand, and no prejudice was to stand in the way of the reception of any new theory that might contain a living truth."

President Jordan then proceeds to describe the alleged photographs of the retina by Messrs. Rogers and Lee, and states that their full significance was first brought out at a meeting of the Astral Camera Club on April 1st: "The supremacy of mind over matter, already indicated in a hundred ways, was thus splendidly illustrated. As a thousand miles of ether may be made to vibrate, at the command of the will of the psychic adept, so may the grosser forms of matter be shaken or removed when this subtle and resistless force acts upon it."

Later in the article will be found a description of an experiment made with an instrument exhibited by Mr. Marvin, the president:

"He had devised a camera with a lens having curved facets arranged on the plan of the eye of the fly. To each one of the seven facets led an insulated tube provided within by an electric connection, so that electric or odic impulses could be transferred from the brain or retina through the eye of each different observer to the many-faced lens. From the lens these impulses would be converged on a sensitive plate, as the rays of light are gathered together in ordinary photography. From the members of the Camera Club, seven of those having greatest animal magnetism and greatest power of mental concentration were chosen for the experiment. Connection was made from the eye of these observers to the corresponding parts of the lens; then all were to remain in utter darkness and perfect silence, each person fixing his mind on a cat."

The composite 'psychograph' of the cat is reproduced "in advance of the publication of the regular bulletin of the Society in which the apparatus used is figured in detail." We must admit that we may need at any time to begin our science over again from the beginning, but President Jordan and the editors of *Appleton's Popular Science Monthly* take great responsibility in dating this from a meeting of 'The Astral Camera Club.'

We regret to criticize a second article in *Appleton's Popular Science Monthly*, a journal which accomplishes so much for the diffusion of scientific knowledge, but an extended editorial article on the speech by Lord Kelvin, on the occasion of the recent Jubilee Celebration (printed in Science, IV., p. 68) appears to be very unfortunate. Lord Kelvin said finely:

"But when I think how infinitely little is all that I have done I cannot feel pride; I only see the great kindness of my scientific comrades and all of my friends in crediting me for so much. One word characterizes the most strenuous of the efforts for the advancement of science that I have made perseveringly during 55 years; that word is failure. I know no more of electric and magnetic force or of the relation between ether, electricity and ponderable matter, or of chemical affinity, than I knew and tried to teach my students of natural philosophy 50 years ago in my first session as professor. Something of sadness must come of failure; but in the pursuit of science inborn necessity to make the effort brings with it much of the *certaminis gaudia*, and saves the naturalist from being wholly miserable, perhaps even allows him to be fairly happy, in his daily work. And what splendid compensation for philosophical failures we have had in the admirable discoveries by observation and experiment on the properties of matter, and in the exquisitely beneficent applications of science to the use of mankind with which these 50 years have so abounded!"

We are informed that this is 'a false note' and 'false sentiment.' We are told that Lord Kelvin ought to have said:

"Science in my day has been most prolific of blessing to mankind; it is proceeding apace with its appointed task of enabling men to understand *for practical purposes* the world in which they live, and what shall be the limit to its achievements in that direction no one can foretell. As to the 'riddle of the universe,' of which we sometimes hear, that lies beyond its ken; only when thought ceases to be conditioned will that riddle—not be read but—disappear."

Lord Kelvin has doubtless also read Mr. Spencer's works, and in any case was not regretting that he had not seen the Holy Grail by means of fasting or 10 grs. of hashish. It was a fine thing to acknowledge in the presence of those who had gathered to celebrate his contributions to science and invention that he had failed to learn what he most desired to teach 'the relation between ether, electricity and ponderable matter.' We remember the reply of the savant when asked a certain question, "Madame, I do not know." "Then what is the use of your science?" "Madame, to be able to answer, 'I do not know.'"

UNIVERSITY AND EDUCATIONAL NEWS.

The chemical laboratory building at the University of Illinois was destroyed by fire on August 17th. The building was three stories high above the basement and contained five laboratories. It was one of the largest and best of its kind in the country and was erected at a cost of $40,000. The fittings, apparatus and supplies are estimated to have brought the entire value to $75,000. The *Scientific American*, from which we take this item, states that it is supposed that the laboratory was struck by lightning, but it seems possible that this, like the recent fire, in the Harvard chemical laboratory, may have been due to spontaneous combustion of chemicals.

It is commonly supposed that Princeton is 'a rich man's college.' The authorities of the University have, however, issued a pamphlet entitled 'The Cost of an Education at Princeton,' showing that of 54 honor men nearly three-fourths expended only $500 or less annually, and nearly one-half $400 a year or less.

According to the *N. Y. Evening Post* the Marquis of Bute has signified his intention of contributing £10,000 to the University of South Wales, to be applied to the purposes of technical education in Wales. The Drapers' Company has also promised £10,000 towards the fund for providing new buildings, and the British government has promised £20,000 on condition that an equal amount be raised by public subscriptions.

We learn from *Nature* that the Technical Education Board of the London County Council has addressed a letter to the Councils of University and King's Colleges on the subject of the financial assistance to these institutions during the forthcoming session. It is pointed out in this letter that the Board cannot undertake to ensure regular annual grants towards either of these colleges. It is further recommended that the Councils of the two colleges should confer together before making any application for assistance, with a view of coordinating the work now specially carried on in connection with Oriental languages. A question has been raised regarding King's College, as to whether the Board can legally make a grant to an institution of a denominational character. But since the discussion of these questions will take some time, it is proposed to continue the grants of £1,500 to University College and £1,000 to King's College for next year, on the understanding that such a conference shall be held.

Prof. W. Dames has been appointed successor to the late Professor Beyrich in geology and paleontology at Berlin, and will also have charge of the collections in geology and paleontology in the Museum of Natural History.

Dr. Wilhelm Wien has been promoted to an associate professorship of physics at Berlin.

DISCUSSION AND CORRESPONDENCE.

THE DEWEY DECIMAL CLASSIFICATION AND SCIENTIFIC CLASSIFICATION.

To the Editor of Science: Every one who hopes for any good results from the bibliographical conference held this summer in London must be pleased to learn that that body did not see its way to adopt the decimal classification as a foundation for the system to be used in the proposed international index to scientific literature. To adopt that system, even with modifications, would undoubtedly have resulted in a deadlock for the whole science of bibliography, and would have lessened, in a very considerable degree, the usefulness of the international bibliography scheme. And more—it might, if such a thing could be possible, have hampered the progress of science as a whole, as far as scientific work is dependent on the sources of information and the methods of making these sources available.

It is ludicrous to see how certain Belgian, and, surprisingly enough, also English, supporters of the decimal classification are full of enthusiasm over this so-called 'new scientific language,' which is destined to take the place that was held by Latin in olden times. As one of these enthusiasts at great length explained: 'Värme' is a Swedish term, 'Chaleur' is French, 'Heat' is English, and you must know these different languages to be able to make out what these terms mean. But if you write down the magical formula '536,' then, of course, all the world knows everything about it! But if the treatise on '536' should happen to be written in Japanese, and you do not know that language, would you be any happier, if these three figures were written on the top of the title-page?

No completely satisfactory scheme for the classification of the sciences has ever yet been made, and very likely never will. Science is ever progressing, and with each step it knocks some part of your system upside down. And the solution is *not* found by letting odds be even and deciding for all time that '536' shall always mean 'Heat.'

The decimal classification is now being discussed from both sides in French and German bibliographical publications,* and it might result in clearing up the subject of classification as a whole, and in the laying down of some foundation for a flexible scheme that might be used in the international index. And if that be so, the enthusiasts in Bruxelles have done a good work, even if not exactly in the direction they meant.

Some features of the decimal classification might be retained, namely, first of all, the use of decimals, and, perhaps, the form divisions. But the scheme itself is too hastily made up, and contains too many blunders, to be used as it stands, or even as a foundation for the scheme itself.

I suppose there are very few libraries of any consequence that have adopted the scheme unreservedly. It would be interesting to know the standing of those 1000 American libraries using the system that were spoken of in the Bulletin of the *Institut International* in Bruxelles. In the two libraries, where it was first used, Amherst College and Columbia University, it has all been made over again.

It has never been perfectly clear, I think, whether it was devised as a system for arranging books on the shelves of a library, or as a scheme for the classification of knowledge. If you attack it on the grounds of its failure in libraries, its advocates explain that it is mainly a means of classifying knowledge, and *vice versa!*

* The favorable part of the discussion was reviewed at some length in the last number of the *Library Journal*, but it was only mentioned that there was some dissent.

The subject of scientific classification is a very important one, and it is well to know that it is in as good hands as those of the committee of the London Conference. But while this committee works, others do not need to sleep. The science of classification, and of bibliography generally, has no representative in this country, neither a society nor a periodical. The *Library Journal*, 'chiefly devoted to Library Economy and Bibliografy,' is really devoted exclusively to the former. The few short contributions to bibliography that have appeared there of late have been of small consequence, and perhaps naturally so. The librarians are confronted with many practical questions of administration that urgently need solution, and have little time to devote to mere theoretical questions. But there is certainly not only room, but need, for some center for the study of bibliography proper, and more particularly, classification. It is too late now to make any proposition for forming a section of bibliography at the Buffalo meeting of the American Association. But, in the meantime, would not the editor of SCIENCE consider the establishment of a department for bibliography in the columns of this JOURNAL? If the men who work in this field could have such an intellectual meeting place they might by and by find their way to meet and organize for work.

AKSEL G. S. JOSEPHSON.

THE JOHN CRERAR LIBRARY, CHICAGO.

METEOR OR BIRD?

TO THE EDITOR OF SCIENCE: In your issue of July 31 (p. 140), quoting from the daily press, it is stated that Mr. William R. Brooks, Director of Smith Observatory, while observing the moon recently, saw a dark, round object, believed to be a meteor beyond the earth's surface, pass slowly across the moon's surface in a horizontal direction. Is it not possible that this 'object' may have been a bird?

Few astronomers, in my experience, are aware of the number of nocturnal migrating birds that may be observed under proper conditions. If, during the September migration, a comparatively low-power glass is focused on the full moon, at certain elevations, it is probable that an almost continuous stream of migrants will be seen passing through the narrow angle subtended by the moon's limbs. Thus at Tenafly, N. J., on the night of September 3, 1887, in the observatory of the late Mr. J. F. Panlison, Mr. John Tatlock, Jr., and myself, using a $6\frac{1}{2}$-inch equatorial, saw no less than 262 birds between the hours of eight and eleven. (*Auk.*, V., p. 37.)

Several years later we obtained nearly similar results from the observatory of Columbia University, New York City, where, thanks to the courtesy of Professor Rees, we were permitted to use a glass, the finder of the large telescope proving strong enough for our purpose.

Previously, observations of this kind had been made at Princeton, N. J., by Mr. W. E. D. Scott and Prof. C. A. Young, in October, 1880, and April, 1881. On the first named date four and one-half birds were recorded per minute, for a period not stated; on the latter date thirteen birds were noted in three-quarters of an hour. (Bull. Nutt. Orn. Club, VI., pp. 97, 188.)

The spring migration of birds begins in this latitude in February, reaches its height early in May, and is concluded by June 10th. The fall migration begins about July 1st, reaches its height in September, and is not concluded until December. It is evident, therefore, that an observer of the moon is likely to have birds cross his field of vision at almost any time of the year, though the movement can be studied with greatest profit during the September migration, when the heavens are, doubtless, more thronged with birds than at any other time.

It happens that we are now on the eve of this great flight of feathered meteors, and astronomers who have the time and inclination to focus their glass on the moon this coming 21st of September can render an important service to ornithology.

In the first place, their observations would throw much light on the question of 'highways of migration.' It is generally accepted as a fact that birds are guided in their nocturnal journeys by the topography of the land over which they are passing, and that river valleys and coast lines are the most frequented pathways. The results obtained by observers situated within the limits of the same wave of migration would have a direct bearing on this subject.

But a more important question to determine, and one about which much less is definitely known, is the height at which these night-flying birds migrate. Both Messrs. Scott and Young, and Mr. Tatlock and myself, solved this problem by a hypothetical assumption of the inferior and superior distances at which a bird would be visible. In this way we arrive at the conclusion that the birds seen were between one and three miles above the earth. There is much confirmatory evidence of the truth of this supposition. For instance, Mr. R. A. Bray records in *Nature* (Vol. 52, p. 415) a flight of birds observed by him through a telescope directed toward the sun, at 3 p. m., on September 30, 1894, at Shere, Guilford, England. The birds were invisible to the naked eye, but must have been at least two or three miles away, as both birds and sun were in focus.

Additional observations are needed, however, before this matter can be considered as satisfactorily settled. If, by experiments made during the day, the observer can ascertain with exactness the lesser and greater distances at which a bird would be visible through a glass focused on the moon, and the appearance of a bird at a known distance, he would then have established some basis for comparison of the observations made at night.

It is also of importance to note the time occupied by the bird in crossing the moon's face. This varies greatly ; some birds appearing as a mere flash of wings, while others are silhouetted against the moon with great distinctness, and are in the field for several seconds.

Assuming that small birds migrate at the rate of about forty miles an hour, and that they pass through the field at right angles to the line of vision, we have here a means of determining approximately the width of the angle at their point of crossing and consequently, in connection with the moon's elevation, their height above the earth.

Frank M. Chapman.
American Museum of Natural History.

CURIOUS FREAK IN AN APPLE TREE.

Some very curious apples were found last year in an orchard about a mile north of Lake Erie. The apples on the northeast side of a certain tree were Rhode Island Greenings, such as the tree had always borne, while those on the southwest half of the tree were of a mixed character, each apple being partly Greening and partly Talman Sweet.

The different kinds occurred in sections, for the most part corresponding to the carpels. In some, three sections or three-fifths were Greening and two-fifths Talman Sweet, while in others the proportions were reversed. In others one-fifth was Greening or Talman Sweet, and in others again the proportion of Talman Sweet was still less.

The different parts were in most cases easily distinguished by color and by the greater protuberance of the Greening as forming part of a larger apple. The flavor of the parts was as purely Greening or Talman Sweet as if they had belonged to separate apples on separate trees, except where the two came together.

The line of demarkation between the parts, though not very definite, corresponded in most cases with the divisions between carpels, and ran from base to summit, except that a small part round the summit seemed in all cases to be Greening. Sometimes a portion of Talman Sweet was found wedged in at the base of a segment, extending only about half way to the summit.

A short distance to the southwest of this tree stands a Talman Sweet tree ; and there can be no reasonable doubt that the phenomenon arose from cross-fertilization between the pollen of the Talman Sweet and the ovule of the Greening. It is difficult, however, to see why the pollen, which acts directly upon the ovule, should so profoundly affect the receptacle and calyx, which make up the fleshy part of the apple. Equally difficult is it to understand why cross-fertilization, which must frequently occur in apple trees, should in one instance produce mixed fruits, and in a thousand cases produce no appreciable effect whatever. Perhaps some of the readers of Science can throw light upon the subject.

T. H. Lennox.
Woodstock, Ont.

I had the privilege of examining samples of the apples of which Mr. Lennox writes, and they bore what seemed to me and my associates to be incontrovertible evidence of the immediate effect of cross-pollination. I had never before been convinced that such immediate effect in flavor and other varietal characteristics can occur in the apple, but I am now satisfied that it may occur; but, like heredity of mutilations, it is certainly rare and therefore apparently exceptional. L. H. BAILEY.

CORNELL UNIVERSITY.

SCIENTIFIC LITERATURE.

The Florentine Painters of the Renaissance with an Index to their Works. BERNHARD BERENSON. New York, G. P. Putnam's Sons. 1896. Pp. 141.

This little handbook, by an accomplished student of art history, deserves notice in these pages because it is the first attempt we have seen to apply elementary psychological categories to the interpretation of higher works of art. A painting, says the author, is of only two dimensions and yet must suggest the third dimension to the spectator's mind. The artist to do this, must give *tactile values* to retinal impressions. "It follows that the essential in the art of painting * * * is somehow to stimulate our consciousness of tactile values, so that the picture shall have at least as much power as the object represented, to appeal to our tactile imagination." From Giotto onwards, the Florentine painters preeminently did this, so that the phrase 'tactile value,' instead of the more familiar word 'form,' appears on every page of Mr. Berenson's account of their characteristics. The high pleasure derived from tactile values artfully portrayed would seem to be due to the rapidity and intensity with which they are suggested. The tactile aspect of reality is actually 'heightened' by the picture, and thereupon ensues the secondary enjoyment of our own capacity for the enhanced experience. The rendering of movement is a step farther in the same direction; we feel the motor life of the figure in ourselves and a heightened sense of our own capacity results. To say that pictures have a 'life-communicating value' is thus to sum up the explanation of their effect on us from this point of view.

The essay is charmingly written, and will be useful to all art-students. Whether we get much deeper into the secrets of art-magic, or account for the sense of preciousness that some paintings diffuse, much better on Mr. Berenson's terms than on more familiar ones, may be left an open question. Mr. Berenson himself has to add 'spiritual significance' to his other terms of 'life-enhancing value.' But until we can define just what the superior 'significances' are, in the better of two good pictures—and surely we hardly ever can—the explanation of all merit by significance remains somewhat unsatisfying. The better picture remains simply the better picture, and its ultimate superiority might, in the end, be a matter of immediate optical feeling and not a matter of extraneous suggestion or significance at all.

W. JAMES.

HARVARD UNIVERSITY.

Atlas of Nerve-cells. By M. ALLEN STARR, with the cooperation of OLIVER S. STRONG and EDWARD LEAMING. LIII. Plates, 13 diagrams, pp. 79, 4to. Macmillan & Co., 66 Fifth Avenue, New York. 1896. Price, $10.

This latest volume from the University press of Columbia University contains much more than the preface indicates.

A short preface serves to explain the nomenclature employed. The nerve cell is designated as a neuron. It has protoplasmic branches as dendrites and the pin-head enlargements along the surface of the dendrites as gemmules. The axis cylinder process is termed the neuraxon; its branches, collaterals; and the terminations of these branches, end brushes. Immediately following the preface is a valuable description of the silver method of impregnation by Dr. Strong, recounting the manner of preparing the sections here employed for the plates, and explaining the modifications in technique which he has introduced with such good results. Upon the photographic methods employed, Dr. Leaming adds a chapter which will materially assist those who propose to work along similar lines.

The body of the book follows and contains LIII. plates, which are reproductions of photomicrographs, and thirteen diagrams, together with the corresponding text. The sections have been made largely from human material. The nerve cells of the cord and spinal ganglia, and those of the cerebellum, quadigemina, thalami, striata and cerebral cortex, are represented and described in the order named. At the very end there is given a plate from Hammarberg illustrating the size and distributions of the nerve cells in six localities of the human cortex.

In the description of the plates cell structure is disregarded, because all structure is obliterated by the silver method, and attention is therefore given alone to the shape and size of the cell bodies and to the number, direction, form and terminations of their branches. The description of the plates forms but a fraction of the text, the remainder of which is a running account, by Dr. Starr, of the architecture of the parts named.

This lucid and terse account is purposely dogmatic and is well illustrated by the diagrams, many of which are essentially new.

Moreover, the teachings of the plates are used where the silver method has enlarged our notions of the architecture, and thus the plates are made contributory to the more general narrative. The double character of the connections between the different cell groups in the central system is one of the more important points which is emphasized throughout.

Turning to the plates themselves, which in the stricter sense compose the *Atlas*, the question is as to what is gained by the photographic representation of the sections. Our impression of a microscopic section is usually based on several pictures offered to the eye at different depths within the object, for such sections always have an appreciable thickness, and only one level can be brought in focus at a time.

Photo-micrographs necessarily give a picture of but one of these levels, and the rest of the specimen is out of focus. The picture thereby obtained is independent of the draughtsman's bias and rigidly accurate, exactly what is desired. Thus, in this case the plates show to perfection the cell bodies and the larger branches, which were accurately focused. On the other hand, the connection of the neuraxon with the cell body is often lost, for it not uncommonly passes out of focus just at the point of junction. So, too, the mass of dendrites, especially where most abundant, as in Purkinje's cells, is of necessity inadequately shown, and the proper relation of the end brushes to the dendrites is obscured.

If the draughtsman is in danger of too great completeness in his drawing the photo-micrograph suffers from a lack of this quality and shows far less than the specimens themselves. By this method therefore accuracy is gained at the price of limitation.

This criticism is intended for the benefit of those who at first sight may feel a disappointment that the whole matter is not entirely cleared up by photographic treatment. A reading glass can be used with advantage in the study of these plates, and, above all, they require careful scrutiny to be appreciated. The silver method is notoriously fickle, and it needs more than the usual skill and perseverance to obtain results by means of it; hence an atlas with good plates cannot fail to be useful to many persons and in many ways; and accompanied, as this one is, by a most instructive text, there can be no question of our indebtedness to the authors for their contribution to neurology.

H. H. DONALDSON.
UNIVERSITY OF CHICAGO.

Die Insel Tenerife. Von DR. HANS MEYER. Leipzig, S. Hirzel. 1896. 8vo, pp. VI., 328. Four maps and 33 illustrations.

The book before us makes good its claim as a scientific guide book to a most interesting region. Humboldt and many other well-known men have given us their estimate of these famous islands. The peak of Tenerife, from its beautiful form and location, has been a favorite theme even from the most ancient times, when the virtues and charms of the 'Fortunate Islands' were proclaimed by bards and philosophers.

The work, however, like many such attempts, while it is not technical enough for the scientist, has a decided advantage over a mere traveller's day book in that a great deal of scientific information of an accurate character and in an easily comprehended form is given in a pleasant and popular style. The origin of the early inhabitants as well as the fauna and flora are carefully treated, and while some vexed questions in ethnology are touched upon, there is nothing in the shape of a bitter attack upon former theories. The facts are brought out more as suggestions, and they are numerous and fruitful to the careful student, while they are of interest to the more superficial traveller, from the insight they give as to the influences, climatic and otherwise, which have supplied this bit of 'environment' with its germs, and have produced the peculiar life forms of the group.

The position of the islands in the belt of the Northeast Trade winds, which have been a predominant factor in causing the changes which have been brought about, indicate the immediate source of the forms of life to be largely southern Europe; since 60 per cent. of its birds, insects and flowers come from the Mediterranean basin.

The earliest human migrations must have been by boat, but all trace of any skill in this direction had completely disappeared by the time of the Spanish invasion, as no boats were found. The inhospitable shores and the dangerous surf must have been the cause of this condition of things. The land offered the settlers all they wanted and they were content. The theory suggested of the descent of the race, for it was a distinct type as described by the Conquistadors, from the Berber family, is very interesting reading.

From the time at which these islands were called the 'Insulæ fortunatæ,' by the expedition of the King of Mauritania in B. C. 40, they were practically lost sight of until 1402. In that year their relations with Europe began. It took nearly 100 years, however, to conquer the stubborn resistance of the real owners of the islands, and the fearful destruction of life is one of the saddest chapters in the history of Spanish colonization. To-day there is probably no pure blooded member in existence of the original race which inhabited the islands.

The island is still, however, the 'Ultima thule;' the troubles of civilized life do not bother the 'Isleño;' and the mild, balmy air makes it the wonderland of peace. If the almost wild activity of modern existence can be called life, then the Canaries supply us with the dreamland of childhood.

The author is evidently very much in love with the subject of his sketch, and the smooth surface of his description is only ruffled when he comes under the influence of the hated Spanish control, or the very loud English tourist. He is evidently a Sybarite in the enjoyment of nature.

His description of the trips made to all parts of the volcano are full of interest; and while it is true that the sketch given by Humboldt upon the occasion of his visit 100 years ago still holds good, there is much that is introduced of a geological nature, which cannot but help add to the pleasure of a trip to this locality on the part of one not familiar with this subject. As was to be expected, the best part of the book is the sketch of his trip to the main peak, and the word picture of the sunrise as seen from the top is extremely well done.

It seems a pity that even one sentence should appear in such a book which grates upon the scientific mind; but on page 64 a rather remarkable explanation is given which should not have escaped the author's attention. It reads as follows: "The difference in temperature between the soil and the air, and the friction of the wind upon the crest of the range, condense the moisture of the cold Trade wind into small banks of cloud." This explanation would hardly pass muster with the meteorologist; since the cause of condensation is not the mere contact of the air with the soil, or the friction against it, but the fact that the air current is forced into a higher and colder layer of air, which so reduces its relative humidity that the point of saturation is reached.

The maps of the book are carefully prepared, and they cover the field of geology, the forms of vegetation and the cultural regions, besides giving a good road map. The illustrations, while they are good, are not what might be expected from clear photographs when reproduced by some of the more modern processes.

At the close of the work is a discussion of the craniological collection by Dr. F. von Luschan, which is to be regarded as a preliminary notice, since the main results are reserved for a future publication.

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George Brown Goode, one of the ablest and best men in America, died at Washington on September the sixth, at the age of forty-five years.

SCIENCE

Friday, September 11, 1896.

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

THE BUFFALO MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

*THE ARTISTIC ELEMENT IN ENGINEERING.**

A friend of the writer, a successsful business man and much interested in things artistic, when informed of the choice of subject for this paper, gave expression to a feeling of surprise doubting if there was any relation between engineering and æsthetics.

One of the leading engineers of America once asked a professional brother what he did for recreation, and on being told of a modest interest in pictures and music likewise expressed surprise, saying, "You are the first engineer that I have ever known to be a musician." There was also an implication, though unintentional, of a diminished respect—perhaps on both sides.

These two incidents may be taken to typify in a general way the attitude that is held by the business world, on the one side, and the engineering fraternity, on the other, towards the relationship which it is proposed here to discuss.

That the artistic element is not recognized as it might or ought to be in the present American day is natural. The rapid development and growth of our land, the intensive study of science and the concentration of the efforts put forth to adapt it to everyday affairs, has exalted one phase of

*Address of the Vice-President before Section D.—Mechanical Science and Engineering.

the economic idea, the quick attainment of profitable results, and clouded the truer, broader meaning that looks toward the best things and the highest life of the people. Into the midst of this active, restless, business life entered the engineer, doing more and more of its work and becoming more and more a recognized part of it and an undisputed element in its growth. He has acquired the characteristics of the life about him, zeal, energy, alertness, readiness in meeting quickly changing conditions, and absorption in the work in hand. He plans rapidly and executes to-day with an eye for to-morrow's profits. As another has said, "The world measures the efficiency of the engineer in dollars and cents," just in fact as it measures that of any other man, and engineers, as other men, largely accept the standard.

Time was when he was only the tool of some business man who had money to expend in a certain way and who employed him, under direction, because of some individual ability. But times are changing. In place of the isolated worker there is growing up a profession with professional standards and an *esprit de corps*, and whose members are to be retained, not hired. Cultured, and with the openness and clearness of mind that only come from deep study, broad training and large experience, these are to be people of influence whose advice and services are sought, leaders, whose judgments are respected and men who can mingle with the best anywhere on a common ground of attainment and character. They are to be entrusted with the expenditure of public funds in increasing extent and with an augmenting confidence. The very nature of an engineer's qualifications, his technical knowledge, the cultivation of his judicial and critical faculty, his training in fidelity to the trusts reposed in him by private clients, all these fit him for places of large responsibility concerned with public works; and the people, tired of political management, are beginning to find this out.

These are no new thoughts, though none the less true, for others have recently written in confident strain of the coming engineer of the twentieth century. Yet it should be emphasized that the desired change is not, after all, so far ahead of us. To some extent, at least, the coming engineer has already arrived and is making himself felt. The leaven is at work.

With an engineering practice based solely on immediate results by way of expected profits in dollars and cents, the æsthetic element has little to do, though even here its absence may mean financial loss. But from the standpoint of this paper engineering is to be considered in the broader light of Telford's well-known definition: 'The art of directing the great sources of power in nature for the use and convenience of man,' while the engineer is he who designs and executes engineering works.

It is not necessary here to dwell upon the breadth and comprehensiveness of these simple fundamental statements, but let us not forget that they are broad and comprehensive. With an engineering practice based on a generous interpretation of the above, the artistic has much to do.

The engineer is primarily a designer. He works with the materials of nature as his medium and her powers as his tools, wherewith to express his thought and his purpose to serve and benefit man. Just as in the making of a picture, the brushes, paint and canvas are not the chief things, so here it is not the stone, steel and brass or the powers of gravity, steam, air and electricity that are most important, but rather the character and quality of the design and the degree of realization in its execution. The design may be bad or good, according as it ignores or harmonizes with principles underlying all such acts of creation. The result may be a happy one only when the means employed are rightly chosen and properly adapted to the end sought. In this process of creating something of value, something that helps man to a fuller, richer and better life, the artistic cannot be left out. In its absence the design falls far short of its possible perfection and man is deprived of what is due him, though not perhaps distinctly conscious of the loss. In a certain sense then every engineer is an artist, and in some directions at least, as in architecture and other forms of construction and in the making of public parks, the result of his cultured brain may attain to the dignity of a work of 'fine art.' Perhaps, in its true essence, there may be as much fine art in the design of a machine to produce bolts as there is in the making of a picture for the Salon; certainly the well-planned tool with fine proportions and parts perfectly related is above the poor canvas.

To every true man there is a joy in creation that is not satisfied with anything less than the best of which he is capable. As Emerson has said, "I look on that man as happy who, when there is question of success, looks into his work for a reply, not into the market, not into opinion, not into patronage." * * * "What is vulgar, and the essence of all vulgarity, but the avarice of reward? 'Tis the difference of artisan and artist, of talent and genius, of sinner and saint." But beyond this, which is the purely personal side of the matter, lies service, the designing for the use and convenience of man. From the vantage ground of his position as a man of educated intelligence and trained ability, the engineer owes the world his best effort. It needs and asks for technical skill and scientific knowledge whereby to-day's work may be done. But also, without knowing exactly what it wants, it feels the need of those added qualities it cannot define, and seeks for guidance and help to something better for to-morrow. In the long run, it will honor the man that meets the demand and will measure his efficiency on more grounds than that of dollars and cents.

To the superficial or hasty thinker there may appear a conflict here between the utilitarian and the artistic, but there can be no *real* antagonism. The result of an act of designing is to be judged as a whole in the light of all the purposes to be fulfilled. The physical conditions imposed by the materials used and the forces of nature employed are to be met. These conditions must be expressed in the design frankly and candidly, and in such a way as to indicate clearly its purpose and to gratify the observer through its proportions, symmetry, harmony and decoration. The end desired must be attained in the most direct and simple way, so that the expenditure of money may be a minimum. These are the three elements of design, scientific, æsthetic, and the financial. A disregard of the requirements of the first may mean structural or organic weakness, on the one hand; or on the other, an excess of material that unduly adds to the cost and at the same time may produce heaviness or ugly proportions in the completed work. Non-compliance with the demands of the second makes the design fail in fulfilling its complete mission; this applies with the same force to those cases where a poorly directed attempt has been made to be artistic in expression, as to those in which no attention whatever has been paid to the matter. Artistic treatment often costs money, yet the mere expenditure of cash will not secure it. On the other hand, the proper display of good taste may often come without the spending of a dollar more than is made necessary by the other conditions surrounding the problem. A wealth of ornamentation may be brazen and vulgar, while beauty and grace may be found in the simple lines of a machine or bridge, or in the curving of the curb by the roadside. The disregard of the financial side may mean either a weak, meagre and unsatisfactory result, or an unwise lavishness in expenditure, in both cases producing in the long run a loss and waste of money.

The current engineering practice gives great attention to the first and last of these elements, and but little comparatively to the second. There is no branch of it but would be benefited by adding to scientific and business ability a knowledge of the principles of artistic design and an impulse to give expression to it. The effect on the life of our communities and the Nation by such a change is not easily estimated, The writer does not expect, however, to see an immediate revolution. This is not a change that comes naturally in that way, but rather by way of development and growth, generally slow, although it may at times be accelerated. In this development our people as a whole must increase in artistic sensitiveness. We are not an æsthetic nation, but we have latent possibilities in that direction; we are young, confident and impressionable and have the courage to be original in design, which counts for much. We have evolved the American locomotive, the American truss bridge, the American automatic machine, the American much-debated tall building, and many other things especially adapted to American needs. We shall grasp the artistic possibilities of construction quickly when we come to know what they are, and will apply them confidently, not always at first with the most happy results. We shall learn something from the old world and will assimilate much that is good in its practice, but in the end engineering here will be both artistic and American.

There are evidences here and there that this process of change is going on. American machine design when compared with that of other countries shows some marked characteristics. A writer in the *Engineering Magazine* says of these that "the best ones are directness of design, by which is meant the shortest cut to reach a given end, the designer having in mind the thing to be done quite as much as the machine which is to do it; lightness and a close proportioning of parts; in machine work a near approximation to pattern; rapidity of construction and rapidity of action in the finished machine; the substitution of special steels and new alloys, hollow construction, etc., for older materials and construction, and a generally neat appearance of work, and burrs, lips and roughness of casting removed. The American designer is not an artist like the Frenchman, but is more attentive to appearances than the Briton. He is gradually curing himself of the tendency to tawdry ornament, needless accessories of fancy castings, stenciled paints, japanning out of place and bright work for mere effect." These are good qualities and in the line of improvement. Some recent installations of power plants illustrate a movement that will have considerable influence on engine design. In many of our larger cities there are engine rooms fitted up in elegance, with marble floors and wainscott, decorated walls and ceilings, brilliantly lighted and with all the appliances of the plant, engines, dynamos, switch boards and even the smaller accessories in keeping with the surroundings. These plants are used as drawing cards or advertisements. There are other plants not so used, where there is displayed less elegance, but fully as much artistic sense in adapting the room and its treatment to its purpose. In many of these places only the enclosed type of engine can be used. In all of them the standard of maintenance must have its influence on the matter of design, which will in turn react on the former. An engine might pound itself to death in a dark basement, but would have its slightest vagary looked after in one of these better planned housings. This result cannot be entirely accounted for by the larger room, the better light, the rules and regulations. There is a refining, educating influence in these artistically planned constructions that makes better men and more efficient workmen of the attendants. Whatever they may cost, there is a credit side to the balance sheet.

Our railways are contributing toward this change. They have found the decoration of passenger trains a profitable thing and, so stimulated, have carried it to excess. Handsome terminal stations, adorned in good taste, are supplanting the dingy, forbidding and inconvenient places so long in use, while the shed type of depot is being crowded out by beautiful, quaint buildings set in the midst of lawns and flower beds. More significant still is the tendency to adopt a high standard of maintenance, under which the roadbed is kept trim and neat, flanked by sodded slopes and bordered by clean and well-kept buildings; which also requires the rolling stock, the shops and yards to be maintained in a high state of efficiency. This is not necessarily in itself artistic, but it furnishes at least a necessary foundation. That the railway management understands, to some degree, the commercial value of the artistic element in its business is further evidenced by the nature of its advertising, that seizes on any advantage of scenery or artificial effect that is at hand.

Not much can be said in praise of the artistic qualities of our bridges, for these attributes are conspicuous through their absence. The American bridge satisfies the conditions of stability and least cost, but of beauty of line or balanced proportion that make it fit into and harmonize with the landscape or even that makes it attractive considered by itself, it has little. And this is to be the more regretted because an intelligent application of right principles would much improve the effect, without adding much, if any, to the cost or making the structure less safe and durable. It is true that the truss with parallel chords, especially of the through type, does not lend itself readily to artistic treatment, yet even here something can be done. It is not so much a matter of adding ornament as the proper treatment of the organic lines, the length of spans, the relation of length of panel to height of truss, the location of the piers and the form of their outlines. Ornamentation is not to be used so much for its own sake, but rather where it is needed to accentuate these organic markings. There are some truss bridges of such size that they give pleasure to the observer through their massiveness, though lacking in other desirable qualities. The cantilever, like the Pratt and its relatives, is difficult of treatment, while arch forms, either braced or of the suspension type, are naturally pleasing and best adapted for artistic expression. Of these types we have a few satisfactory examples, like the Eads and the Grand Avenue bridges at St. Louis, the Brooklyn and Washington bridges at New York. In our public parks are to be found many small bridges of good design, while in our cities there are some creditable ones of larger dimensions. There is some tendency toward the use of curved chords in bridges designed for urban use, and a further evidence of interest in the curved line through the introduction of the Melan arch. In some respects it is unfortunate that the economical element has driven out the stone arch, which possesses so many of the elements of a beautiful structure for most situations, and it may be that this new form will become a substitute for the old, with added characteristics of its own. However much we may admire the inventive genius and mechanical ingenuity of those who have worked out the types of rolling or lift bridges that cross the Chicago river, the less said about the beauty of the designs the better. Perhaps the environment imposes ugliness on the designer. But that problem is hardly solved yet, and will not be, until some man gets hold of it that combines æsthetic with scientific qualities and has insight keen enough to see the possibilities of the situation and adroitness enough to manage, not only the physical, but also the human factors—a rare combination.

In the entire field of engineering there is no portion of it that includes a greater variety of intricate and difficult problems for solution than that connected with municipal life. Here the engineer has to do with matters touching the home life; the dwelling, its heating, ventilation and lighting, its drainage and water supply, etc. There is the business life that demands attention for the stores, office blocks, banks and exchanges, manufactories and shops, warehouses and elevators with all of their requirements of heating, cooling, lighting, ventilation, drainage, power and internal communication through elevators, pneumatic systems and alarms. Then there is the larger life of the city as a whole that needs public buildings, churches, schools, hospitals, libraries, museums, hotels, theaters, railway stations and markets, each with its own peculiar demands; streets and systems for rapid transit, both intramural and suburban; the distribution of water, heat, cold, light and power; pneumatic systems for carrying packages; electrical conduits; sewerage and garbage systems, with the plants for their treatment or disposal; wharves and railway yards; parks, boulevards, play grounds, plazas; the opening of new territory to accommodate the city's growth.

The engineer here comes in close contact with the people that daily and hourly use the results of his work. He already influences their health and bank accounts for the better, gives them greater ease and convenience at work or play and saves their time. This is what is asked of him and he meets the demand well. But what an uplift would come to city life, how much richer it would be, if he could put an artistic quality into his designing and the people would learn to appreciate it. It is not to be inferred that there is an entire absence of this, but rather that artistic effects have been largely confined to individual cases, and not made manifest in the general life of the city. For instance, there are numerous examples of suburban dwellings, beautiful internally and externally and with harmonious settings; there are occasional business blocks whose treatment is satisfactory, but very few public buildings that have an adequate artistic meaning and are so situated as to express this advantageously if they did posssss it. Without detracting in the least from the acknowledged merits of Trinity Church, Boston, it must be admitted that its roomy location on one side of an open plaza adds greatly to its effectiveness. Think of its being placed in the middle of a block on Washington street, or set in the midst of brownstone fronts on Fifth avenue! All public buildings need both room and an appropriate setting. They are the larger and more important pictures in the gallery of city structures; yet under the prevailing system of rectangular blocks, bounded by long, straight and narrow streets, the hanging committee has nothing but the walls of corridors on which to place them. The worst of the matter is that the exhibition is a permanent one. Along these alleyways must also be hung the narrow, vertically elongated panels that seem to be so popular to-day, in favor because they pay. The observer needs a twenty story ladder in order to study their details or even to know if they have any and can find no point from which they can be seen as entireties. At their sides hang strings of pictures whose horizontality exaggerates their skyward tendency. It is not the modern tall building in itself that is here objected to, but its location on sites that will not admit of a display of its best qualities. With wide, clear surroundings and effective grouping they may be made agreeable, as is illustrated by the happy combination at the southeast corner of Central Park.

One of the good results of the tall building craze is the bringing closer together of two branches of designers; from the architect the engineer will learn more of art and he will teach the former better construction. While retaining their separate functions, the collaboration will result in a higher mutual respect and appreciation and a better grade of work on the part of each.

It is undisputed that the rectangular plans of American cities are neither adapted to meet æsthetic conditions nor the demands of traffic. The long streets, without variation in width and direction and without the breaks afforded by little parks, are tiresome to the eye. They are not placed with any regard to the topography or the natural features of the landscape or to give prominence to some important structure, nor do they furnish direct lines of travel. But the plan is weighted down to the ground by millions of money. So it is not a question of what it ought to be, but one of mitigating the present evils and avoiding a repetition of these in the future. Radical treatment must be resorted to by way of diagonal avenues from congested centers and the widening out of the intersections of important streets into parks and plazas. There must likewise be a heroic struggle with the water fronts and internal water courses, places full of picturesque possibilities, though usually given over to filth and ugliness. These changes are made imperative not only by aesthetic requirements, but also by the demands of health and business.

In the planning of additions to large cities, the designer is hampered by the supposed necessity of tying to the older plans, by the desire of owners and speculators to realize to the largest extent on the sale of lots, or by his uncertainty as to what the future growth and character of the population may be. An examination of the block plan of many of our cities would show a heterogeneous arrangement of streets, especially in outlying districts, without regard to mutual relations, matters of grade and drainage or artistic position. This irregularity may be more inconvenient and less pleasing than a right-angled plan. Our towns and smaller cities reproduce in miniature the conditions of the larger centers. Here again it is a question of improvement instead of original design, only the problems involved are not so intricate and their solution not so costly. So it is hardly possible for a designer to plan an ideal city or to have the full swing and liberty of the men who laid out the city of Washington and established its system of grades and drainage. But in spite of difficulties there exist some suburban districts, laid out, built up and adorned on the principles of good taste. Thanks to the systems of rapid transit that are increasing the number of these attractive places!

In the design and maintenance of water supply plants, American practice shows some respect for the artistic element. This is not confined to any particular system or any part of any one plant, but is quite general. The engine houses are not ugly and their interiors are often attractive. Gate houses, aqueducts and dams are decoratively treated and form pleasing features in the landscape. The slopes of reservoirs are kept trimmed and the grounds generally turned into lawns with flower beds and perhaps a fountain. No doubt, the sanitary conditions imposed have much to do with this, but the result is none the less in good taste. We cannot avoid, however, a stray shot at the ugly standpipe with conical cap, sometimes seen in our smaller towns. This is unnecessary. When enclosed it has been made an interesting object, and even the bare pipe can be ornamented in such a way as to relieve its nakedness.

There is much encouragement in the growing appreciation and enjoyment of public parks and boulevards. Cities and towns all over the land are trying to beautify what they already have and are adding new territory to their park resources. Admirable skill has been shown in utilizing the natural features of the local landscape, the rocks, tree masses, meadows, ravines, ponds and streams, the wide expanse of ocean or glimpses of bright water. The curving roads and paths, with undulating gradients, have a beauty of their own and lead one from point to point of the ever-changing scene, and yet bind it all into one harmonious whole. While the landscape engineer deserves credit, not so much praise can be given park commissioners for the artificial adornments which they have added to his work. Notwithstanding the fact that these are sometimes labeled as artistic, they do not always fit in appropriately.

The writer firmly believes that there is a latent æsthetic quality in American life that is now struggling to find both means for its gratification and methods of expression. Before there can be knowledge of its meaning and power there must be many attempts and many failures. The whole process is one of education and that largely in the school of experience. This applies to the industrial and constructive arts as well as to the fine arts. The engineer will share in the general movement, but this is not enough. As a designer of so much that the world needs for daily use he must do more than keep up; he must keep in advance. He must not only have a capacity to enjoy, but also the power to originate and apply. To this end he must give preliminary study and thought to the principles of æsthetic design, so gaining an intellectual knowledge of them. American engineering schools are doing little or nothing to help the young engineer to this. So far as the writer knows, there is but one American text-book, Prof. Johnson's book on bridges, that includes any discussion of the matter. A course of study in engineering æsthetics near the close of college life would be a great help and stimulus to a young graduate, at least opening his eyes to the fact that there was such a thing. After knowledge comes the application of principles as tests to an engineer's own work and to that of other men. And, finally, with theoretical and practical knowledge well in hand and a love of what is beautiful, comes the impulse to work artistically. With such engineers and an appreciative clientele American engineering would be artistic. To this end let us work.

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*GEOLOGICAL MYTHS.**

Many years ago I visited the British flagship 'Bellerophon' in the harbor of Bermuda, and was told that when the ship was first named the sailors wrestled with the sonorous but unmeaning name, and quickly transformed it into 'Billy-ruffian,' and it became at once intelligible, and belligerent, and satisfying.

There arose, however, a contest in the forecastle as to whether 'Billy-ruffian' or 'Bully-ruffian' was the correct thing; certain rude fellows of the baser sort wish-

* Address of the Vice-President before Section E, Geology and Geography.

ing to have the word pugnacious in both its proximal and distal extremities.

This illustrates the principle of attraction in language whereby words without meaning to the users tend to be modified into forms which at least appear intelligible.

It is said that when asparagus was introduced into England the peasants immediately called it 'sparrow-grass,' and went on to explain the reason it was called sparrow-grass was because the sparrows ate the red berries.

This illustrates the second step of the process. The word is first attracted into a form which has a meaning, and in its turn this meaning requires a justification, and this the meaning itself quickly suggests.

The peasant was not disturbed by, or did not observe, the fact that the sparrows do not eat the red berries. This would have been to have risen to the 'verification of hypothesis'—an indefensible encroachment on the terrain of the British philosopher.

I propose to trace the history of several myths which have their origin in remarkable geological phenomena, for I hardly need to say that I do not use the word myth in the modern fashion of newspaper English, as a false report, a canard, in short, a newspaper story; but as meaning a history, treasured and hallowed in the literary and religious archives of an ancient folk, of some startling or impressive event, that, in the stimulating environment of poetry and personification, has completed a long evolution, which disguises entirely its original,—

> "Has suffered a sea-change
> Into something new and strange,"

so that, in fact,its study is paleontological.

I propose to speak of the Chimæra, or the poetry of petroleum; of the Niobe, or the tragic side of calcereous tufa; of Lot's wife, or the indirect religious effect of cliff erosion, and of Noah's flood, or the possibilities of the cyclone and the earthquake wave working in harmony.

THE CHIMÆRA.

The myth of the Chimæra is told, in its earliest form, in a quaint old translation of Hesiod, who, according to the Marbles of Paros, lived about nine centuries before the Christian Era.

> "From the same parents sprang Chimæra dire,
> From whose black nostrils issued flames of fire;
> Strong and of size immense; a monster she
> Rapid in flight, astonishing to see;
> A lion's head on her large shoulders grew,
> The goats and dragons terrible to view;
> A lion she before in mane and throat,
> Behind a dragon, in the midst a goat;
> Her Pegasus the swift subdued in flight
> Backed by Bellerophon, a gallant knight,
> From Orthus and Chimæra, foul embrace,
> Is Sphinx derived, a monster to the race."

The same story is told a little later by Homer* with more grace of diction.

> "And Glaucus in his turn begot
> Bellerophon, on whom the gods bestowed
> The gifts of beauty and of manly grace.
> But Proetus sought his death; and mightier far,
> From all the coasts of Argos drove him forth.
> * * * * *
> To Lycia, guarded by the gods, he went;
> But when he came to Lycia and the stream
> Of Xanthus, there with hospitable rites
> The king of wide-spread Lycia welcomed him.
> Nine days he feasted him, nine oxen slew;
> But with the tenth return of rosy morn
> He questioned him and for the tokens asked
> He from his son-in-law, from Proetus bore
> The token's fatal import understood,
> He bade him first the dread Chimæra slay,
> A monster sent from heav'n—not human born,
> With head of lion and a serpent's tail,
> And body of a goat, and from her mouth
> There issued flames of fiercely-burning fire.
> Yet her, confiding in the gods, he slew.
> Next with the valiant Solymi he fought
> The fiercest fight he ever undertook;
> Thirdly the women-warriors he overthrew,
> The Amazons."

It will be seen here that Bellerophon, like Hercules or St. George, is a professional wandering slayer of dragons. His

*Iliad., VI., 180; Earl Derby's Translation, VI., 184–216.

name from βάλλω, the far-throwing rays of the sun, shows him to be a type of the wide-spread sun-myth, whose rising rays strike down the forms of darkness.

But the myth of Chimæra is independent of him, and is always localized; there is always the tail of a dragon, the body of a goat and the head of a lion, or the three heads of lion, goat and serpent, and it vomits fire, and ravages in the mountains of woody Lycia.

The classical prose writers describe the phenomenon with curious accuracy. Seneca says:

> "In Lycia regio notissima est.
> Ephestion incolæ vocant,
> Perforatum pluribus locis solum,
> Quod sine ullo nascentium damno ignii innoxius circuit.
> Laeta itaque regio est et herbida nil flammis adurentibus."

(In Lycia is a remarkable region, which the inhabitants call Ephestion.* The ground is perforated in many places; a fire plays harmlessly without any injury to growing things. It is a pleasant region, therefore, and woody, nothing being injured by the flames.)

Strabo says, simply: "The neighborhood of these mountains is the scene of the fable of the Chimæra, and at no great distance is Chimæra, a sort of ravine, which extends upward from the shore." And Pliny, with his accustomed mingling of truth and fiction, says: '— et ipsa (Chimæra sæpe flagrantibus jugis' (and Chimæra itself with its flaming peaks). And again: "Flagrat in Phaselide Mons Chimæra et quidem immortali diebus ac noctibus flammâ." (Mount Chimæra burns in Phasilis with a certain immortal flame shining by day and by night.) Also: "In the same country of Syria the mountains of Hephæstius, when touched with a flaming torch, burn so violently that even the stones in the river and the sand burn while actually in the water. This fire is also increased by rain. If a person make furrows in the ground with a stick which has been kindled at this fire, it is said that a stream of flame will follow it."

* That is Vulcan.

Servius, the ancient commentator of Virgil, explains the myth as follows: "The flames issue from the summit of the mountain, and there are lions in the region under the peak, the middle parts of the hill abound with goats, and the lower with serpents." While the modern commentators say: "The origin of this fire-breathing monster must be sought probably in the volcano of the name of Chimæra in Phaselis, in Lycia,"* and the myth did not escape the great, but largely wasted, erudition of Knight, who says: "In the gallery in Florence is a colossal image of the Phallus, mounted on the back parts of a lion, and hung round with various animals. By this is represented the cooperation of the creating and destroying powers, which are both blended and united in one figure, because both are derived from one cause. The animals hung round show also that both act to the same purpose, that of replenishing the earth, and peopling it with still rising generations of sensitive beings. The Chimæra of Homer, of which the commentators have given so many whimsical interpretations, was a symbol of the same kind, which the poet, probably having seen in Asia, and not knowing its meaning (which was only revealed to the initiated), supposed to be a monster that had once infested the country. He described it as composed of the forms of the goat, the lion and the serpent, and breathing fire from its mouth, (Il. V., 233). These are the symbols of the creator, the destroyer and the preserver, united, and animated by the fire, the divine essence of all three.

"On a gem published in the Memoirs of

* Smith's Dict. of Clas. Antiq. Sub. Chimæra.

the Academy of Cortona this union of the destroying and preserving attributes is represented by the united forms of the lion and the serpent crowned with rays, the emblems of the cause from which both proceed. This composition forms the Chnoubis of the Egyptians."*

And thus the matter rested until, in the end of the last century, Admiral Beaufort,† while anchored off Lycia on hydrographic work, saw each night a strong flame on the peak of a mountain a few miles back from the coast, and was told by the inhabitants that it had always burned there.

He visited the place, and found flames of natural gas issuing from a crevice on a mountain of serpentine and limestone.

In 1842 Spratt and Forbes ‡ report as follows on the locality: Near Ardrachan, not far from the ruins of Olympus, a number of serpentine hills rise among the limestones, and some of them bear up masses of that rock. At the junction of one of these masses of scaglia with the serpentine is the Yanar (or Yanardagh), famous as the Chimæra of the ancients, rediscovered in modern times by Captain Beaufort. It is nothing more than a stream of inflammable gas issuing from a crevice, such as is seen in several places among the Apennines. The serpentine immediately around the flame is burned and ashy, but this is only for a foot or two; the immediate neighborhood of the Yanar presenting the same aspect it wore in the days of Seneca, who writes "Læta itaque regio est et herbida, nil flammis adurentibus."

Such is the Chimæra, 'flammisque armata Chimæra,' § deprived of all its terrors. It is still, however, visited as a lion by both Greeks and Turks, who make use of its classic flames to cook kabobs for their dinner.

* Richard Payne Knight. Discourse on the Worship of Prapus, p. 73.

† Beaufort's Karamania, 35, 52, 85.

‡ Travels in Lycia, II., 181, 1847.

§ Virgil, Æneid, VI., 288.

In 1854 it was visited by the Prussian painter, Berg, who has reproduced the scene in a fine painting now in Berlin.* The flame which he says, gives the odor of iodine, is three or four feet high. Several extinct openings were found in a pool of sulphurous water.

The Austrian geologist, Tietze,† found the flame two feet across, and a smaller one adjacent. The ruins of an ancient temple of Vulcan, near by and of a late Byzantine church, show how strongly it has impressed the inhabitants in all ages.‡

The natural phenomenon of a spring which is found by historic documents to have been burning for nearly three thousand years is sufficiently striking, although the slow escape of such gas from Tertiary limestones is not uncommon. The mention of sulphurous waters in the neighborhood may justify us in going back to the same antiquity and drawing from the remark of Theophrastus (Περὶ τῶν λίθων) on the oxidation of pyrite in contact with bitumen, an explanation of the constant ignition of the gas.

Theophrastus says: "That, also, which is called Epinus (or Spelus) is found in mines. This stone cut in pieces and thrown together in a heap exposed to the sun, burns, and that the more if moistened or sprinkled with water."

We may of course assume the more prosaic spontaneous combustion of the volatile hydrocarbons to explain the constant rekindling of the sacred fires.

It remains to consider how the myth and its name arose. The mountain is still called Yanar-dagh, the burning mountain, and in a learned work on coins of Sicyon, which

* Zeitschrift, All. Erdkunde, III., 307.

† Beiträge, zur Geologie Lykien. Jahrbuch d. K. K. Geol. Reichsanstalt, XXXV., 353.

‡ C. Ritter, Erdkunde, Theil. 19, 751.

reproduces the Chimæra, M. Streber derives the name from the Phœnician word Chamirah, which means the burning mountain.

But the Greek word χαμαίρα means a goat, and has almost the same sound, and we can see clearly how, as the Greek settlements spread over Lycia, from the north, the meaningless Phœnician names were retained like the Indian names in America, and how the story slowly went back to the fatherland—et crescit eundo—of a strange mountain called Chamira, from which portentous flames escaped, and then of a monster Chimæra, of goat-like form, vomiting flames and ravaging in the mountains of woody Lycia. And so the story was finally fitted for the manipulation of the poets, who little thought they were making the stout Bellerophon run a quixotic tilt against a burning gas well.

THE NIOBE.

Like the Chimæra, the Niobe is an episode in Greek mythology, easily separated from the rest without disturbing the Greek Pantheon. I do not need to describe the great group of the Niobe, the mother weeping over her children, who fall before the shafts of Apollo, which adorns the gallery of the Uffizi at Florence, and forms one of the masterpieces of Greek sculpture, the glory of Scopas or Praxiteles. I do not need to recall the story as told by Homer, how Niobe, the daughter of Tantalus, proud of her twelve children, despised Latona, who had but two; how, therefore, Phœbus and Artemis slew all the twelve with their arrows:

"They lay unburied on the plain for nine days, when Zeus changed them to stone, and on the tenth day the heavenly gods buried them. And now, upon arid Sipylus, upon the rocks of the desert mountain, where, they say, are the couches of the divine nymphs, who dance upon the banks of Achelous, Niobe, though turned to stone, still broods over the sorrow the gods have sent upon her."

And Ovid says:

"She weeps still, and borne by the hurricane of a mighty wind,
She is swept to her home, there fastened to the cliff of the mount,
She weeps, and the marble sheds tears yet even now."

As one climbs from the Gulf of Smyrna, between Mount Tmolus and Sipylus, up the rich valley of the Nif, or Nymphio, there appears, high up in the vertical wall of limestone, the colossal bust of a woman standing on a high pedestal and in a deep alcove. It is cut out of the living rock, like the Swiss lion at Lucerne.

A recess twenty-five feet high and sixteen feet wide has been cut in the rock for the lower part, and a smaller alcove of much greater depth surrounds the bust itself. All the face of the rock around is smoothed, and a broad ledge is cut around the pedestal to receive the offerings of the ancient Phœnician worshippers of this almost prehistoric statue of the great Mother Cybele, or of Meter Sipylene; gods of the Phœnicians.

From the valley below it makes the impression of a full-length statue with flowing robes, but near at hand the robes are seen to be the very tears of Niobe, formed where the drip of the waters from the limestone roof of the alcove has first struck her cheeks, and running down across her breast has made rippling surfaces of bluish tufa, which has all the effect of tears.

The statue had been greatly corroded, and the stalagmite tears had formed already in the days of Pausanias, who says: "When standing close to it the rocks and precipice do not show to the beholder the form of a woman, weeping or otherwise, but if you stand farther back, you think you see a woman weeping and sad."

And even in the times of Homer the memory of the earlier and vanished worshippers was at best a dim tradition, and the facile imagination of the Greeks had built up the whole beautiful legend, every element of the surrounding scenery adding its portion of suggestion, and it is marvellous how all parts of the story still linger in the valley.

As the grand missionary, artist and geologist, van Lennep, from whom I have obtained most of this account,* who in all his travels in Asia Minor collected carefully and labelled carefully, and sent valuable material to his Alma Mater, Amherst, was climbing to the statue, his guide, a cake-seller by the roadside, said: "There is a tradition that this statue was once a woman, whose children were killed, and she wept so that God changed her to stone. They say that her tears make a pond down there, and still keep it full."

All the people of the region, ignorant and learned, agree in this, while all travellers have called this the statue of Cybele.

Their name for the valley, Nif, is a corruption of Nymphio, as Homer says, 'the couches of the divine nymphs.' Sipylus, the name of the mountain to this day, was also the name of the oldest son of Niobe.

Niobe was the daughter of Tantalus. Tantalus, from ταλαντεύω, to balance, is a rock poised in the air, an allusion to the ledges overhanging the statue, and threatening to fall and crush it.

That she is the mother of many children may be a reminiscence from Cybele, the All-mother, and the mention of the couches of the divine nymphs seems to suggest some ancient nature worship of the valley. The children slain by the arrows of Phœbus are the masses of rock dislodged from the cliffs around her by the action of sun and rain and forming the great talus at the foot of the bluff.

"They lie unburied on the plain," Homer tells us, "till on the tenth day the heavenly gods bury them," as the fallen rock quickly disintegrates under the influence of the weather in this warm climate. The Greek word, Niobe, connects itself with the pouring of water and the falling of snow (νίζω νίπτω and νίφω), so a Greek impersonation of the drip from the marble cliff upon the ancient rock sculpture might easily have acquired the name of Niobe, the weeping one.

*Asia Minor, II., 300. London, John Murray, 1870.

"It seems, thus," says van Lennep, "that this sculpture was executed in a very remote antiquity, to represent Cybele, the mother of the gods, or some form of nature-worship, that the water drip from the rock above gave it, from the first, the same striking watermark which it still bears, maintained by the same cause, and that this appearance suggested to the lively imagination of the Greek the whole myth of Niobe—her tears, her sorrows, her strange transformation, her perpetual weeping; so this most ancient statue is not an image sculptured to represent this story of Niobe, but is itself the very original from which the story sprung." It is thus an impressive testimonial of the vast importance of the loose bond by which the second molecule of CO_2 is held combined in calcic bicarbonate.

LOT'S WIFE.

Looking down on that most marvellous of all lakes—the Dead Sea, the Lacus Asphaltites of the Romans—the sea of Lot of the Arabs, still stands the great column of salt into which Lot's wife was changed.

"She was changed into a pillar of salt," says Josephus, "for I have seen it, and it remains to this day."

And Irenæus explains how it came to last so long with all its members entire, because "when one was dissolved it was renewed by miracle." It was, in fact, the geological miracle of erosion.

The column looks down from the plain of Sodom, and on the great southern bay of the sea, ten miles square, and but one or two feet deep, where sulphur, deposited by many hot springs, is abundant in the clay, and where bitumen oozes from every crevice of the rock, and every earthquake dislodges great sheets of it from the bottom of the lake, where the Arabs still dig pits for the 'stone of Moses' to gather in, and sell it in Jerusalem, and where, in that most ancient fragment of the Pentateuch, four kings fought against five, and the kings of Sodom and Gomorrah slipped in the slime-pits and fell. One who has read of the burning of an oil well or Oil Creek, or in Apscheron will have a clear idea of the catastrophe which overtook the cities of the plain where the Lord rained upon Sodom and upon Gomorrah brimstone and fire out of Heaven.

Following the latest extremely interesting researches of Blankenkorn,* we may picture the upper cretaceous plateau of Judea—an old land, cleft at the end of the Tertiary by many faults, between which a great block sank to form the bottom of this deep sea. It carried down in the fossiliferous and gypsum-bearing beds the source of the bitumen and the sulphur. We may picture the waters standing much higher than now during the pluvial period, which matched the northern glacial period, rising nearly to the level of the Red Sea, but never joining it. In the succeeding arid interglacial period, the time of the steppe fauna in Europe, the sea shrank to within a hundred meters of its present level, and deposited the great bed of rock salt which underlies the low plateaus around its southern end. The advent of the second glacial period was here the advent of a second pluvial period, which swelled the waters and carried the bitumen-cemented conglomerates over the salt beds to complete the low plateau. After the second arid period with some lava flows, and a third pluvial period with the formation of a lower and broader terrace, the waters shrank to the present saturated bitterns in the present arid period. In the earlier portion of this last or post-glacial stadium, a final sinking of a fraction of the bottom of the trough, near the south end of the lake, dissected the low salt plateau, sinking its central parts beneath the salt waters, while fragments remain buttressed against the great walls of the trench forming the plains of Djebel Usdum and the peninsula El Lisan, with the swampy Sebcha between. Imagine a central portion of one of the low plains which extend south from the 'Finger Lakes' to sink, submerging Ithaca or Havana in a shallow extension of the lake waters. It exposed the wonderful eastern wall of Dijebel Usdum, seven miles long, with 30–45 m. of clear blue salt at the base, capped by 125–140 m. of gypsum-bearing marls impregnated with sulphur, and conglomerates at times cemented by bitumen. It was this or some similar and later sinking of the ground, at the time when geology and history join, which, with its earthquakes, overthrew the cities of the plain and caused the outpour of petroleum from the many fault fissures and the escape of great volumes of sulphurous and gaseous emanations, which, ignited either spontaneously, by lightning or by chance, furnished the brimstone and fire from heaven, and the smoke of the land going up as the smoke of a furnace which Abraham saw from the plains of Judea.

But with Lot's wife the case is different. The bed of salt out of which she was carved, and has been many times carved, was exposed by the very catastrophe which destroyed the cities; and Lot fled to Zoar in a direction opposite to that in which the salt bed lies. As Oscar Fraas found his Arabs calling the salt pyramid 'Lot's col-

* Dr. Max Blankenkorn, Entstehung und Geschichte des Todten Meers. Zeit. Deutsch. Palestina-Vereins, vol. xix., p. 1, 1896.

umn,' so, in early times, when the tradition of the burning cities was gradually growing into the myth of Sodom and of Lot, some old name of the salt column, grown meaningless, may have had such sound as to suggest the term, 'Lot's wife'—Bint Sheck Lut, or the woman's own name in the current language, as Chamirah, the burning mountain, suggested Chamæra, the goat, and the answer to the question why was the salt column called Lot's wife was quickly given and woven into the legend. In that dry climate successive erosions have reproduced it along the seven-mile ridge of salt, still called Kashum Usdum, or Sodom.

THE FLOOD.

Only through an exegesis of the German words Alluvium and Diluvium would the young geologist be reminded of the time when the Flood was a burning question in geology, an igneo-aqueous question, so to speak; when commentaries explained the fossil shells in the Apennines as due to Noah's Flood, and Voltaire tried to break the force of this important proof of the truth of the Bible by declaring these shells to be the scallop-shells thrown away by expiring pilgrims of the Crusades; when Andreas Scheuzer apostrophized his fossil salamander ('Homo diluvii testis et theoscopos'):

"Betrübtes Beingerüst von einem alten Sünder
Erweiche Stein und Herz der neuen Bösheits-kinder."

This ancient sinner's scattered and dishonored bones
Should touch the stony hearts of modern wicked ones.

It was thus a great surprise when one of the most powerful and philosophical works of the century on geology, 'Die Ansicht der Erde,' of Suess, had as its opening chapter an explanation of the Flood as due to a coincidence of a cyclone and an earthquake at the mouth of the Euphrates. The Biblical account is plainly exotic, told by a people ignorant of sea-faring—a fresh-water account of a salt-water episode. The description of the vessel as a box or ark, the going in and shutting the doors, and the opening of the windows, remind one of a house-boat and indicate the adaptation of the story to the comprehension of an inland people. Its minor discrepancies and blending of the Jahvistic and Elohistic elements show the story has come by devious courses from a distant source.

The account of the Chaldean priest, Berosus, 250 B. C., located the occurrence at the mouth of the Euphrates, where the native boatman still pitches his boat within and without with pitch, as the ark was pitched.

Berosus, priest of Bel, quoted by Alexander Polyhistor, says that the Flood occurred under the reign of Xisuthros, son of Otiartes. Kronos announces to Xisuthros, in a dream, that on the fifteenth of the month Daisios all mankind shall be destroyed by a flood. He commands him to bury the writings containing the records of the history of his country at Sippara, city of the dead, then to build a vessel, to stock it with provisions, then to embark with his family and his friends, also to take quadrupeds and birds with him.

Xisuthros obeys the command. The Flood occurs and covers the land; it decreases; he lets out birds to gain knowledge of the state of things, and finally leaves the ship and prepares with his family, an offering to the gods. Xisurthros is then, for his piety, translated to live among the gods, with his wife, his daughter and the steersman. Of the ship of Xisuthros, which finally stranded in Armenia, there still remains a portion in the Cordyaian Mountains in Armenia, and the people scrape off the bitumen with which it is covered, and use it as an amulet against sickness. And as the others had returned to Babylon and had found the writings at Sippara they built towns and erected temples, and so Babylon was again peopled.

Twenty years ago George Smith excavated and translated the inscribed tiles of the library of Asurbanipal, King of Assyria, 670 B. C., who, at the time of the founding of Greece, was gathering copies of the sacred writings of the ancient cities of Asia. The historical books of this library carry the annals of the Babylonians back 3800 B. C., but contain no certain account of any flood. How remote must then have been the great catastrophe which had filtered down in tradition and become embalmed in sacred myth and stately poem before the dawn of history! I present here, after the latest translations of Haupt and Jensen,* the last but one of the cantos of the Gilgamos Epic, corresponding to the eleventh sign of the zodiac, Aquarius (or month of the curse of rain), containing the story of the Flood.

Gilgamos (= Nimrod), the hero of Urruh, leaves his native town sick and troubled by the death of his friend Eabani, and visits his ancestor Samasnapisthim (= Xisuthros) called Hasisadra (= the devout wise man). Hasisadra spoke to him, to Gilgamos, " I will make known unto thee, O Gilgamos, the hidden story, and the oracle of the gods I will reveal to thee. The city of Shuripak, —the city which, as thou knoweth, lies on the bank of the river Euphrates—this city was already of high antiquity when the gods within set their hearts to bring on a flood storm (or deluge). Even the great gods who were there: their Father Anu; their councillor, the warlike Bel; their throne-bearer, Adar; their prince, Ennugi. But the Lord of unfathomable wisdom, the god Ea (the god of the sea), sat alone with them in council, and announced their intention unto the field, saying, Field! Field! town! town! field! hear! town; give attention, O man of Shurippak, son of Ubara-Tutu (The splendor of the Sunset, Lenarmont, Sayce). Destroy thy house, build a ship, save all living beings which thou canst find. Withdraw from what is doomed to destruction. Save thy life and bid the seed of life of every kind mount into the ship.

" The vessel which thou shalt build, 600 half cubits in length, shall be her shape, and 120 half cubits the dimensions for both her width and depth. Into the sea launch her. When I understood this, I spake unto the god Ea—My lord thy command which thou hast thus commanded, I will regard it, I will perform it, but what shall I answer the city, the people, the elders? (The young men and the elders would ridicule me.)

"The god Ea opened his mouth and spake unto me, his servant: 'And thou shalt thus say unto them, " I know the god Bel (the god of Shurippak) is hostile to me, so I cannot remain in (the city); on Bel's ground I will not rest my head. I will sail into the deep sea; with the god Ea, my lord, I will dwell." But upon you there will pour down a mass of water. Men, fowl, and beast will perish, the fish only will escape. * * * And when the sun will bring on the appointed time Kukki will say, " In the evening the heavens will pour down upon you destruction."

" 'Then, however, close not thy door until the time comes that I send thee tidings. Then enter through the door of the ship, and bring into its interior thy food, thy wealth, thy family, thy slaves, thy maidservants and thy kindred. The cattle of the field, the wild beasts of the plains * * * will I send you, that thy gates may preserve them all.'

" Hasisadra opened his mouth and spake. He said to Ea, his lord: 'No one has ever built a ship in this wise on the land. However, I will see to it, and build the ship upon the land, as thou hast commanded.' (The description of the building of the vessel very partial.) I built the ship in six

* Haupt: in Die Ansicht der Erde. The first part from a later translation; Johns Hopkins' Circulars (VII., No. 69, p. 17), P. Jensen in Dr. Carl Schmidt, Das Naturereignis der Sintflut.

stories. I saw the fissures, and added that which was lacking. Three sars of bitumen I poured upon the outside, three sars of bitumen I poured upon the inside. (Thirteen lines of description illegible.) The vessel was finished. All that I had I brought together, all that I had in silver I brought together. All that I had of gold I brought together. All that I had in living seed I brought together. And I brought all this up into the ship, all my manservants and my maidservants, the cattle of the field, the wild beast of the plain, and all my kindred, I bade embark.

"As now the sun had brought on the appointed time, a voice spake: 'In the evening the heavens will rain destruction. Enter into the interior of the ship and shut the door. The appointed time is come.' The voice said, 'in the evening the heavens will rain destruction.' With dread I looked forward to the going down of the sun. On the day appointed for embarking I feared (greatly). Yet I entered into the interior of the ship and shut to my door behind me to close the ship. To Buzurbil, the steersman, I gave over the great structure with its load. Then arose Museri-ina-namari from the foundations of the heavens; a black cloud, in whose middle Ramman (the weather-god) let his thunder roar, while Neba and Sarru rush at each other in warfare.

"The Throne-bearers stalk over mountain and land,
The mighty god of pestilence let loose the whirl-winds (?)
Adar lets the canals overflow unceasingly.
The Anunnaki raise their torches,
They make the earth glow with their radiant gleams.
Ramman's inundating wave rises up to heaven,
All light sinks in darkness.
In a day they lay waste the earth like a plague, the winds raging blow.
Mountain high they bring the waters to fight against mankind.
The brother sees the brother no more,
Men care no more for one another.
In heaven the gods fear the deluge and seek refuge.
They mount up to the heavens of the god Anu.
Like a dog in its lair the gods crouch at the windows of heaven.
Istar (the mother of mankind) cries like a woman in childbirth,
The sweet-voiced queen of the gods cries with loud voice:
'The dwelling place of mankind is reduced to slime.
That has come which I announced before the gods as an approaching evil.
I have announced the evil before the gods,
The war of destruction against my children have I announced.
That which I brought forth, where is it. It fills the sea like fish-spawn.'
Then the Gods wept with her over the doings of the Anunnaki.
They pressed their lips together.

"Six days and six nights the wind and the deluge and the storm prevailed. At the opening of the seventh day, however, the storm lessened, the hurricane, which had waged a warfare like a mighty army, was appeased, and storm and deluge ceased. I sailed the sea mourning that the dwelling-places of mankind were changed to slime. Like logs the bodies floated around. I had opened a window, and as the light of day fell upon my face I shuddered and sat down weeping. My tears flowed over my face. Wherever I looked was a fearful sea. In all directions there was no land. Helpless the ship drifted into the region of Nizir. There a mountain in the land Nizir held the ship stranded, and did not allow it to advance farther toward the heights. On the first and second day the mountain of Nizir held the ship. Also on the third and the fourth day the mountain of Nizir held the ship. Even so on the fifth and the sixth day the mountain of Nizir held the ship. At the approach of the seventh day I loosened a dove and caused it to go forth. The dove went, it turned, and it found not a place where to rest, and it returned. I loosened and I caused to go forth a swallow. It went, it turned, and it found not a place where to rest, and it returned. I loosened and I caused to go forth a raven. The raven flew off, and as it saw that the water had fallen it turned back. It waded in the water, but it returned not.

"Then I caused all to go forth to the four winds, and made a sacrifice. I erected an altar on the peak of the mountain. I disposed of the measured vases, seven by seven; beneath them I spread seeds—cedar and juniper. The gods smelled the odor. The gods smelled the good odor. The gods gathered like flies above the master of the sacrifice. From afar then the goddess Istar at her approach raised the great bows that Anu has made as their glory. She said, 'By the ornaments of my neck never will I forget. These days will I remember and never will I forget them forever. May the gods come to my altar. Bel shall never come to my altar, because he has not controlled himself, and because he made the deluge, and my people he has given over to destruction.'

"Bel also, at his approach, saw the vessel from afar. Bel stood still; he was full of anger against the gods and the god-like ones.

"What soul has then escaped?

"Never shall man survive the destruction.

"Adar opened his mouth and he spake. He said to the warrior Bel:

"'Who, also, if it be not Ea, can have planned this? And Ea knew and has informed him.' Ea opened his mouth and spake. He said to the warrior Bel: 'Thou herald of the gods, warrior, why hast thou not controlled thyself; why hast thou made the deluge? Visit upon the sinner his sin, upon the blasphemer his blasphemy. Be persuaded not to destroy him. Be merciful that he be not destroyed. Instead that thou shouldst make a deluge, let the lions come, and let them cut off men. Instead that thou shouldst make a deluge, let the hyenas come, and let them devour men. Instead that thou shouldst make a deluge, let the famine come and destroy the land. Instead that thou shouldst make the deluge, let the god of pestilence come and destroy the land. I have not disclosed the decision of the great gods. Hasisadra has interpreted a dream, and has understood the decision of the god.' Then Bel came to a better mind. He mounted to the interior of the vessel; he took my hand and made me to rise; myself made he to rise. He made my wife to stand up, and put her hand in mine; he turned around to us and blessed us.

"'Hitherto Hasisadra was mortal, and behold, now, Hasisadra and his wife are lifted up to the gods. He shall dwell far away at the mouths of the rivers.'

"They took me, and in a secluded place at the months of the rivers they made me abide."

Surippak, the home of the wise man, on the banks of the Euphrates, of high authority before the deluge, is the same as Sippara, where Xisuthros (= Hasisadra), according to Berosus, buried the holy writings before the flood. Its ruins have been found in the Hill of Abu-Habba, about halfway between Babylon (now Hilleh) and Bagdad.*

It was 'at the mouths of the rivers;' that is, in time of the poem, the Euphrates and the Tigris emptied separately into the Persian Gulf. Now the Schat el Arab, formed by the union of the two streams, empties into the gulf, perhaps 400 kilometers below the site of the ancient city, across a delta so low and flat that the tide runs up 300 kilometers, and at Old Nineveh the elevation is only 300 m. Delitsch † has collected the evidence that the two streams once flowed separately into the gulf. Pliny says that almost nowhere does the formation of land by a stream advance so rapidly as here. He mentions a

* Carl Schmidt, loc. cit., p. 20.

† Wo lag das Paradies.

town, Alexandria-Antiochia, which, in the third century B. C., was about 1,600 m. from the sea, and had its own harbor, and 300 years later was 33 kilometers inland. Other historical documents make it probable that the streams were separate 150 years B. C. Rawlinson says that the delta advanced 3.2 kilometers in 60 years. All the attendant circumstances accord with this location of the story. Here, among a maritime people, as connoisseurs, they ridicule the building of a ship on the land. Ea is the goddess of the sea. And it is marvellous that this trait of the original is preserved in the Koran, where the story is told at length: "And he made the ark, and as often as the elders of his people came by him they ridiculed him, and he said, 'If you rail at us, be sure that we shall also rail at you as you rail at us.'"*

From the time of Moses and the Tower of Babel, pitch or bitumen had been much used in the Euphrates valley, where the Teritary marls produced it abundantly. In Genesis xi. 3, it says of the Tower of Babel, "slime had they for mortor," and a primitive folk still pitches its boats inside and out on the waters of the Euphrates.

Thus the starting-point of the ark is well ascertained, and its landing-place can also be quite clearly located. It was in the land of Nizir, says the record. The Mesopotamian lowland is a narrow, northward extension of the Persian Gulf, between the Arabian plateau on the west and the Zagros Mountains, the scarp of the Persian highlands, on the east. An inscription of Asurnacir-pal, from the same library, reads: "Left Kalzu (by Arbela) and entered the region of the town of Babite, and approached the land Nizir." This is the account of a military expedition, and it followed up the great war road, by which, 500 years later, Darius Codomanus fled from the armies of Alexander. The region of Nizir was east of the Tigris, at the foot of the Zagros chain, 300 feet above the sea, and the craft of Hasisadra must have been swept 160 miles northeast, and stranded in the foothills on the valley border.

*Koran, XI., 40, 41.

Early accounts placed this landing on Mount Judi, in southern Armenia, where a temple in its honor was built in 776 A. D. Berosus places it in the Cordyaiean Mountains of Armenia, Genesis in Mt. Ararat (Araxes). It is remarkable how the tradition had clung to this grand volcano. The people still tell of the wood and pitch being carried from the ark as amulets, and dare not attempt to ascend the sacred mountain, and disbelieve the accounts of those few foreigners who have reached the summit. Indeed, a Constantinople newspaper account of a scientific commission sent out by the Turkish government in 1887, to study the avalanches in the mountain, tells of the finding of the ark, encased in the ice of a glacier on the mountain.

We may contrast the Chaldæan and Biblical accounts in several matters. The sending out of the birds and the bow in the heavens join with many other points to prove the identity of the stories.

In many ways the Biblical account is modified to suit the comprehension of an inland folk. While the Gilgamos epic describes a violent hurricane and inundation, which expended its force in six days, the Biblical account describes a long-continued rain of forty days, or, in the Elohistic document, of one hundred and fifty days. "And the waters were dried up from off the earth, and the face of the ground was dry." In the epic the forests were destroyed, and the face of the earth reduced to slime.

Waters rising from great rains would have swept the ship down the valley, while the epic makes it go from the gulf northeast to the region of Nizir. And, indeed, what seems the better translation of the Noachian account agrees with this. Gen.

vi. 17, "I do bring a flood of waters" is better translated "I do bring a flood from the sea," and Gen. vii. 6, "Noah was six hundred years old as the flood of waters" (or better, 'from the sea') "arose."* As Amos says, writing 'two years after the earthquake.' † "Seek him that maketh the day dark with night, that calleth forth waters of the sea, and poureth them out upon the face of the earth."‡

We may now try to strip the account of its abundant personification, and see how far it is susceptible of a possible or probable translation into scientific language.

There are, first, the warnings. Hasisatra, the wise man, and, we may assume, wise in in the ways of the sea, stands on the shore of the ancient harbor-town, Surippak, and receives the warnings of Ea, goddess of the sea. These were the unusual swellings of the sea from small premonitory earthquake shocks beneath the waters. There is next added a voice, or noise, a more unusual warning, not personified. This may have been the rumbling which may precede any severe earthquake. It is a region where earthquakes are antecedently probable. From the circle of fire that surrounds the Pacific, a zone of seismic activity connects the East and West Indies by way of the Mediterranean, and passes this region. The volcanic area of northern Mesopotamia and Syria is in seismic activity much of the time. Many towns have been several times destroyed and hundreds of thousands of people have been killed. And the recently sunken areas of 'Lemuria' to the south indicate a region of profound faulting apt for the production of earthquakes.

In the Ægean the sinking of the great land blocks by which the sea was formed is so recent that it is embalmed in the Greek mythology; Poseidon, god of the sea, ever warring victorious against the gods of the land. And, though rarely noted on the lower Euphrates, earthquakes and seaquakes, as the Germans say, are not rare across the northern parts of the Indian Ocean; the wise man accepts this warning of impending danger and builds a great craft for the safety of his home, and with the increase of the threatenings embarks his family, regardless of the ridicule of the townsfolk.

"Then arose from the foundations of the heavens a black cloud, in whose middle Ramman (the god of storms) lets his thunders roar, while Neba and Sarru rush at each other in battle. The throne-bearers stalk over mountain and plain." These latter are the great slow-moving sand columns (whirlwinds) which precede and hang on the borders of the coming storm. They still occur around Bagdad, change day into night, and extend over the whole valley of the Euphrates. "The mighty god of pestilence lets loose his hurricanes." So far it is the description of the oncoming of a mighty storm. Then follow elements which may be interpreted as earthquake phenomena. The Biblical account says the foundations of the great deep were broken up, and at the end they were stopped. This may be explained as the uprush of the ground waters, so marked at Charleston and New Madrid, on the Indus plain, at Lake Baikal, where a lake ten by fifteen miles was formed, and in the delta of the river Selenga, when the fastenings of the wells were blown into the air like the corks of bottles. "The Annuniki raise their torches; they make the land glow with their radiant gleams." The Annuniki are the gods of the underground, the gnomes or kobolds of German saga, and their raising their torches is the inflaming of the natural gases, so common in these bituminous Tertiary beds, in the fissures opened by the

* J. D. Michaelis (Bunsen); majim = water, mijam = from the sea.

† Amos, i., 1.

‡ Amos, v., 8.

earthquake—a frequent occurrence also in similar regions on the Caspian.

In the earlier translation by Haupt the suggestions of earthquake intervention were even more striking than in the later translations. "Adar lets the canals overflow unceasingly. The Annuniki bring floods from the depths. They make the earth tremble by their might." Although hurricane inundations have overwhelmed great areas of land, the earthquake wave is in many ways a mere probable agency here for the production of a flood, exceptional as this must have been to have impressed itself so deeply on this ancient folk. We recall the Lisbon earthquake wave; how the United States warship Monongahela was carried ashore in 1863, at Santa Cruz, and landed on the tops of the houses; or how the great seismic wave of 1868 carried the Wateree in the harbor of Arica, Peru, seven or eight miles inland, landing her in a tropical forest, where she ended her days as a hotel, while her consort, the Fredonia, rolled over and over, and sank with all on board; or the last terrible earthquake waves in Japan and China.

The account then advances strongly to its climax and catastrophe. "Ramman's flood-wave mounts up to heaven." All light sinks in darkness. Terror overcomes gods and men. "Like dogs in their lair the gods crouch at the windows of heaven." This is the description of the incoming of the great cyclonic waves, perhaps reinforced by earthquake waves, for when the seismic tension has just come to equal the resistance the great additional strain caused by the relief of pressure of the low barometer of the cyclone has not infrequently set loose the impending earthquake. Of 64 hurricanes in the Antilles 7 were accompanied by earthquakes. In the Bay of Bengal the cyclones average one a year and destroy a million people in a century; and once at Calcutta, in 1737, when the waters rose 40 feet, 14 ships were carried over the trees and 300,000 people were killed; and on the Kistna in 1800 the cyclone and the earthquake occurred together. Indeed, several of these cyclones have been traced across into the Persian Gulf, and one in 1769 was accompanied by an earthquake on the lower Euphrates—the very site of the ancient myth. On the broad plains of the Punjaub are many indications of similar inundations. I travelled, said Ibn Batuta (1333), through Sind to the town Sahari, on the coast of the Indian Sea, where the Indus joins it. A few miles from here are the ruins of another town, in which stones in the form of men and animals in almost innumerable amount occur. The people were so sinful that God changed them to stone and their animals and their grain. It is interesting to observe the different effects these disturbing events have upon people of different grades of culture.

The Negritos of the Andaman Islands have a demon of the land who causes the earthquakes, a demon of the sea who causes the floods.

The King of Dahomey in 1862 had received the missionaries in the land. The spirit of his fathers shakes the earth because old observances were not followed. The King executes three captive chiefs as an envoy to inform his fathers that the ancient rites shall be re-established.

After the great earthquake of Kioto and Osaka in Japan, in 1596, the warrior Hidiyoshi goes to the temple of Daibutzu (the Buddha), where the enormous bronze statue had been overthrown, and upbraids the fallen idol and shoots it with arrows.

In 62 A. D. Oppolonius of Tyana, at Phæstus, in Crete, was preaching to a company of worshippers of the local deity, when an earthquake arose. "Peace," he said, "the sea has brought forth a new land." An island was found between Thera and Crete, Santorin, beloved of all geologists in modern times. The crowd loses all judgment in wonder and admiration.

A true flood panic occurred in the time of Charlemagne. Stöffler, a celebrated astronomer and professor of mathematics at Tübingen, found, as the result of abstruse calculation, that the earth would be destroyed by a flood in 1524. The news spread rapidly and filled Europe with alarm. In Toulouse an ark was built by advice of the professor of canonical law to rescue at least a part of the people. Indeed, in our own days, Prof. Rudolph Falb and similar prophets announce a new flood in the year A. D, 7132.* And Falb has by his unverified earthquake predictions caused panics in Athens and Valparaiso.

It is the western migration of this ancient story that is noteworthy, and its association with the punishment of sin by the religious genius of the Hebrews which has made it world-wide. Such myths of observation, dependent on local floods or the suggestion of fossils, are most widely spread, and they find place in cosmogonic myths—explanations of the origin of land and sea; national myths—explanations of the origin of peoples; and myths of destruction of land or people, with or without the idea of punishment for sin.

They are wanting among the Africans and in Australia and Oceania according to Lenormant; more accurately among the Papuans of Oceania, for the Feejee Islanders kept great canoes on the hill-tops for refuge when the flood should return.

In China the great Cyclopedia (2357 B. C.) says: "The waters of the flood are destructive in their inundation. In their wide extent they surround the mountains, overtop the hills, threaten the heaven with their waters, so that the common folk is dissatisfied and complains. Where is the able man who will undertake to control the evil. Kwan tries nine years, Yu eight years. He completes great works, cuts away woods, controls the streams, dykes them and opens out their mouths. He feeds the people."

* Schmidt, loc. cit., p. 61.

This refers to the 'Curse of China,' the Yang-ze-Kiang, which flows sometimes into the Gulf of Pechili north of the promontory of Shantung, sometimes to the south of the Yellow Sea.

Our own Indians gave Catlin 160 flood myths. The dog of the Cherokees is well known. On Cundinamarca in Mexico there were four destructions: of famine, personified by giants; of fire, by birds; of wind, by monkeys; of water, by fishes.

The Quichés of Guatemala say: As the gods had created animals who do not speak or worship the gods and had made men from clay who could not turn their heads—who could speak indeed, but not understand anything—they destroyed their imperfect work by a flood.

A second race of mankind was created, the male of wood, the woman of resin, but it was not thankful to the gods. The gods rained burning pitch on the earth, and sent an earthquake, destroying all but a few, who became monkeys. A third attempt succeeded so well that the gods themselves were terrified at the perfection of their work, and took from them some of their good qualities, and the normal man resulted.*

The Arawaks of British Guiana and Venezuela were for their sins twice destroyed—once by flood, and once by fire, and only the good and wise were saved.

The flood is a perennial blessing in Egypt, and when the Greeks told the priests of the deluge of Deucalion they said, 'Egypt has been spared this.'

There is an inscription on the walls of the tomb of Seti-on, in Thebes, 1350 B. C. The sun-god, Ra, is wroth with mankind, and the council of the gods decree its doom. Hathor, queen of the gods, does the work,

* Schmidt, 'Sintflut,' 57.

till all the land is flooded with blood. She sees the fields flooded with blood, she drinks thereof; her soul is glad; she does not know mankind. Only those who, at the right time, fix their thoughts above are spared, and of these the Majesty of Ra says: 'These are the good.'

In Persia there are no flood myths preserved before time of Zoroaster.

In India, where the flood is a constant scourge, the four Yugas (ages) and the four Manvartaras, the alternate destructions and renewals of the human race, are Vedic myths, and no trace of the flood story appears in the Vedas. The Satapatha-Bramahna, written just before the time of Christ, is especially interesting, from the blending of the Chaldean account with the Indian mythology. In this oldest account the flood came from the sea, the warning and the rescue of Manu, the Indian Noah, from Vishnu, in form of a fish. Here all the suggestion may be indigenous. There is no punishment.

In the Mahabharata the ship lands on the highest peak of the Himalaya. In the last part of the story, in the Bhagarata Purana, the motive of the flood is that the wickedness of man was great in the earth. Vishnu, in the form of a fish, warns Manu Satjavrata, the well-doer (Ea was a fish-god in the Chaldæan story, and Oannu, in Berosus, was a fish-god), that in seven days the three worlds will sink in an ocean of death, but in the midst of the waves a ship will be provided for Manu. He is to bring all useful plants and a pair of all irrational animals into the ship. The sea rose over its banks and overwhelmed the earth. Violent wind and cloudburst from measureless clouds contributed to the flood. Vishnu, in form of a gold-gleaming fish, guided the ship. Before the flood the holy Vedas were stolen, afterwards they were restored by Vishnu.

In Greece, also, as the sinking of the land has persisted to greater extent into the most modern times, so the flood-myths have there greater variety and definiteness than elsewhere, and later the Chaldæan account was grafted on to the earlier with greater fulness. The story is not known to Hesiod in the 'Works and Days' (8th century B. C.), though he enumerates several destructions of the sinful race of man, and the 'Iliad' mentions destructive cloudbursts as the usual punishment of heaven on the unjust judge.

Thus, in the Bœotian myth Ogyges, it is significant that Ogyges was son of Poseidon, god of the sea, and I have heard the name itself derived from an Aryan root, meaning a flood. Ogyges is rescued in a boat.

The story of Deucalion's flood is first given in the Hesiodic catalogues, 800 to 600 B. C. Pyrrha and Deucalion were alone rescued in a ship. As told in an archaic form by Pindar* (500 B. C.), 'Pyrrha and Deucalion, coming down together from Parnassus, founded their mansion first, and, without marriage union, produced the strong race of the same stock, and hence they were called Laioi from a word meaning stones, as they threw stones over their heads to form the first men.

Apollodorus (100 B. C.) shows the first influence of the Semitic myth. He extends the flood over almost all Greece, and says Deucalion offered sacrifice on leaving the ship. Later, the ark, the taking-in of animals and sending-out of birds, appear in the Greek myth, and Lucian, or pseudo-Lucian, in "De Dea Syria" (160 A. D.), in a chapter on Hydrophoria, narrates an Armenian flood-myth, which had its home in the upper Euphrates, at Hierapolis, the modern Mambedj, and blends the Hellenic and Semitic story. "The most say that Deucalion Sysythes built the sanctuary, that Deucalion under whom the great deluge occurred. Of Deucalion I heard also in Hellas the story which the Hellenes

*Olympics, IX., 4 (500 B. C.)

tell of him, which runs as follows: The first men had grown very wicked upon the earth, and, in punishment, suffered a great evil. The earth sent up from its bosom mighty masses of water. Heavy rains followed, the rivers swelled, and the sea overflowed the land, until all was covered with water, and all were destroyed; only Deucalion, of all mankind, remained alive. He had built a box or ark, and his family, as also pairs of all kinds of animals, entered into it. All sailed in the ark as long as the waters continued. So the Hellenes write of Deucalion. To this the inhabitants of the holy town add a very strange story; that in their land a great fissure opened in the earth, and this received all the water. Deucalion built altars after this happened, and by the opening built a temple to Here. I saw the opening. It is under the temple, and is very small. As a sign and remembrance of this story, they do as follows: Twice a year water is brought to the temple from the sea. Not alone do the priests bring this; out of all Syria and Arabia, India, and from beyond the Euphrates many go down to the sea, and all bring water. They pour it out in the temple, and it flows into the fissure, and the small opening receives a great quantity of water. And this ceremony, they say, Deucalion appointed in the temple in remembrance of the catastrophe and his rescue. A statue of Here is in the temple, and another god, which, although it is Zeus, they call by another name. Between the two stands a golden column. The Assyrians call it the sign, give it no special name, and cannot explain its origin or its form. Some refer it to Dyonysus, others to Deucalion, others to Semiramis. There is on its top a golden dove. Therefore, it is said to represent Semiramis. Twice a year it is taken to the sea to bring water, as described above." There were similar Hydrophoria at Athens.

AMHERST COLLEGE. B. K. EMERSON.

SECTION A—MATHEMATICS AND ASTRONOMY.

THE Vice-Presidential address before Section A was necessarily omitted, as illness in his family had prevented Prof. Story from preparing an address and from attending the meeting.

The vacancy in the chair was filled by the election, by the Association, of Prof. Alexander Macfarlane as Vice-President for the Section.

The following papers were presented before the Section, in number one less than were read at the Springfield meeting last year.

An Analog to De Moivre's Theorem in a Plane Point System: By E. W. HYDE.

Three points, e_0, e_1, e_2, at the vertices of an equilateral triangle, are taken as a reference system, and an operator ω is assumed such that

$$\omega e_0 = e_1,\ \omega^2 e_0 = \omega e_1 = e_2,\ \omega^3 e_3 = \omega^2 e_1 = \omega e_2 = e_0.$$

Then the action of the general operator

$$x_0 + x_1\omega + x_2\omega^2,$$

in which $x_0 \ldots\ldots x_2$ are scalars, is discussed. The x's are shown to be functions of a scalar n and an angle θ, designated as $K(n, \theta)$, such that

$$[K_0(n, \theta) + \omega K_1(n, \theta) + \omega^2 K_2(n, \theta)]^k$$
$$= K_0(n^k, k\theta) + \omega K_1(n^k, k\theta) + \omega^2 K_2(n^k, k\theta),$$

which is the analog of De Moivre's theorem. Addition-multiplication theorems for the K-functions are found, and a trigonometry of them developed.

Rational Scalene Triangles: By ARTEMUS MARTIN; read by the Secretary.

In this paper, which will appear in the *Mathematical Magazine*, formulæ are given for calculating the sides of rational triangles, with numerous illustrative examples.

New elements of the variable R Comæ, resulting from observation in July and August, 1896, and

Photometric Observations of Colored Stars: By HENRY M. PARKHURST.

The large discrepancies in photometric measures of colored stars led the author, who employs the method of extinctions in his photometer, to investigate the absorption of three principal colors—red, yellow and blue—by differently colored shades. The relative proportions of the three colors in the light of any particular star were measured, and corrections were deduced so that the effect of color was very largely overcome in observations by the method of extinctions.

Motion of the Great Red Spot and Equatorial Belt of the planet Jupiter from 1879 to 1896: By G. W. HOUGH.

From the comparison of his micrometrical measures (not mere drawings) of definite points upon the visible disk of the planet, the author obtained the (changeable) rate of rotation of the spot about the planet's rotation-axis, and he showed charts and diagrams of the motions of the belt both in latitude and longitude. No theory of the nature of the spot was advanced. The paper will be printed in the *Monthly Notices* of the Royal Astronomical Society.

On the direct application of a rational differential equation to a series of points whose coordinates represent observed physical properties: By ROBERT B. WARDER.

The theory for the speed of chemical action gives rise to differential equations, which are usually integrated before being applied to test a series of measurements. As the theoretical 'constant' often proves to be variable (showing that the assumed rational formula does not fully represent the processes of Nature), the character of the variations must be determined by one of several modes of calculation. The paper was mainly an inquiry as to the best methods of computing the required quantities. Three methods had been tried in an application to Lichty's determination of the speed of esterification of monochloracetic acid, and a further paper (offered with this for publication in the *Journal of Physical Chemistry*) was read before Section C.

A proposed fundamental integral-transcendent: By JAMES MCMAHON.

A large number of transcendent integrals are reducible to the fundamental form

$$\int \log \sec x \, dx.$$

which may be computed from a series and tabulated for different values of x. Let the function *ils* x (integral-log-secant x) be defined by the equation

$$\int_0^x \log \sec x \, dx = \text{ils}\, x,$$

then ils x may be computed and tabulated from the development

$$\frac{2}{\pi} \text{ils} \frac{\pi x}{2} = S_2 \frac{x^3}{3} + \frac{S_4}{2}\frac{x^5}{5} + \frac{S_6}{3}\frac{x^7}{7} + \frac{S_8}{4}\frac{x^9}{9} \cdots\cdots$$

$$\left(\text{where } S^n = \frac{1}{1^n} + \frac{1}{3^n} + \frac{1}{5^n} \cdots\cdots ad\ inf.\right)$$

which is convergent when $x < 1$, and can be used when the argument $\frac{\pi x}{2}$ lies between 0 and $\frac{\pi}{2}$,—a sufficient range, since ils $\frac{\pi}{2} = \infty$ and ils $0 = 0$.

Numerous integrals were given which are expressible in terms of ils x, of which we illustrate by only three:

$$(1)\quad \int_0^x \log \cos x \, dx = - \text{ils}\, x.$$

$$(3)\quad \int_{\frac{\pi}{4}}^x \log \tan x \, dx = \text{ils}\left(\frac{\pi}{2} - x\right) + \text{ils}\, x - 2\, \text{ils}\, \frac{\pi}{4}.$$

(This may be denoted by *ilt* x, integral-log-tan x.)

$$(11)\quad \int_1^x \frac{\log x}{1+x^2} dx = \text{ilt}\, (\tan^{-1} y), \text{ etc.}$$

Analogous relations are found for hyperbolic functions. The paper will appear in the *Annals of Mathematics*.

On the Level of the Sun-Spots: By EDWIN B. FROST.

The correctness of the Wilsonian doctrine that Sun-spots are depressions in the solar photosphere is examined, and evidence is brought forward from recent direct visual observations (Howlett, Sidgreaves, Spoerer), from the rate of solar rotation deduced from faculæ, spots, and surface (Dunér), and from the thermal absorption over spots, to support the view that spots may be masses of absorbing gases above rather than below the photosphere. The paper will be published in the *Astrophysical Journal*.

Sedenions: By James B. Shaw; presented in outline by Prof. E. W. Hyde.

If q be any quaternion, Φ the operator on q such that if

$$q = w + xi + yj + zk,$$
$$\Phi\, q = (a^{i}w + b^{i}x + c^{i}y + d^{i}z) + (a^{ii}w + b^{ii}x + c^{ii}y + d^{ii}z)i + (a^{iii}w + b^{iii}x + c^{iii}y + d^{iii}z)\, j + (a^{iv}w + b^{iv}x + c^{iv}y + d^{iv}z)\, k.$$

Φ is called a *Sedenion*. The paper (offered for publication in the *Bulletin of the American Mathematical Society*) is a development of the elementary formulæ of *Sedenions* considered as an algebra of sixteen units. These formulæ are developed by the aid of Quaternions.

On the Distribution and the Secular Variation of Terrestrial Magnetism, No. IV: On the Component Fields of the Earth's Magnetism: By L. A. Bauer.

This paper, to appear in *Terrestrial Magnetism*, continues the researches hitherto published by the author, and is an attempt to resolve the prevailing magnetic field of the earth into its components. The paper was illustrated by maps and diagrams.

Determination of the Weights of Observations: By J. R. Eastman.

A brief account was given of a method of determining the weights to be used in combining the results of observations made in a series of years with the same instrument (meridian circle). The results also showed the futility of excessive repetition of an observation with a view to increased accuracy.

On the Composition of Simultaneous and Successive Vectors: By Alexander Macfarlane.

Vector Algebra is commonly founded partly on physical ideas, partly on arbitrary formal laws. The author prefers to give it a purely geometrical or physical basis. The sum of simultaneous vectors is commutative, because they have no real order; the sum of successive vectors is not commutative, because they have a real order. The square of a sum of successive vectors differs from the square of a sum of simultaneous vectors by a set of terms depending on the order of the succession. This was illustrated by the generalized form of the Exponential Theorem for space.

All the papers on the program having been read, at the conclusion of the session on Wednesday afternoon, August 26th, Section A adjourned.

Edwin B. Frost,
Dartmouth College. *Secretary.*

SECTION B—PHYSICS.

The address of the Vice-President, Carl Leo Mees, upon *Electrolysis and some Outstanding Problems in Molecular Dynamics*, will be printed in this Journal.

The meetings of the section were full and interesting. One of the sessions was interrupted by the introduction of Dr. Chas. E. West, of Brooklyn, a founder of the Association, who gave reminiscences of Joseph Henry and exhibited a small helix made by Prof. Henry and used by him in conjunction with Dr. West on July 10, 1842, to magnetize needles during a thunder storm. Dr. West also exhibited a fragment of wood from the ship of Captain Cook, given him by the elder Silliman sixty years ago. The remarks of Dr. West were listened to with profound interest and the section tendered to him a vote of thanks.

The section enjoyed a visit to the home of Mr. Edgar B. Stevens, a manufacturer of Buffalo, who has a large collection of Crookes' tubes with accessory apparatus for the exhibition of the Röntgen rays.

On Friday afternoon the section made a special excursion to Niagara Falls, and the members were courteously received at the large Power House, at the Carborundum Factory and at other places of interest.

During the seven working sessions of the section twenty-nine papers were read in full and two by title.

Polarization and Internal Resistance of a Galvanic Cell: By B. E. MOORE.

The E. M. F. between each electrode of a cell of the Leclanché type, without depolarizer, and an auxiliary carbon electrode was determined during the polarization of the cell and during its subsequent recovery.

The Lead Storage Cell: By B. E. MOORE.

The author explained from Nerst's theory the character of the curves of charge and discharge of a lead storage cell.

A Theory of Galvanic Polarization: By W. S. FRANKLIN and L. B. SPINNEY.

The authors pointed out the existence of a term in the energy equation of the electrolytic cell depending upon an irreversible or sweeping process at each electrode. Experiments were described showing that the coefficients of these terms do not in general vanish with the current.

On the Counter Electromotive Force of the Electric Arc: By W. S. FRANKLIN.

The author attempted the experimental determination of the decay of E. M. F. between the carbons of the electric arc after the circuit is broken. It was pointed out by G. W. Patterson that the results were entirely ambiguous.

On the Element of Diffraction in Fresnel's Experiments with two Mirrors and with the Biprism: By ERNEST R. VON NARDROFF.

The author discussed in detail the coloring by diffraction of the central band obtained by Fresnel's mirrors and Fresnel's bi-prism.

Segmental Vibrations in Aluminum Violins: By ALFRED SPRINGER.

Five years ago the author pointed out that the acoustical properties of aluminum are approximate to those of wood. Continued experiments made with aluminum sound boards have verified this earlier conclusion. The author exhibited several aluminum violins, together with a device, called a bass bar, by means of which the quality of the tone produced by the instrument can be controlled.

Preliminary Note on a proposed new Standard of Light: By CLAYTON A. SHARP.

It is proposed to define a standard of light as a flame of definite size produced by a gas of definite composition burning in a continuously renewed atmosphere of definite composition. Experiments have been made with a mixture of equal parts of acetylene and hydrogen burning in an atmosphere of pure oxygen. The mixture of acetylene and hydrogen issues from a small tube, surrounding which is a larger tube supplying oxygen. The importance of using dry gases was pointed out.

A Photographic Study of the Röntgen Rays: By W. A. ROGERS.

Note on the Duration of the X-Ray Discharge in Crookes' Tubes: By BENJAMIN F. THOMAS.

It has been found that slow make and break in the primary of an induction coil produces almost as strong effect on a Crookes' tube as very rapid make and break. This seems to indicate the long duration of activity of the tube at each discharge. The author has shown, however, that the duration of the acting discharge is as short as $\frac{1}{5000}$ second and probably as short as $\frac{1}{50000}$ second.

Preliminary Communication concerning the Anomalous Dispersion of Quartz for Infra-

red Rays of Great Wave-length: By Ernest F. Nichols.

In the absence of the author this paper was presented in abstract by Prof. E. L. Nichols. The author has investigated the optical (?) properties of quartz for waves greater than 4 μ.

The reflection from a surface cut perpendicular to the optic axis was found to decrease steadily from $3\frac{1}{2}$ % at wave-length, 4.5 μ to a minimum of 0.29 % at 7.4 μ. From this point the reflection increases rapidly to 14 % at 8 μ, 36 % at 8.1 μ, reaching a maximum of 76 % at 8.4 μ. A second minimum of 51 % was found at 8.6 μ and a second maximum of 65 % at 8.8 μ; beyond which the reflection falls to 50 % at 9 μ.

The transmission through a quartz plate 18 μ in thickness cut perpendicular to the optic axis shows three pronounced minimum and four maximum values between 4 μ and 7 μ. The last maximum is at 7 μ. The transmission at this point is 80 % From this point the transmission falls to 51 % at 7.6 μ, 36 % at 7.7 μ, 12 % at 7.9 μ and to a value less than 1% at 8.1 μ. Beyond 8.1 μ the transmission is imperceptible.

A computation of the indices of refraction from observed reflection and transmissions by the Cauchy formula has given results which agree with the Ketteler-Helmholtz dispersion formula, which, according to Rubens' constants, requires rays in the region of 8 μ to be bent towards the apex rather than towards the base of a quartz prism.

The reflection and transmission measurements were made with a Torsion Radiometer. The radiations pass through a fluorite window into a vacuum chamber, and fall upon a blackened vane of mica, 2x15 mm., which is carried by a light arm at a distance of 2 mm. to one side of a quartz fibre. The deflection of the vane is observed by means of a mirror, telescope and scale. The sensitiveness of the instrument, with a full vibration period of 12 seconds, was such that the rays from a candle at a distance of six meters gave a deflection of 61 divisions on a scale distant 1 meter from the instrument. When properly protected the instrument is absolutely without 'drift,' and the zero point remains constant within a centimeter for days at a time.

An Experimental Study of the Charging and Discharging of Condensers: By F. E. Millis.

In the absence of the author this paper was presented by Ernest Merritt, who exhibited a number of very fine photographic tracings of alternate current curves and of curves obtained by the charge and discharge of condensers. The instrument used was essentially a tangent galvanometer with a miscroscopic soft iron magnet and mirror placed in an intense magnetic field and having about 17,000 free half-vibrations per second.

Notes on certain Physical Difficulties in the Construction of Modern Large Guns: By W. LeConte Stevens.

The author related some experiences in connection with the manufacture of a large gun at the Watervliet arsenal, on the Hudson river.

On the Photographic Trace of the Curves described by the Gyroscopic Pendulum: By Ernest Merritt.

The author exhibited a number of the curves.

On the Distribution of High Frequency Alternating Currents throughout the Cross-Section of a Wire: By Ernest Merritt.

The author exhibited, by platted curves, the results of extensive calculations from the formulæ of Lord Kelvin and Heaviside.

On the Compactness of a Beam of Light: By Ernest R. von Nardroff.

The author calls the solid angle subtended by the extreme rays of a beam of light at a point the *vergency* of the beam. Assuming the luminous source to be of uniform brightness, he shows that the quotient—intensity of beam divided by vergency—is a constant; this he calls the compactness of the beam. He applies this conception to the discussion of various theorems in connection with optical instruments.

Some Points in the Mechanical Conception of the Electro-magnetic Field: By W. S. FRANKLIN.

The author pointed out the importance of applying the conceptions of Maxwell and Lodge directly to the explanation of fundamental principles instead of to special cases. In addition to the explanation of the two laws of induction he applied the conceptions of Maxwell to the explanation of the energy stream and to the explanation of electro-magnetic waves.

Mechanical Models of the Circuit: By BROWN AYRES.

The author exhibited a model consisting of a number of fly-wheels arranged in a circuit with spring connections. The model represented in a striking manner nearly all of the fundamental phenomena of the electric circuit, particularly the phenomena of electrical oscillation and resonance.

Graphical Treatment of Alternating Currents in Branching Circuits: By HENRY T. EDDY.

The author gave an elegant treatment of the general problem of branched circuits containing resistance, inductance and capacity, showing the construction of the locus of the resultant current vector for varying frequency.

Description and Exhibition of a Convenient Form of the 'Interferential Comparer,' and of an Interferential Caliper Attachment for Use in Physical Laboratories: By W. A. ROGERS.

Description and Exhibition of a Bench Comparator for General Use in Physical Laboratories: By W. A. ROGERS.

On the Rule for the Dynamo and Motor: By ALEXANDER MACFARLANE.

In the discussion of this paper Prof. S. T. Moreland gave a mnemonic rule, not generally known, associating the directions of the electric current and of the magnetic field with the hand in such a way that the force is in the direction one would naturally push.

Note on the Effect of Odd Harmonics upon the Virtual Values of periodically varying Quantities: By FREDERICK BEDELL and JAMES E. BOYD.

The authors showed that the virtual value of a periodic E. M. F. is independent of the phase relations of its odd harmonics, but dependent only upon their amplitudes.

Experimental Determination of the Relative Amounts of Work Done in changing the Lengths of two metal Bars under the same Thermal Conditions, by an Envelope of Heated Air, and by Pure Radiations in a Vacuum: By W. A. ROGERS.

The author explained the difference in the behavior of a metal bar in an air bath and in a vacuum.

An Experimental Method of Finding the Value of a Unit of Force in Any System Whatever: By W. A. ROGERS.

A new Alternating Current Curve-tracer: By EDWARD B. ROSA.

The author described an apparatus by means of which the successive points in an alternate current or E. M. F. curve are platted directly, avoiding the necessity of taking and entering numerical observations. He exhibited a large number of curves, originals and enlargements.

Visible Electric Waves: By B. E. MOORE.

The author described an arrangement in which stationary electric waves on a wire are rendered visible by the brush discharge from the various portions of the wire.

Electrical Waves in Long Parallel Wires: By A. D. COLE.

The author described some preliminary work carried out in connection with the determination of the dielectric constants of liquids.

The Influence of a Static Charge of Electricity on the Surface Tension of Water: By EDWARD L. NICHOLS and JOHN ANSON CLARK.

The authors used a dropping apparatus for determining the surface tension, and a novel electrometer for measuring E. M. F. This electrometer consisted of a light conducting sphere suspended by a long conducting fibre near a large plane plate. The movement of the sphere was observed by means of a telescope.

Determination of the Specific Heats of Nitrogen by Adiabatic Expansion: By W. S. FRANKLIN and L. B. SPINNEY.

The authors pointed out the fact that of the four quantities R (in the equation $pv = Rt$), K, C_p and C_v associated with a gas only two are independent; and they described some incomplete experiments for the indirect determination of C_v.

The Analysis of Vowel-sounds, by Means of the Sympathetic Vibrations of a Rigid Body: By L. B. SPINNEY.

The author described the manner of mounting a light mirror so as to vibrate with sound waves impinging upon it, and exhibited a number of photographic tracings.

Polar and Interpolar Effects of the Galvanic Current on Living Animal Tissues: By C. P. HART.

Description and Exhibition of a Portable Apparatus for Recording Curves of Alternating Currents and Electro-motive force: By H. J. HOTCHKISS.

The author exhibited the apparatus, and also, some photographic tracings taken by means of it.

The discussion of Nomenclature and Units was made a special order for the last Sectional meeting, but on account of lack of time it was deferred and made a special order for the meeting of next year.

IOWA STATE COLLEGE. W. S. FRANKLIN.

THE PHYSIOLOGY OF COLOR IN PLANTS.

SINCE the preparation of my recent summary of the uses of color in plants* the work of Stahl in the botanic garden at Buitenzorg has been published,† by which some of the current conclusions are seriously modified.

I have pointed out in the paper cited above that the theories concerning the relations of plant colors to animals are by no means on a secure basis, and Stahl by a large number of experiments in which red and green leaves were fed to snails, rabbits, antelopes, etc., finds that the choice of food depends on the degree of hunger of the animal to a much greater extent than on the color of the plants eaten. He concludes that in no instance is it placed beyond doubt that color areas have been developed as a 'warning' to serve as a protection against animals, but is disposed to regard the so-called warning devices as accidental.

Because of the prevailing acid reaction of red leaves, this author uses the term 'Erythrophyll' to denote the reddish coloring matter, instead of 'Anthocyan.' So far as its physical qualities are concerned, he confirms the view of Engelmann that its spectrum is complementary to that of chlorophyll. He does not, therefore, agree with the theory of Kerner that color layers may serve as a protection of the chlorophyll against intense sunlight,‡ but formulates an extended and modified statement of Pick's conclusions,§ in which he sug-

* MacDougal: Physiology of Color in Plants. Pop. Sci. Monthly, May, 1896.

† Ueber bunte Laubblätter. Ann. d. Jard. Bot. Buitenzorg, 13: 137–216. 1896.

‡ Pflanzenleben, 1: 364. 1890.

§ Bot. Centralblatt, 16: 1883.

gests that the color layers act as a screen for the conversion of light into heat, useful not only in the trans-location of the carbohydrates, but also in all metabolic processes. Such a use is subserved in alpine plants; in those of eastern North America, in which the climatic conditions are alpine; in the pistils of anemophilous plants, to promote the growth of pollen tubes; in extra floral nectaries, to accelerate the metabolism of the carbohydrates, and in many adaptations in the Cryptogams.

Reasoning from the fact that a large number of plants growing in shady moist situations, and in the tropics where the air is much warmer than the leaves, are provided with erythrophyll, absent from specimens under the opposite conditions, he substantiates and extends the idea of Kerner that the color in these instances is a device for promoting transpiration.

Further, the colors of young shoots and leaves act in the same manner, and, by increasing the amount of water conducted to these parts, secure a greater supply of nutritive salts.

It is but proper to say, however, that this method of reasoning does not explain in any adequate manner the autumnal colors, nor of course the occurrence of colors in external hairs, or in the internal tissues, where no relation, or no useful relation, to light can exist.

By far the most interesting portion of the paper is that in which the results of the investigation upon the whitish or silvery patches due to air cavities underneath the epidermis of leaves of Begonia, Dracæna, etc. It was found that if the under side of such leaves were coated with some substance easily melted, such as cocoa butter, and the upper side exposed to light or heat, the portions of the leaf under the silvery areas were less easily heated, and consequently less easily cooled, than the neighboring green areas.

This device retards chlorophyll action, but under the cool, damp conditions in which such plants are found it promotes transpiration by preserving a temperature higher than the surrounding atmosphere.

The velvety appearance of many leaves is found to be due to the papillose extension of the epidermal cells in such form as to act as lenses in entrapping rays of light or heat striking the surface at any angle, thus securing an additional aid to transpiration.

The chief results of the paper may be summarized as follows: The existence of 'warning' colors is not proven; the conclusion of Pick that leaf-red converts light into heat, useful in translocation of carbohydrates, is broadened to include the general metabolism of the plant in its application; the 'protection' theory of leaf-red by Kerner is refuted in great part; the conclusions of Kerner as to the uses of leaf-red as a means of promotion of transpiration are extended and substantiated; and the silvery white as well as the 'velvety' appearance of many leaves are to be regarded as means for the promotion of transpiration under different circumstances.

D. T. MacDougal.
Minneapolis, Minn.

CURRENT NOTES ON ANTHROPOLOGY.

MORTUARY CEREMONIES.

Properly studied, the mortuary ceremonies of tribes offer one of the most productive fields of ethnologic research. A valuable contribution to this branch has lately appeared in Dr. W. Caland's *Die Altindischen Todten- und Bestattungsgebräuche* (pp. 191, J. Müller, Amsterdam, 1896). Its investigations are based on a close collation of the rituals for the dead in the various Vedas and other sources, a number of them still in manuscript. The earlier researches of Colebrooke, Wilson, Max Müller and others have been considered, and extensive additions to their studies are offered. All the steps of the ceremony of incineration are examined in the original texts, followed by those referring to the gathering of the bones, the erection of the funerary monument, the offerings to fire, the strewing of the seed, and the numerous steps of the complicated ritual. These the author handles with a thorough mastery of the subject and the language. When it is remembered that to an ancient Aryan (and to many non-Aryans) no object in his life was so important as that he should have proper funeral rites, the interest attached to such ceremonies will be appreciated.

M. Felix Regnault, in the Bulletins de la Société d' Anthropologie of Paris (Fasc. 1, 1896), in an article on funeral rites, argues that incineration and various other methods of destroying the flesh were intended for the benefit of the living, not to follow out the wishes of the dead. The survivors wanted the bones for charms and fetishes.

THE PSYCHOLOGY OF PRIMITIVE MAN.

What is the mental state of savages, and, going beyond them, what were the mental powers of early man, are queries of prime interest in ethnology. Some have placed the hunting tribes on a par with immature individuals in civilized lands; while others hold 'the gray barbarian lower than the Christian child.' This is the opinion of Dr. Friedmann, who, in a paper analyzed in the *Centralblatt für Anthropologie*, Heft 3, undertakes to prove that the state of primitive thought is nothing more nor less than insanity, and has its parallel only in our asylums for mental diseases. He claims that to the savage, as to the insane, there is no distinction between the idea and its reality, that the law of causality is restricted to the narrowest sensuous limits, and that the logical processes of thought are constantly violated. All this is true, but do we dare or care to say how true it is also of the people at large around us?

The same subject has been treated at length by Prof. Pinsero, of Palermo, whose views are epitomized in *L'Anthropologie.* He thinks that early man was mentally lower than the anthropoid apes, for these had a religion, to wit, serpent worship (!) and man had none.

No doubt the estimate of the savage mind has been placed too high by various writers; but this looks as if the current is just now as much too strong in the other direction.

D. G. Brinton.

University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS.

SCIENTIFIC RESEARCH AND COMMERCIAL SUCCESS.

A letter from Prof. W. Ostwald on scientific education in Germany and England has been communicated by Prof. W. Ramsay to the London *Times* and is made the occasion of 'leaders' in that journal and in *Nature.* Germany has, as is well known, supplanted Great Britain in the control of the fine chemical markets of the world, and this is due more to scientific research than to commercial enterprise. Prof. Ostwald informs us that there are many chemical works in Germany, each of which employ more than one hundred students of chemistry who have taken their Doctor's degrees at the University, and are engaged not in the management of the manufacture, but in making inventions. These chemists have been trained for years under men such as Prof. Ostwald; they have published theses containing the results of original research, and finally are able to devote their lives to invention and investigation. Those who cannot appreciate the scientific importance of research will be convinced by the logic of commercial success.

If a very small part of the money spent by the government of the United States in the protectection of manufactures by import duties had been used in higher technical education, and especially in the encouragement of scientific research, we feel sure that the industries and commerce of the country would be in a very different condition from that in which they are now found. They would not need to ask protection from foreign competition, but would dictate terms to every nation. Both in Great Britain and the United States enormous sums of money are annually spent, and well spent, in primary and secondary education. Yet this education is chiefly of advantage to the individual, whereas higher education and research, chiefly of advantage to the State, are neglected by it.

Nature does not hesitate to urge that a ministry and council of science be established in Great Britain equal in rank and importance to the war council. We fear that it will be a long while before anything would be gained by urging that we should have a minister of science in the Cabinet, but the modest request that the office of director-in-chief of scientific bureaus and investigations in the department of agriculture be created should be seconded by all who are interested in scientific research, or in commercial or agricultural success.

THE GERMAN ZOOLOGICAL SOCIETY.

THERE will be found in the issue of *Die Natur* for August 23d an interesting account of the German Zoological Society by Prof. O. Taschenberg. Many who are familiar with the important work of the Society may not realize that it was only founded in 1890 and has held but six meetings; the first in Leipzig in 1891, under the presidency of Prof. Leuckart; the second in Berlin and the third in Göttingen, under the presidency of Prof. Schultze; the fourth in Munich and the fifth in Strasburg, under the presidency of Prof. Ehlers, and the sixth in May of the present year at Bonn, under the presidency of Prof. Bütschli.

Yet in these few years the Society has contributed to the advancement of zoology in an unusual degree. It has not only published annually its scientific proceedings, but in accordance with its constitution has discussed and carried out plans requiring scientific cooperation. It has secured the establishment of a marine biological station in Heligoland, and has agreed upon and published a system of zoological nomenclature. It will be noticed that in the second of these works the Society has undertaken to legislate not only for Germany, but for the scientific world. It has further proceeded with plans that concern all zoologists. It has secured the republication of the 10th edition of the *Systema Naturæ* of Linnæus and the publication of the *Zoologisches Addressbuch*, to which we have recently called attention. It has now carried into effect the plans for the publication of a complete *Species animalium recensium* (this, its original title, has now been changed to *Das Tierreich*), which, as all zoologists know, is one of the most extensive scientific works ever planned.

The German Zoological Society demonstrates what can be accomplished by proper organization and sets an example to other countries, which, if not followed, will leave to Germany tasks that should be accomplished by international cooperation.

REPORTS ON ENGINE-TRIALS OF 1896.

Le Revue Universelle des Mines de Liége published in its issue of 1896, Volume XXXIV., an account of the work of the Experimental Engineering Laboratory of Prof. Dwelshauvers-Dery in the early part of the current year. The following is a brief abstract of this series of reports :

These experiments were conducted in the operation of the experimental engine of that laboratory for the purpose mainly of ascertaining the effects of draining the steam-chest, while in action, of superheating, of steam-jacketing, and, further, to obtain a measure, on a large scale of operation, of the mechanical equivalent of heat energy.

The latter, the most interesting and important, perhaps, from a general and purely scientific point of view, are also exceedingly important as corroborating, on this large scale of work, the earlier laboratory tests of Joule, and especially of Rowland. The engine is a machine built especially as an 'experimental engine,' and so constructed as to permit the investigation of as many as possible of the numerous problems of steam engineering, while at the same time combining in its design the requisites for practical work of a less scientific character and permitting the instruction of students in the methods of manipulation of steam-engines. The series of researches here described was made by setting the engine in operation and continuing its action until it had become 'steady' in all its essential conditions of operation, then by means of the steam-engine indicator ascertaining the state, the quantity and quality of the steam *en route* through the cylinders, and measuring the power developed *en gros* and net by the indicator and the Prony brake and by their comparison. A sufficiently complete description of the engine and the details of the accessory apparatus is given in the paper of which this is an abstract.

A delicate and accurate brake system permits the measurement, with great precision, of the quantity of work delivered to the strap of the brake and its comparison with the exact quantity of heat into which it is transmuted and which is carried away by the water employed for cooling it, the weight and change of temperature of which are measurable with similarly satisfactory accuracy. The outcome of the investigation, of which the detailed computations need not be stated here, gave the value of the heat-equivalent as 427.2 kgm. per calorie, as the mean of six experiments, or within one-tenth of one per cent. of that now accepted generally as the result of Rowland's determination under similar conditions of temperature, 426.9.

The figure 426.9, 778 foot-pounds in British measures, has already come to be generally accepted by engineers in their computations relative to the heat-motors and this first exact comparison of the two energies on a large scale, and especially using the steam-engine itself as the apparatus of determination will undoubtedly settle the question of the accuracy of that figure—certainly within the limits of precision demanded by the engineer.

The steam-engine has not usually been regarded as an instrument of precision; but the six trials here recorded gave the figures, the integral numbers being taken, 428, 427, 422, 438, 428, 421, a degree of regularity being thus attained which may appear surprising to one not an expert in this field of applied science. For all steam-engine trials it may be assumed that henceforth the figure adopted for the Carnot heat-thermodynamic equivalent will be taken as 778 foot-pounds per *B. T. U.*, 427 kgm. per calorie.

The investigation of the effect of drainage of the steam-chest during the operation of the engine, with the object of securing perfectly dry steam at entrance into the steam-cylinders, was made in a series of eight engine trials, and at the constant boiler pressure and engine power, as secured at the brake. When the drain cocks were closed, the steam entered the cylinders carrying 5 to 8 per cent moisture; when open, the moisture ranged from 1.54 to to 1.86 per cent. An effective separator at the engine would have undoubtedly had a similar effect, and the trials reported may be taken as measuring the value of that now almost invariable accessory of the high-speed engine in this country. The engine delivered about fifteen horse-power during the trials.

The results of these experiments showed that gain by draining the moisture from the steam before entrance, under the stated conditions, into the cylinders, amounted to the following quantities:

Steam saturated at entrance.—The gain, unjacketed, was 9.29 per cent.; jacketed, 12.08 per cent.

Steam superheated.—A loss was experienced by drainage, of 5.33 per cent., unjacketed; 1.34 per cent., jacketed.

Engine jacketed, economies.—With saturated steam, the economy obtained by jacket action, without drainage, was 26.47 per cent.; with drainage, 28.73 per cent.

With steam superheated, without drainage, the gain was 25.02 per cent.; with drainage, 27.86 per cent.

Steam superheated.—With steam superheated 4° C., the gain obtained amounted to 21.7 per cent., without jacketing and without drainage, 9.07 per cent. with drainage; with jacketing it amounted to 20.16 per cent. without drainage, 9.07 with drainage. With jackets in operation and without drainage, the gain by superheating was 20.16 per cent., and with drainage 7.7 per cent.

It thus appears that separation of the moisture from the entering steam is found to be an important matter; with superheated steam any drainage is obviously, as here shown by direct experiment, wasteful.

GENERAL.

AT the close of the regular Meeting of the American Association for the Advancement of Science at Detroit next year the Association will adjourn to Toronto to welcome the British Association.

THE meeting of Russian naturalists and physicians will in 1897 be held at Kief from the 21st to the 30th of August.

THE annual meeting of the Association of Official Agricultural Chemists will be held in the lecture hall of the National Museum, of Washington, on November 6th, 7th and 9th. The Association of Agricultural Colleges and Experiment Stations will convene on the following day, November 10th.

THE monument to Lavoisier mentioned in the last number of this JOURNAL will be designed by M. Barrias, a member of the *Institut.*

WE learn from *Natural Science* that the principal part of the paleontological collection of the late Mr. William Pengelly, of Torquay, has been presented by his widow to the British Museum (Natural History) and to the Museum of Practical Geology, Jermyn Street. The fossils were obtained chiefly from the Paleozoic formations of Devon and Cornwall, but also comprise a series of bones and teeth from the Happaway Cavern, near Torquay.

ANOTHER serious earthquake is reported to have occurred on the evening of August 31st in the northeast provinces of the main island of Japan, the same provinces that suffered so severely from the earthquake and tidal wave of June 15th, last.

THE iron work of the dome of the Yerkes observatory (which is 110 feet high, 90 feet in diameter, and weighs about 200 tons) is now in position, and it is hoped that it may be possible to move before winter the lenses now ready in the work-shop of Mr. Alvan Clark.

WE regret to record the death of Prof. J. L. Delbœuf, who died at Bonn, on August 13th, at the age of sixty-five. M. Delbœuf, who was professor at Liége, had offered a paper entitled *Sur les suggestions criminelles* at the recent Munich Psychological Congress, but seems to have been attacked with illness on his way to the meeting. We also regret to learn of the death of Prof. Richard Avenarius, of Zurich, one of the ablest of contemporary philosophers and psychologists.

THERE will be held in Madison Square Garden, New York, during the two weeks beginning January 25, 1897, a 'Gas Exposition.' The offices for the present will be located at 280 Broadway, where applications may be made for exhibition spaces, or information of any character relating to the exhibition.

DR. S. RAMON Y. CAJAL, professor of histology and pathological anatomy in the University of Madrid, is the editor of a new journal entitled *Revista Trimestral Micrografica.*

THE first or 'general' part of Dr. Richard Hertwig's *Lehrbuch der Zoologie* has been translated by Prof. George W. Field, of Brown University, and will be published soon by Henry Holt & Co.

THE *Botanical Gazette* states that Prof. J. M. Coulter's Flora of Western Texas, published among the contributions from the U. S. National Herbarium and issued in three parts, has been republished and bound into a single volume. The original edition of the first part had been entirely exhausted.

MR. THOMAS HICK, lecturer in botany at Owens College, Manchester, and the author of papers on sea-weeds and on paleobotany, died in August at the age of fifty-six. *Natural Science* states that, at a meeting held recently at the Manchester Museum, it was decided to collect a sum of money with a view to purchasing his collection of microscopic sections of coal plants and depositing them in the Museum. Any surplus will be devoted to the purchase of a portion of his library, to be given to the Yorkshire Naturalists' Union or to perpetuate his memory in such other manner as may be decided upon by the contributors.

MR. JOHN HOUSTON, a civil engineer and railway constructor, died at Arlington, N. J., on August 30th. He was born in Scotland, but had lived in America for fifty years.

PROF. CÆSARE LOMBROSO, of Turin, in a recent compilation on 'graphology' included three pages from a work on the same subject by M.

Cremieux-Jamin without giving credit to this author. The matter was brought into the courts at Rouen. It was stated that the plagiarism was accidental and shown that M. Cremieux-Jamin had been given adequate recognition in the preface, but Prof. Lombroso was compelled to pay a considerable fine.

In view of the failures to observe the solar eclipse in Norway and Japan, it is fortunate that the party taken to Novya Zemblya by Sir George Baden-Powell obtained very good results. Mr. Shackleton, one of the party, has written to *Nature:* "I obtained about eight photos during totality. The most successful are those at the beginning of the eclipse, also at the end and the long exposure near mid-totality. The two photos near the beginning of totality are very interesting; the one nearest the time of the beginning of totality shows, I think, without doubt, as many bright lines as there are in the Fraunhofer spectrum with the same instrument; so in all probability we have succeeded in photographing the 'reversing layer.' The plate at the end of totality also shows a great many lines, but not as many as the beginning; probably they are the same as those photographed by Mr. Fowler in the metallic prominences of 1893—certainly most of them are. The long exposure near mid-totality gives a good ring at 1474 K, and also one near K (3969λ), and several other fainter ones. The spectra are not so extensive in ultra-violet lines as those of 1893, probably because of the cloudy state of the sky. The corona-photos have also come out very well."

According to *The Lancet* a new meteorological observatory has recently been erected at Edinburgh, about half way up Ben Nevis. The principal objects are to determine, with greater precision than has hitherto been possible, the extent to which anticyclones descend on the mountain, and to obtain records of temperature, pressure and humidity for comparison with those noted at the summit and at Fort William. With this knowledge the inquiry into the character of coming cyclones as regards their shallowness or depth, and of the occupying anticylones, will be greatly extended, particularly in view of the important practical question of forecasting the weather. The instruments to be used are a new Fortin barometer, with extended scale adapted to the height by Mr. Casella, of London, dry and wet bulb, and maximum and minimum thermometers; rain guage, and instruments for measuring solar and terrestrial radiation. The erection of the new laboratory has been promoted by the Meteorological Society, and the observations are to be made and recorded by Mr. Muir, one of the assistant masters in the Edinburgh High School.

At the Electrical Congress held at Geneva from August 4th to 8th the magnetic units provisionally adopted by the American Institute of Electrical Engineers were rejected and no units nor names were adopted. The Congress, however, adopted a photometric unit entitled *bougie décimale*, based on the Hefner amyl-acetate lamp.

We learn from *Die Natur* that Dr. B. Hofer, privatdocent of zoology in the University of Munich, has been elected to a newly founded chair of fish culture and the diseases of fishes in the veterinary school of Munich. This would seem to be the first academic recognition of this subject and it would be an advantage if the example were followed in America, where there are many openings for students having a scientific and practical knowledge of the subject.

The Botanical Gazette calls attention in an editorial article to the neglect of foreign literature by German botanists. Dr. Correns explains, in the *Botanisches Centralblatt*, that he did not know of an article by Prof. MacDougal because *The Botanical Gazette* is not to be found in Tübingen. It is probable that American scientific work will not be adequately recognized on the continent of Europe until an international method of indexing and abstracting scientific literature has been devised. In the meanwhile, although the orderly advance of science is obstructed, American students have an advantage over their foreign colleagues similar to that of him wearing 'the invisible cap.'

A correspondent of *The Lancet* writes that Lord Kelvin's remarks at the banquet given in his honor in July last have led to some misunderstanding in certain quarters, and M. de Fonvielle, a distinguished scientific journalist, has written to Lord Kelvin, congratulating him upon the 'failure of the atomic theories.' In reply Lord Kelvin expressed his regret at the misunderstanding, and goes on to say: "I do not allude in this passage to anything which I am in the habit of teaching either in my classes or in my published works. I am as much convinced as ever I was of the absolute truth of the kinetic theory of gases. All I know is I have not succeeded, in spite of fifty years of effort, in understanding more about the luminiferous ether or the manner in which it operates in regard to the electrical and magnetic forces. It is on this point I remain as ignorant as I was fifty-five years ago, when I first became convinced that the ether operated essentially in all these actions."

PROF. H. F. OSBORN has contributed to the September number of *The Century* an account of 'Prehistoric Quadrupeds of the Rockies,' well calculated to impress on the reader the interest and importance of paleontological research. The American Museum of Natural History has collections of great value, gathered by Prof. Osborn, Dr. Wortman and others, and under their direction Mr. Charles Knight has prepared a series of water-color drawings designed to give an idea of the appearance of the extinct animals in their natural surroundings. These were exhibited last winter at the reception of the New York Academy of Sciences and are undoubtedly the most life-like reproductions hitherto executed. Nine of the drawings have been reproduced on a large scale, and accompany Prof. Osborn's article in *The Century*.

M. DELEBECQUE has communicated to the Paris Academy a description and explanation, by M. Forel of Lausanne, of the phenomena known as the *Fata Morgana*. These have long been observed at the Straits of Messina and have been described by Humboldt and others. The phenomena consist in an apparently great enlargement, in a vertical direction, of the rocks, buildings, etc., on the opposite side of a lake or strait. M. Forel finds that it is not a real enlargement, but a number of different images, some erect and some reversed, and attributes it to complex mirage.

WE regret having printed a note in the last issue of this JOURNAL in which it was assumed that an article by President Jordan in the September number of *Appleton's Popular Science Monthly* might have been intended seriously. It is a satire on 'impressionist physics,' and ought to be so recognized by every one, even apart from the signature of President Jordan. It is, however, impossible to parody, other than by republication, much that has been written on this subject, and President Jordan will probably receive letters asking for admission to the 'Alcade Camera Club.'

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of the late Martin Brimmer, of Boston, Harvard University will receive $50,000 on the death of his widow.

THE six buildings of the New York State Veterinary College of Cornell University have been completed and the laboratories and museums are being fitted up.

BY private gifts, a Japanese fellowship in economics has been established at the University of Wisconsin, and Mr. M. Shiozawa, of Tokyo, Japan, has been elected to the fellowship for the coming year. A second fellowship in economics has been arranged for 1896–97 only, to be held by a graduate of Rockford College, and Miss Mary A. Salvin has been elected to the fellowship.

THE forty-third report of the Department of Science and Art of the Committee of Council of Education of Great Britain shows that the expenditure of the Department was £745,470 for the year 1895. Of this amount over £150,000 was in direct payments to encourage instruction in science. The number of visitors during 1895 was 1,040,628 at South Kensington and 355,248 at Bethnal-green, a decrease of more than a quarter of a million from the year before.

GEORGE T. WINSTON, President of the University of North Carolina, has been elcteed President of the University of Texas.

PROF. NATHANIEL SCHMIDT, of Colgate University, has been appointed to the new chair of Semitic language and literature, recently endowed by Mr. Henry W. Sage in Cornell University.

Dr. Franz Hofmeister, professor of pharmacology at Prague, known for his researches in physiological chemistry, has been called to the chair at Strasburg, vacant by the death of the late Prof. Hoppe-Segler.

Prof. F. F. Jerisman has resigned the chair of hygiene in the University of Moscow.

DISCUSSION AND CORRESPONDENCE.

THE LICK REVIEW OF 'MARS.'

Having sought to throw discredit on Mr. Lowell's work, almost before it was begun, some two years ago, the Lick Observatory now renews the attack in Prof. Campbell's review of Mr. Lowell's book. Formerly it decried the work because the theories upon which it was started were too original; now it attempts to seize the credit of the results and calls the theories 'mostly old.' Such a remarkable act of appropriation cannot be allowed to pass unnoticed.

In order to unmask at once the character of the article, we will take first the two points in which the writer sums himself up.

1. Prof. Campbell asserts that of the two leading faults of the book, one is: 'that there should be so many evidences of apparent lack of familiarity with the literature of the subject' on Mr. Lowell's part; and he introduces, quotations at great length from a translation by Prof. W. H. Pickering, of Schiaparelli's work, to which translation he professes his obligation. Of this it is only necessary for us to say that the translation in question was made at the Lowell Observatory, a fact which Prof. Campbell neglects to mention, although the fact was so printed on the paper from which he quotes. We are willing to have the Lick indebted to us for its knowledge of Schiaparelli's work, but it must not suppose us ignorant of our own translation to which its knowledge is due. As the public could not have been expected to know whose the translation was, while we, on the other hand, could not have failed to do so, we are in doubt whether to wonder most at the simplicity or the bare-facedness of such a proceeding.

2. The writer asserts, as the other fault, that the observations were not continued long enough to support the conclusion of seasonal changes on the planet. If he will read again our translation of Schiaparelli he will find that that eminent observer has noticed seasonal changes for years and that what our observations disclosed was not only the fact of changes, which they corroborated, but the character of the changes and the process of their development, thus furnishing an important link in the chain of evidence for Mr. Lowell's theory.

3. With regard to the literature of Mars contributed by the Lick and referred to in the article the succeeding points will show whether that literature was unknown to Mr. Lowell or whether its unimportance made mention of it unnecessary.

4. We will begin with the Lick attempt to claim the discovery of canals in the dark regions for Prof. Schaeberle in 1892, because the latter saw 'streaks' there then. Not only did Prof. W. H. Pickering and Mr. Douglass discover these same 'streaks' at Arequipa, of which fact the writer of the article is apparently ignorant, but Mr. Douglass' discovery, at Flagstaff, in 1894, was not of 'streaks,' but of canals, in the technical sense in which that word is used for Mars; and it is to the detection of these 'canal' peculiarities that the importance of the discovery is due, since it is these peculiarities that impart an artificial appearance to the entire system of canals. The difference between 'streaks' and 'canals' in the dark regions is of exactly the same kind as the difference between the streaks seen in the light areas by Madler, Dawes, Kaiser and others, prior to Schiaparelli's discovery of them as 'canals.'

5. The North Polar Sea was seen by Schiaparelli; the South Polar Sea has been drawn by many previous observers, but not recognized as such. Its limits and the proof of its character are due to Prof. Pickering's polariscope observations at this observatory. Its function in the climatology of Mars was first thoroughly discussed by Mr. Lowell in his book, and this is the precise meaning of his words, 'never distinctly noted or commented on before.'

6. The Lick article asserts that the first irregularity on the terminator was seen at the Lick Observatory, in 1890, but it omits to mention

that it was a casual visitor who detected it, so that to this visitor, and not to the Lick staff, belongs the discovery. What such an outsider's discovery betokens about the efficiency of the staff it is not our purpose to remark. The value of our observations consisted in their great numbers, in the fact that depressions were seen for the first time, in the systematic search made for them all around the planet and in the information they have yielded in regard to its meteorology and topography. Of Prof. Campbell's attempt to criticise the discussion of these observations it is useless to speak, as, owing to his ignorance of the original data, his guesses on the subject are not important.

7. The Lick article asserts that the vegetation theory was suggested by Schiaparelli. If the writer will read, once more, our translation of Schiaparelli he will see that such is not the case, and that not only is Schiaparelli speaking solely of the canals, but that he rejects the mere suggestion of vegetation, nor does he hold it to-day. Nor is this all, for Prof. W. H. Pickering suggested the same theory many years before.

8. The attempt to disparage Mr. Lowell's discovery that the Martian longitudes came to the meridian twenty minutes behind time, by attributing it to Prof. Keeler, will be seen to be an error, by any one who cares to consult the original papers of both.

9. As to any knowledge at the Lick Observatory of a Martian atmosphere, it has been purely negative, Prof. Holden going so far in an article, in the *North American Review* for 1895, entitled 'Mistakes about Mars' as to declare that the opposition of 1894 would be memorable for having proved an absence of atmosphere. We may let Holden's Mistakes about Mars speak for themselves.

We could go on in this manner, but we have shown enough. We should not have noticed an article like the one before us had it not been an attempt on the rights of property, rights at least as sacred in intellectual matters as in those more material ones which the laws protect.

A. E. DOUGLASS,
For the Observatory.

LOWELL OBSERVATORY, FLAGSTAFF, ARIZONA, August 14, 1896.

COMMERCIAL MICA IN NORTH CAROLINA: THE STORY OF ITS DISCOVERY.

IN an interesting and instructive article on Mica and Mica Mining, published in the *Popular Science Monthly*, for September, 1892 (Vol. XLI., p. 652), C. Hanford Henderson makes the following statement concerning the discovery of commercial mica in North Carolina:

"The location of the mines has been largely accidental. So far as I have been able to learn, the first one opened was the Sinkhole Mine in Mitchell county. The spot was marked by the existence of trenches, many hundred feet long in the aggregate, and in places fully twenty feet deep. Large trees growing on the *débris* indicated that the workings were very ancient. It was supposed that they had been for silver; and when the trenches were re-opened, at the close of the war, the search was for that metal and not for mica. Silver seems to dominate in the Carolinian dream of mineral wealth, when it is, of all such dreams, the one least likely to be realized. The search for silver being unsuccessful, the mines were again abandoned. The mica that had been thrown out was left on the dump, and soon advertised the real character of the mine. A stock driver, passing that way, carried a block of it to Knoxville, where it attracted the attention of men acquainted with its value. They investigated the matter, emigrated at once to Mitchell county and began systematic mining for mica. As the mineral was then selling for from eight to eleven dollars a pound, the rewards were considerable, and much enterprise was shown in the development of the industry."

This statement was also published in the *Engineering and Mining Journal*, for January 7, 1893 (Vol. LV., p. 4), as a part of an abstract of the above paper.

During the summer of 1880, as the assistant of the late Prof. W. C. Kerr, State Geologist of North Carolina, and in the capacity of a special agent of the Tenth Census, I visited the various mica localities of the State, for the purpose of securing statistics and such other information as was deemed necessary in making up his report. While in Bakersville I made careful inquiry concerning the origin of the mica industry, and by reference to my notes taken at the time, and the accompanying letter of ex-United States Senator Thos. L. Clingman, received in August of that year, I am in a position to throw more light upon the subject.

The story then current in Bakersville was quite similar to that above given. On July 27th I had a conversation with Mr. C. T. C. Deake ('Old Roan'), editor and proprietor of the 'Roan Mountain Republican,' a very intelligent and well-informed citizen, who said in substance: Gen Clingman while prospecting for *silver* at the Sinkhole Mine threw out mica.* A wagoner took some to Knoxville, Tenn. Here Messrs. Heap and Clapp were engaged in the hardware business. They knew the value of mica in New York. Clapp came first and leased the Sinkhole and other mines. This was about '70.

A few days later Mr. T. G. Heap, the surviving member of the firm, informed me that his attention was called to the existence of mica at the Sinkhole *silver* mine by a peddler of county rights in a broadcast wheat-sowing machine. This individual, 'footing it,' through the country, came to the Sinkhole Mine, and seeing the bright, shining mica brought a sample to Knoxville, where he exhibited it on the street. No one recognizing its value save himself, he immediately dispatched his partner, Clapp, to lease the mine, which had been forfeited by the previous lessee (see Gen. Clingman's letter), and the first work was done 'on the day of the great eclipse, 1869.'

That "silver seems to dominate in the Carolinian dream of mineral wealth" was amply demonstrated during my trip through the Blue Ridge country sixteen years ago. As Henderson states, it was supposed that the prehistoric trenches of Mitchell and other counties were abandoned *silver* mines. That they were not has been conclusively shown by both Prof. Kerr and Gen. Clingman. The latter in his letter states positively that his object in opening the prehistoric mine at William Silvers, known as 'Sinkhole,' was for the purpose of obtaining *mica*.

*Based upon this and similar statements I, too, expressed the opinion that the search was for *silver*. See an article on 'Mica Mining in North Carolina,' published in the Mining Record, N. Y., July 2, 1881.

The association of silver with the excavations of this particular locality may have been due to the fact that they occurred on the property of a Mr. Silvers, and that they should eventually become known as old *Spanish silver* mines is not, at least, impossible, considering the widespread tradition that the early Spanish explorers reached western Carolina.

Gen. Clingman's letter is as follows:

Asheville, August 18, 1880.

Dear Sir: Your favor has been received, and I will, with pleasure, make you a brief statement with reference to the mica operations in our own State.

During the summer of 1867, when in New York, I learned that mica, owing to the failure of supplies from New England, had become very scarce in the market. Prof. A. Trippell told me that he had for certain parties paid $8 per pound for ordinary mica.

Knowing that it existed in several localities in North Carolina, of good quality, I, on my return, made examinations in several of the counties. I commenced with Cleveland, on the east, and passed through Rutherford, Burke, and McDonald east of the ridge. I then examined the northeastern part of Buncombe, south of the Black Mountains, and gave a good deal of time to Yancey and Mitchell. I caused work to be done in Cleveland, Burke, Yancey and Mitchell. I became satisfied that the latter county held out the best prospects for a good supply of the mineral.

I therefore returned to New York, and made an arrangement with Messrs. Sloane and Menden, then doing business at 113 Liberty street. They agreed to work all such mines as I had secured or might secure, and pay me one-half of the net profits. Mr. Menden, in January, 1868, visited with me some localities east of the Ridge, and we had some mica taken out in Cleveland. Owing to the severity of the winter weather, he postponed his visit to Mitchell and Yancey until the opening of the spring. In May we went into Yancey and Mitchell to the Ray Mine and some others. Owing to the roughness of the roads, however, he declined to go with me to the Silvers and

Buchanan Mines and decided to abandon the business. It may seem singular, but nevertheless it is the fact, that on my previous hasty examination I had selected what have since proved the three best mines, viz.: the Ray Mine in Yancey, and the Silvers, or Sinkhole, and the Buchanan Mines of Mitchell.

After Messrs. Sloane and Menden declined prosecuting the engagement, not being willing to abandon it entirely, in the summer of 1868, I caused some work to be done at the William Silvers, or Sinkhole Mine, as it has since been called. The shafts I had sunk and the tunnels driven showed an abundance of good mica. Being obliged to leave, I contracted with the foreman, who was managing the workmen employed, to save the blocks of mica, which were more than sufficient to pay the expenses of the operation. I learned, however, that soon afterwards he, having heard that some members of his family were sick, abandoned the work and left the mica lying on the ground. As I was then in very bad health, I did not feel able to superintend the work myself, and [as I] was not in condition to employ suitable agents, I decided to abandon the enterprise and surrendered my contract to Mr. Silvers and told him to make some new arrangement.

Mr. Heap, who has been the largest operator in the mica business, informed me that he had been induced to go into the business by this circumstance. A horse driver, on his return, knocked up one of the blocks of mica left on the ground and carried it to Knoxville in the autumn of 1868. On seeing it, Mr. Heap made inquiries as to the locality, obtained a lease from Mr. Silvers and commenced operations there. His success encouraged others to embark in the business, Mr. Garrett Ray being one of the first to begin in the early part of 1869, at a place where I had taken some specimens. The working gradually spread to other localities in these and other counties.

For additional and fuller information, I refer you to a publication of mine in the printed volume of my writings and speeches which you can find in the libraries at Chapel Hill. It begins on page 130, headed *Old Diggings for Mica, etc.* The name of Mr. Silvers is misprinted there. That publication will give you, probably, the additional matter you desire. It was originally published in the *Asheville Expositor* at the time of its date, April 8, 1873.

* * * * * *

Hoping that this statement may be sufficient for your purpose, I am

Very truly yours, etc.

T. L. CLINGMAN.

Prof. F. W. Simonds.

From the above letter it will be seen that the location of the mines was not 'largely accidental;' on the contrary, that Clingman made the preliminary investigations for a purpose, which was to discover commercial mica, and that he succeeded. But, as has often happened, he failed to grasp the prize almost within his reach. Ill health and a want of capital caused him to abandon the enterprise, and strangers, profiting by his preliminary work, reaped a substantial reward.

FREDERIC W. SIMONDS.

SCHOOL OF GEOLOGY,
UNIVERSITY OF TEXAS, July, 1896.

SCIENTIFIC LITERATURE.

Manual of Lithology: Treatment of the Principles of the Science with Special Reference to Megascopic Analysis. By EDWARD H. WILLIAMS, JR., E. M., F. G. S. A., Professor of Mining Engineering and Geology, Lehigh University, South Bethlehem, Pa. With six plates. Second Edition. First Thousand. New York, John Wiley & Sons. 1895.

In reviewing this work particular attention ought to be paid to its objects and to the system of education that has given it birth. The criticisms may seem severe, but they are aimed only at educational methods that the reviewer considers radically wrong, even if circumstances force him to give seeming countenance to them.

The principal points here noted are two: (1), the neglect of considering the student in preparing a text-book, and (2) the habit of spreading instructors over too extended a field.

A text-book to be of practical use to students must be clear, concise and accurate in its statements. In an observational science it should indicate in the most unmistakable language the appearances of the objects, their points of difference and their resemblances. The beginner ought to have the way smoothed off for him and every turning in the road explained. The discipline for the student should not come in the labor of mastering the principles of the science, but in applying them. Time is too short and too valuable to require the learner to spend all his time in clearing his path from the stumps, stones and other rubbish the instructor has left there, either from incompetence, ignorance or indolence. It is this unnecessary rubbish left in the way that wastes the time of our pupils and causes so many of them to graduate before they have really learned anything so that they can apply it.

The preface to Williams' Manual informs the reader in substance that the book is designed to teach beginners to distinguish the different kinds of rocks by means of the naked eye and ordinary lens, and to inform engineers about the various uses of rocks.

Looking at the first object—the student's use —the following sentence, culled from many, will give an idea of the lucidity of expression employed: "It may also be advanced that it does not require a greater amount of heat to metamorphose the walls in the one case than in the other, and that it is as easy to suppose the walls heated before the stoppage of the flow, either by the length of time during which the flow passed or from the fact that the whole region was heated to a point just below metamorphism (by orogenic or other causes) before the fracture and intrusion took place, and that the intrusive supplied the needed increment for metamorphism" (p. 3). This doubtless was one of the 'hot times' frequently heard of, but never before known to produce geological metamorphism through their length. This explanation will not only clear matters up for the beginner, but will assist the physical geologist in solving some of his most difficult problems.

How much attention could the author have paid to the needs of students, when, alone of all the manuals relating to the microchemistry of minerals, he refers to the French one of Klément (misspelled Klémert) and Renard, a publication that has long been out of print, and so rare that the reviewer has not been able to secure even a single copy after years of endeavor.

The only proper place mineralogy, as such, has in a text-book of lithology is when the space is devoted to pointing out the modes of occurrence of the minerals in rocks and the methods employed for their macroscopic identification.

In this book the first is briefly done and the latter hardly at all, while the chief portion devoted to mineralogy falls into the category usually known as 'padding.' The part of the work relating to the general definitions is its most valuable portion, although the statements here are deficient in clearness and precision, while much unnecessary matter has been introduced.

In the rock descriptions what beginner could macroscopically identify an obsidian by being told as its definition that it was 'a compact glass of varying color and luster, of a high acidity, and with content of chemically combined waters never more than one per cent.' (p. 114)? Or how is the learner to distinguish amphibolite from hornblende schist when the massive and schistose states occur almost in the same hand specimen, if he is guided by these definitions? 'Amphibolite, a granular aggregate of dark green to black hornblende with more or less quartz, and sometimes chlorite.' 'Hornblende-schist, a granular and schistose aggregate of the above minerals with similar silica and specific gravity.'

Throughout the book the descriptions and definitions of the rocks are not clear and accurate for macroscopic work, so that the beginner can find any clues to lead him on through the labyrinth. No directions are given to show him how he may avoid errors, and the characteristic appearances of the rocks are almost unnoticed.

It is such teaching as this, the reviewer believes, which crowds a student's head with a mere jumble of words, but leaves him destitute of any real knowledge of their application.

Although this is the second edition, the critic cannot see that the work has any use or place in the class room or laboratory. He regards it as one of the most worthless manuals on macroscopic lithology he has ever seen, and wonders how such a book could have been written by any man who had the slightest comprehension of a beginner's needs or who ever spent a day in a lithological laboratory.

Most of the plates that illustrate the book are of no use to the beginner, since, as a rule, no one except an expert could tell what rock they were intended to represent. The craze for photographic illustration in students' text-books, started by Rosenbusch, is one that should be frowned upon, in every case, except when the characters stand out boldly. The true way to assist the student is to have the plate show him what he is to look for. For this purpose it needs to be diagrammatic and exaggerated, so that the salient points will be grasped readily. In the present system the picture is commonly far more confusing than the original. A text-book is one thing, a volume illustrating original investigations another. The plates, poor as many of them are, in Harker's excellent little book, are of far more real value to a beginner than are any series of photographic prints ever published.

Turning to the engineer's side of this work, he will find it limited to a trifle over eight pages. This contains, for its space, quite a little useful information, but it is altogether too brief to be of much value. It is a great pity that this part could not have been enlarged and the remaining portions condensed.

No attempt is here made to point out the lame system of classification, the evident want of accurate acquaintance with lithological literature, or even with the rocks themselves. The reviewer's duty is not to criticize the book as a scientific treatise, but as a text-book for students wishing to obtain a working knowledge of rocks. The critic can but consider the work as a paste pot and scissors production, in which the materials were culled without judgment or real knowledge ; and is the natural and legitimate result of a system in this country which allows in a university one man to hold two chairs, each of which demands all of his time and energy, however able he may be. Particularly is the system wrong when the two chairs are so diverse as mining engineering and geology. The subject of geology alone is too vast even for a Baconian genius to do justice to it. It contains within its limits two parts or two sciences so different and so great that no college or technical school, and far less a university, can hope for a creditable standing in the geological world, which permits its geological department alone to be covered by one man, however eminent he may be. The butter has to be spread too infinitesimally thin for such a tremendous slice of bread.

The author of the work in question is not to blame, since nothing different ought to, or could, have been expected under the circumstances.

The only thing that the work can here be recommended for is, as a convenient manual in English, for the experienced lithologist to refresh his memory on some points.

M. E. WADSWORTH.

MICHIGAN MINING SCHOOL.

AMERICAN LINGUISTICS.

Langue Tarasque; Grammaire, Dictionaire, Textes. Par RAOUL DE LA GRASSERIE et NICOLAS LEON. *Bibliothèque Linguistique Americaine.* Tome XIX. pp. 293, Paris, Maisonneuve. 1896.

Die Maya-Sprachen der Pokom-Gruppe. ZWEITER THEIL. *Die Sprache der K' ekchi Indianer.* Von DR. OTTO STOLL. Pp. 221. Leipzig, Kohler. 1896.

The above are unusually valuable additions to the science of American linguistics. They present two North American languages hitherto little known to scholars, by careful analyses, according to the most approved methods of modern research.

The Tarascas were the native population of the State of Michoacan in Mexico when it was first discovered by the whites. They belonged among the semi-civilized tribes, though the language they spoke had no relationship to the Nahuatl, nor to any other on the continent. They erected important structures of stone, brick and mortar, and were sedentary and agricultural in habit.

Their language is characterized by the present writers as 'elegant and harmonious, rich and poetic.' Its phonetics are not difficult and its morphology and syntax, though presenting some peculiarities, are not excessively complicated. It is incorporative in a high degree, a unique trait of its infixation being the incorporation in the verbal stem not only of the object, but of a generic particle which includes it. Another oddity is the attraction of the number of the object to that of the subject, as if we were to say, 'I teach him,' and 'we teach hims.' The grammatic analysis is ably carried out. The dictionary, taken from that of Father Gilberti who wrote in the sixteenth century, occupies 150 pages, and the texts, mostly religious and therefore of secondary value, are sufficient to show how Europeans wrote the tongue. A bibliography is added and a slight sketch of the history of the tribe. Both the authors are well known by their previous valuable contributions to American studies.

The work of Dr. Stoll is a continuation of his fruitful contributions to the ethnography of Guatemala. The K'ekchi is a dialect of the Mayan stock still spoken in the department of Vera Paz, Guatemala, by about 85,000 natives. It stands in near relation to the Quiche-Cakchiquel group of the stock, but is sharply contrasted with these idioms by the wearing away of many of the forms, especially in suffix verbal derivatives. This suggests at once that with respect to them it is of modern formation.

The author devotes about a hundred pages to the grammar, which he analyses with the same thoroughness which characterized his former essay on the Pokomchi and the Ixil dialects. The vocabulary presents over three thousand words in correct phonetic form, based on a variety of authorities.

The volume closes with thirty pages devoted to the Uspanteca dialect. This is spoken in and near the village of San Miguel Uspantan, and was formerly included in the Quiche group; but Dr. Stoll shows that it is more closely connected with the Pokom group.

The interest attaching to this work is enhanced by the recent investigations into the archæology of the K'ekchi territory. Their ancestors probably erected the remarkable buildings at Copan, Quirigua and Tzac Pokoma; their pottery belonged to the most perfect on the continent; and the numerous mounds and sites throughout their land still offer most attractive fields for exploration.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC JOURNALS.

PSYCHE, SEPTEMBER.

A. P. MORSE continues his notes on the New England Tryxalinæ by a consideration of the genera Chloealtis and Stenobothrus, one species of each. F. L. Harvey describes and figures a Thysanuran from Maine, possibly distinct from Packard's *Anoura gibbosa*. H. G. Dyar gives the life history of *Ichthyura strigosa* Grote. S. Henshaw adds a new instalment of his biblographical notes, being a list of the entomological articles in *Garden and Forest*, 1892–1895. The Proceedings of the Cambridge Entomological Club follow, the principal point of which is found in A. G. Mayer's account of the pigment in lepidopterous scales.

NEW BOOKS.

The Biological Problem of To-day. DR. OSCAR HERTWIG. Authorized Translation by P. Chalmers Mitchell. New York, The Macmillan Co. Pp. xix+148. $1.25.

Text-book of Paleontology. CARL A. VON ZITTEL. Translated and Edited by Charles R. Eastman. Vol. I., Part I. Pp. 352, 593 Woodcuts. New York and London, The Macmillan Co. $2.75.

A Geographical History of Mammals. R. LYDEKKER. Cambridge, University Press; New York, The Macmillan Co. 1896. Pp. xii +400. $2.60.

The Principles of the Transformer. FREDERICK BEDELL. New York and London, The Macmillan Co. 1896. Pp. iv + 416. $3.25.

The Gas and Oil Engine. DUGALD CLERK. Sixth edition revised and enlarged. New York, John Wiley & Sons. Pp. xii + 538.

Modern Optical Instruments. HENRY ORFORD. London, Whittaker & Co.; New York, The Macmillan Co. 1896. Pp. vi + 100.

A Catalogue of 16,748 Southern Stars. LIEUT. J. M. GILLISS. Washington, Government Printing Office. Pp. xxxi + 420.

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SCIENCE

FRIDAY, SEPTEMBER 18, 1896.

CONTENTS:

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

GEORGE BROWN GOODE.

GEORGE BROWN GOODE was born in New Albany, Indiana, on the thirteenth of February, 1851, and died at Washington, D. C., on the sixth of September, 1896. His illness was brief; on Thursday pneumonia developed, and he died on Sunday evening. His wife, three sons and a daughter are left.

Goode was interested in natural history as a boy, and during his college course at Wesleyan University found opportunity to occupy himself both with zoology and with museum methods. After graduating from the University, in 1870, he devoted himself to these subjects, making a collecting trip to the West Indies in 1872 and 1873. In the latter year, at the wish of his friend, Prof. Baird, he became connected with the Smithsonian Institution, to which his genius, as a man of science and an administrator, was devoted for twenty-three years.

We hope to give later an adequate account of Goode's contributions to ichthyology and to museum administration. His extended series of volumes on 'The Game Fishes of the United States,' 'The Fisheries and Fishing Industries of the United States,' 'American Fishes' and 'Oceanic Ichthyology' are standard works, showing great scientific knowledge and originality and power of expression and arrangement. But few men could have accomplished so much even in a long life devoted exclusively to scientific research. His published works on 'Plan of Classification for the World's Columbian Exposition,' 'Museums of the Future' and other contributions to museum methods and the history of scientific and educational institutions made him the leading authority in America on these subjects. His executive work in the Smithsonian Institution and the U. S. National Museum, extending to every detail and label, will only be appreciated by those who have been associated with him.

It is fitting that we should refer to his connection with this JOURNAL. For him it was only one of many interests, but the JOURNAL had scarcely another friend so able and wise. He contributed an important paper, his address as President before the Philosophical Society of Washington, to the first issue of the new series, and in the last number that appeared before his death his last paper was printed. He not only published in SCIENCE many articles of great value but he also helped continually in its editorial conduct. This JOURNAL, like the Smithsonian Institution, the National Academy of Sciences and other agencies devoted to the advancement and diffusion of science, has suffered an irreparable loss.

But Goode's greatest work was the man himself. He was honored and loved by all. His untiring and unselfish devotion to his work and to the helping of others ended only when he had sacrificed his life to it. A man such as Dana dies, his life work accomplished, and we do not rebel against the order of the world. But when nature, prodigal of life and souls, spends millions of years to bring forth at the end a man such as Goode, and then cuts him down in his prime, we stand at gaze. Each must take up his appointed task, but more wearily.

BOTANICAL SOCIETY OF AMERICA.

THE second annual meeting of the Botanical Society of America, was held at Buffalo, N. Y., on August 21 and 22, 1896, in rooms in the High School building, kindly provided for its use by the Local Committee of the A. A. A. S. Business sessions were held on Friday afternoon, Saturday morning, and for a few minutes late Saturday afternoon. The reading of papers occupied the greater part of Saturday afternoon, and the address of the retiring president was given on Friday evening. Sessions of the Council preceded the business sessions of the Society for which it arranges the program.

The Society was called to order by President WILLIAM TRELEASE, who resigned the chair to the president-elect, CHARLES E. BESSEY, which he assumed with a brief address.

The Secretary announced that since the last meeting one of the most distinguished members of the Society, MICHAEL SCHUCK BEBB, had passed away. A committee consisting of Messrs. COULTER, BRITTON and MACMILLAN, was appointed to prepare suitable resolutions. These, presented later and adopted, are as follows:

"The Botanical Society of America desires to place upon record an expression of esteem for its deceased member, Michael Schuck Bebb, who died December 5, 1895, at San Bernardino, California.

"His published studies upon the difficult genus Salix have brought him to high rank as a professional botanist, and American botany owes to him a debt of gratitude as one of its most distinguished representatives."

The ballots for officers for the coming year, which are mailed to the secretary, when canvassed by the council, showed the election of JOHN M. COULTER, of the University of Chicago, as president; CHARLES R. BARNES, of the University of Wisconsin, as secretary; ARTHUR HOLLICK, of Columbia University, as treasurer; and B. L. ROBINSON, of Harvard University, as councillor. No election having occurred of vice-president and a councillor, the Society proceeded to elect these officers. CHARLES S. SARGENT, of the Arnold Arboretum, was elected vice-president, and F. V. COVILLE, of the Department of Agriculture, councillor.

The council having approved the names of CHARLES H. PECK, State Botanist of New York, and BEVERLY T. GALLOWAY, Chief of the Division of Vegetable Physiology and Pathology, Department of Agriculture, these gentlemen were unanimously elected to membership.

The Society having asked the council to consider the best means of increasing the membership of the Society while preserving rigidly the high standard required by the constitution, the council recommended the appointment of a committee whose duty it should be to see that suitable nominations were made, so that the making of nominations would not go by default as heretofore. With the distinct statement that the making of nominations to membership by this committee shall in no way prevent the making of such nominations by other members, Messrs. Trelease, Atkinson and N. L. Britton were appointed.

Special invitations to the Society to hold its next meeting in Detroit, Denver and Nashville, were read and left with the council for action. Much time was given to the consideration of the question of a winter meeting. After a full expression of the opinions of members had been obtained, the matter was left in the hands of the Council with instructions to determine the feasibility of such a meeting and to appoint it if found practicable.

The Treasurer's report, which was audited and found correct by a committee composed of Messrs. Underwood and MacMillan and Mrs. Britton, showed a balance of about $700, deposited chiefly in the Institution for the Savings of Merchants' Clerks, in New York. The Council directed that the Treasurer give bond for $1,000 in any surety company, the expense for the same to be paid by the Society.

The request of the National Educational Association, that a member be appointed to confer with a committee of that association regarding the unification of requirements in botany for entrance to colleges, was acceded to by designating President Bessey to act as such conferee.

On Friday evening the address of the retiring president, William Trelease, to which the public was invited, was given in the chapel of the High School. A good audience listened to the discussion of 'Botanical Opportunity.' By request of the Society the address is published in full in SCIENCE and in the *Botanical Gazette*. The suggestiveness and timeliness of the address is such that the Council directed that 1,000 separates of it be distributed in the name of the Society.

On Saturday afternoon the following papers were read before the Society:

L. H. BAILEY: *The philosophy of species-making.* 15 min.

GEORGE F. ATKINSON: *Some problems in sporophyll transformation.* 20 min.

CONWAY MACMILLAN: *Some characteristics of a fresh-water insular flora.* 1 hour.

N. L. BRITTON: *A species of Eleocharis new to North America.* 5 min.

CHARLES R. BARNES,
Secretary.

BOTANICAL OPPORTUNITY.*

IN selecting a subject for the first presidential address before the Botanical Society

*Address of the retiring President, delivered before the Botanical Society of America, at Buffalo, N. Y., August 21, 1896.

of America, which you have done me the honor of requiring of me, I have deviated somewhat from the customary lines of such addresses, inasmuch as I have not attempted to present an abstract of recent general progress in botany, nor any results of my own investigation. Such topics, indeed, are more likely than the one I have chosen to interest an assemblage of specialists like this Society, but as the Society is supposed to have as a principal object the promotion of research, the present has seemed to me a fitting occasion to address, through the Society, the large and growing number of young botanists who may be expected to look to this Society for a certain amount of help and inspiration in the upbuilding of their own scientific careers; hence it comes that I have selected as my subject 'Opportunity.'

Let us for a moment compare the conditions under which scientific work is done to-day with those prevalent in the past. From a purely utilitarian, and, for a time, perhaps, almost instinctive knowledge of plants and their properties, beginning, it may be, before our race can be said to have had a history, through the pedantry of the Middle Ages with their ponderous tomes, botany, almost within our own memory, stands as the scientific diversion or pastime of men whose serious business in life was of a very different nature. Such training as the earlier botanists had was obtained as being primarily useful in other pursuits than pure research, though there is abundant evidence that the master often enjoined upon the pupil the possibilities of botanical study, and no doubt he stretched the limits of botanical instruction deemed necessary, just as is done to-day in technical schools, in the hope that the surplus might be so used as to increase the general store of knowledge; but, at best, training was limited and research was recreation and relaxation.

But our predecessors, even the generation immediately before us, lived under conditions which made it possible for a man to hold high place in the business or professional world, to accumulate wealth in commerce, and at the same time to devote much time to the study of nature. To-day the man who is not entirely a business man is better out of business, and, with few exceptions, the man who is not entirely a student is little better than a dilettante in science. Concentration is the order of the day, and specialization is the lot of most men. But specialization, the keynote of progressive evolution, is always intimately associated with a division of labor. Fortunately, the men who enter and win in the great game of commerce and manufacture see in a more or less clear way that nearly every great manufacturing or commercial advance has grown out of a succession of obscure discoveries made by the devotee to pure science, often considered by him, indeed, only as so many more words deciphered in the great and mysterious unread book of Nature, but sooner or later adapted and applied for the benefit of all men by the shrewd mind of a master in the art of money-making. To these men, successful in business, we owe it that to-day not only are some men able to devote their entire time to scientific research and the propagation of knowledge, but that their work is done under favorable conditions, and with a wealth of aids and adjuncts that would hardly have been thought of a generation ago.

Instead of a smattering of systematic botany and organography, given as an adjunct to chemistry, medicine or engineering, the student who wishes may to-day equip himself for a life of research in botany, by a considerable amount of preparatory work in the lower schools, beginning, perhaps, even in the kindergarten, and by devoting the larger part of his undergraduate time in college to the elements of the subject in its broadest, and, if he wish, technical scope, having the benefit of marvelously detailed appliances and a broad knowledge of general facts. If he can and will work for a higher university degree, thus equipped, he may delve into the depths of the most limited specialty, guided for a time for those who have already broken soil there, and left at last with a rich and unexplored vein for his own elaboration. With this training, if he be fortunate in securing a position offering opportunity for research, or if he enjoy independent means, he may hope for a life-time of more or less uninterrupted opportunity for unearthing the wealth of discovery that lies just within his reach.

Considering the prevalent conditions, my subject naturally divides itself into two quite distinct parts: the opportunity of institutions and of individuals. We stand to-day, apparently, at a transition point. Most of the active workers of the present time are college professors, who have done the research work that has made their names known, during the leisure that could be found in the year's routine of instruction or during their long vacations, and with facilities nominally secured for class use, or, in many instances, like those of a generation ago, the private property of the investigator. Even when appreciated at something like its true value, their original work, for the most part, has been closely watched to prevent it from encroaching upon the first duty, class work; and in most cases the facilities that they have been able to bring together are in direct proportion to the number of students attracted to their departments, and, therefore, in inverse ratio to their own leisure for research. But, as I have already stated, the feeling is growing among men able to foster such enterprises that research is a thing worthy of being promoted, and we have before our eyes the spectacle of a gradually unfolding class of institutions in which investigation is not only tolerated but expected, either as an adjunct to instruction, as in the greater number of colleges, as a concomitant of educational displays, as in botanical museums and gardens, or, at least nominally, as a basis for technical or economic research, as in several of the larger drug houses, and, notably, in various agricultural experiment stations and the National Department of Agriculture. Perhaps the time has not yet come when laboratories of botanical research can stand out quite alone and justify their existence without reference to other ends, the utility of which is more generally understood and conceded, but it seems safe to predict that the next decade will see their complete evolution.

Opportunity, for institutions, lies primarily in equipment, and secondarily in its use. The problem of equipment for research is a complicated and difficult one. So long as there were no laboratories specially designed for this purpose it was natural that the instructional laboratory should be furnished with appliances for demonstration, and that these should be amplified, as far as possible, for the repetition of experiments, in the first place, and afterwards for their extension; and it is no doubt true that a number of the smaller educational laboratories are to-day over-equipped when account is taken of the possible use to which they can be put. With a specialization such as we now see in progress, it may be questioned whether the ordinary collegiate equipment cannot be reduced in scope in many instances, with benefit to the institution, by releasing money often badly needed in other directions, either in the same or different departments. On the other hand, it is certain that the equipment of the broader research laboratories, whether connected with universities or independent, must be made much more comprehensive than any which to-day exists in this country.

Under the stimulus of the last two decades, botany has come to the front in most colleges as a study well calculated to develop the powers of observation and the reasoning faculties. Where it still occupies the place of a fixed study of a few terms' duration in a prescribed undergraduate course, it is evident that the necessary equipment of a department is expressible in the simplest terms—for each course, that which is needed to exemplify by the most direct object lessons the subject selected, and enough general and collateral material and literature to complement the work. But the case is somewhat different when, as is now frequent, a considerable option is allowed the student in the courses taken for the baccalaureate degree. Here the temptation exists to secure equipment for the broadest possible series of electives, and it is too often yielded to for the best interests of the institution. However liberal one may be in the matter of electives, it is evident, in most instances, that the student cannot afford to devote more than about one-half of his undergraduate time to a single study like botany, and in this time he can cover only a definite amount of ground. While there is a certain seductiveness in the perusal of long lists of electives in a college catalogue, the serious contemplation of them shows that few, if any, students can hope to take all of the courses of such a list, and as, for the most part, they are garnished out in an attractive form, there is likely to be embarrassment in the wealth of subjects, so that, if left to himself, the student is very likely to select a series of disconnected but pleasing fragments, rather than the proper links in an educational chain. Experience shows the wisdom of limiting the list of electives to those that there is reasonable probability that the student can take, and of making the list a consistent whole, fairly opening up the entire field of botany in such manner as to pave the way for a piece of advanced thesis work at the end, and for specialization after graduation. So far as undergraduate instruction is concerned, where, as is usually the case, funds are limited, it is here desirable, as in the other instance, to limit the scope of the departmental equipment quite closely to the requirements of the courses offered. As the senior thesis work is almost certain to be a further study of some one of the subjects already elected, the provision for it, in nearly every instance, is easily and quickly effected by a comparatively inexpensive addition, in each case, to the standard library and laboratory equipment. Such research work as the head of the department and his assistants find time for, as well as such post-graduate work as may be undertaken, can then be provided for in the same manner, piece by piece, with the exception of the final touches, demanding the use of the larger reference libraries or collections, the provision for which is not likely to be far to seek in the strongest research centers within a very few years.

Great herbaria, broad reference libraries, and large stores of apparatus and living or preserved material, are possible only to few universities and to the still fewer institutions specially endowed for research, to which alone, indeed, they seem strictly appropriate. For the latter, every shade of breadth of foundation is possible, from the laboratory and library limited to the narrowest specialty, to the institution founded and equipped for research in any branch of pure or applied botany. Fairly perfect equipment of the former class it is possible to find here and there, to-day, but though the seed is sown in several places, the broadest institutions, in their entirety, are still to be developed.

No doubt the first requisite in any such institution is a library of scope comparable with its own. Whatever may be said against the prevalent nomenclature discussions, it must be admitted that they are having the effect of bringing to the front the half-forgotten work of many of our predecessors, some of which, at least, is well worthy of resurrection, and, incidentally, this is stocking our larger libraries with a class of books which have confessedly been too much neglected of late. Without for a moment losing sight of the fact that botany is a study of one branch of Nature—an object study—we must recognize that its prosecution beyond the merest elements is not only greatly promoted by but almost dependent upon a knowledge of what has already been done.

Where an institution is located in a literary or scientific center, closely associated with large general libraries, learned bodies and the like, it is usually relieved of the necessity for purchasing and keeping up the long files of such serial publications as the journals, proceedings of societies, etc., of mixed contents, which prove expensive alike in cost, binding and space, which for a given subject are used but seldom, and which, nevertheless, are the most valuable part of a large reference library, since they are hardest to duplicate. But where a botanical institution stands in absolute or comparative isolation it must carry this burden in addition to that of maintaining a library of treatises on botany alone. And, moreover, no sooner is research begun in any direction than the necessity of following up divergent threads running in many directions becomes evident; for so close and complex are the interrelations between things in organic nature, that no single subject can be pursued far without drawing in others at first sight having no possible bearing on it. After the serials, which from their expensiveness can be possessed by only the larger libraries, stand undoubtedly the general classics in the several subdivisions of botany, followed by the more restricted memoirs, and among these, for convenience of use, should be found, whenever possible, separates and reprints from the journals and series of proceedings, even when the latter are complete on the shelves.

Next to books, material preserving records, or available for study, forms the great foundation in any research institution. A generation ago, or even less, this expression would have been taken as synonymous with an herbarium, perhaps associated with a garden of greater or less extent; but to-day the most comprehensive of museum possibilities must be added, so greatly has the subject broadened and increased its needs. For a broadly-planned institution, with ample means, no doubt the scope of the herbarium should be as great as that of the library, comprising every group of plants, representing a wide range of geographical distribution, the effects of cultivation, etc.; and, however limited they may be at first, such museum accessories as alcoholic material, large wood and fruit specimens, and sections for microscopic study, are sure to accumulate quite as rapidly as they can be cared for suitably, and to prove in time a very important part of the equipment. Though some of the best botanical work has been performed entirely in the herbarium, there has long been a growing conviction that for certain groups of plants, even for purposes of description and classification, field observation is absolutely necessary, while it is self-evident that for all studies of biology living material is essential. Side by side with the herbarium, then, and virtually as a part of the same general collection, stands the experimental garden, with its greenhouses and other appliances.

While many of the most useful studies are made with but few aids beyond the library and collections referred to, there is a large class of subjects, now being closely followed by some of the keenest investigators, which demand a special instrumental equipment. However it may be with library and collections, there seems little doubt that, as a rule, apparatus should be obtained only as it is needed for direct use. Except for the rotting of the bindings observed in the libraries of manufacturing cities, and where illuminating gas is used, books, when once classified and indexed, are easily and cheaply kept in a usable manner. If a few simple rules are followed, herbarium material is also preserved safely for generations at a very small cost; and even sections, and specimens in fluid if properly preserved in the first place, may be kept for many years without great deterioration. Instruments designed for research, as a general thing, represent a considerable sum of money, since, excepting microscopes, microtomes and balances, they are rarely made in numbers allowing any great economy in the labor of manufacture. Each of them is also, unfortunately, with few exceptions, calculated for a restricted class of experiments and likely soon to be greatly modified. Apparatus, moreover, is usually of a delicacy of adjustment calling for the greatest care in handling it and the most perfect protection possible against rusting, etc., so that, as a general thing, a case of instruments ten years old is merely a historical curiosity, in part entirely out of date and for the rest so badly out of order as to be nearly or quite useless. Except for a few standard instruments, I think it is now generally recognized that this part of the facilities, however costly it may be, should be regarded as transient, perishable material, rather than a permanent equipment. The history of the most successful physiological laboratories—in which delicate apparatus is chiefly used—furthermore shows that the most important results, as a rule, are not obtained by the use of commercial instruments, but by simple apparatus designed by the investigator to meet the precise needs of the problem with which he is busied, and usually constructed by him or his laboratory mechanic at very little cost.

Although it seems comparatively easy to decide on the proper limits of library, herbarium and instrumental equipment for a given institution, knowing its scope, situation and resources, it is very difficult to arrive at as satisfactory a conclusion concerning the extent of the research garden. As a general thing, such gardens are also intended to be useful in college work, or to afford pleasure and instruction to the public, so that they are likely to be heterogeneous, almost of necessity, and usually they are made far too comprehensive. More than any other class of facilities, garden plants require constant and expensive attention if they are to be kept in usable condition; and with all of the care that can be given them, they are forever performing the most inexplicable and unexpected gyrations with their labels, so that the collections grown in botanical gardens (because of their variety) are notoriously ill-named, though it would naturally be supposed that they, of all collections, would be above suspicion in this respect.

My object being to speak of facilities for research, rather than education or entertainment, I ought to pass by this part of the subject with a mere mention; but I can hardly dismiss it without comment. Where the only object is to supplement the facilities for undergraduate work, the scope of a garden can be very small or moderately large, according to the courses it is to help elucidate. It may be confined to what may be called a propagating bed for plants needed in quantity, either in season or out of season, for class use, to an exemplification of the natural affinities of plants, or to various other instructive synopses, representing medicinal plants, fibre plants, forage plants, fruits, vegetables, timber trees, nut trees, shade trees, carnivorous plants, climbing plants, the sleep of plants, pollination, dissemination, etc., or it may be devoted to several of these combined. If it is to be a pleasure ground as well, not only should the art of the landscape architect be invoked in the arrangement of the plants, but it is necessary to add collections of decorative shrubbery and a large variety of purely ornamental florists' forms of herbaceous plants. If research is added to its aims, the collection must be further augmented by specially selected groups cultivated from time to time as needed for study.

Unfortunately, few, if any, gardens are so richly endowed that they can cover, in a satisfactory manner, the entire field indicated, or even any large part of it. From what has been said of the peculiar difficulties pertaining to the maintenance of botanical gardens, it is evident that in no other line of facilities, whether for pure research or not, is a wise restriction so necessary as here. Once properly prepared, a species is represented in the herbarium on one or more sheets of paper safely and economically stored away in a pigeon hole; but in the garden it is a constant source of care and expense so long as it lasts. Hence it is possible for one of the larger herbaria to contain representatives of more than half of the 200,000 species, more or less, of phanerogams, and a considerable, if smaller, proportion of cryptogams, while it is absolutely impossible for anything like this number to be represented in a living state in the best garden. No doubt the local requirements of every institution will do more to influence the exact scope of its living collections than any theoretical considerations, but it is certain that in most cases the greatest usefulness combined with the minimum expenditure will be reached by adapting the synopses chosen to the chief aims of the institution, as closely as possible, and very rigidly restricting the species cultivated to the smallest number capable of adequately expressing the facts to be shown. Perhaps it is safe to say that an institution able to maintain a herbarium of half a million specimens, representing one-fifth as many species, is doing exceedingly well, if it has in cultivation at any one time 10,000 species of the higher plants; and there are very few gardens which actually grow half of this number, while no inconsiderable percentage of the plants cultivated are so deformed, distorted, dwarfed, and imperfect, as a general thing, that they can scarcely be said to represent the species whose name they bear, either in appearance or technical characters.

This leads to the conclusion that not only class gardens, but research gardens, should be kept within reasonably narrow bounds, so far as permanent planting is concerned, while allowing sufficient elasticity for rapid and ample temporary expansion in certain directions along which work is planned. This does not necessarily mean that any considerable amount of laud not used in the permanent plantation need be reserved for special expansion. As a rule, the more important gardens are situated in or near large cities, and the high price of land alone would prevent such reservation in most instances; but the impure atmosphere of many of the larger cities is a further and even a stronger reason for selecting, for any large experimental undertakings, a suitably located and oriented tract of farming land, easily rented for one or several years at a relatively low figure. Granting the wisdom of such temporary adjuncts to a research garden, a step further leads to a recognition of the possibility of securing the most varied climatic conditions by establishing branch gardens located where particular kinds of study can best be carried on. In no other way can gardens be made to contribute to the fullest extent to the study of marine or seaside plants, alpines, or the great class of succulents, etc., characteristic of the arid regions of our Southwestern States and Territories, and in no other way, except in the field, can these groups be studied satisfactorily, even from the standpoint of the classificatory botanist.

Undoubtedly, too, the research institution of the future will count as a part of its legitimate equipment, the provision, as needed, of very liberal opportunities for its staff to visit even distant regions for the study, in their native homes, of plants which cannot be cultivated even in special gardens in such a manner as to be fully representative.

If the entire equipment here sketched in outline is not only appropriate, but essential to the great centers of botanical investigation that are making their appearance as results of the specialization and division of labor that are now manifesting themselves in the endowment of research, it by no means follows that every institution, even of this class, should try to develop from the start on all of the lines which, intertwined, compose the complex tissue of botany. With ample means, the ideal development is that which from the beginning recognizes all branches as of value, and classifies and develops them alike in proportion to their relative importance. But to secure the greatest return for the money expended, it is desirable to equip fairly well before increasing the force of salaried men much beyond what is needed for the care and arrangement of the material accumulating. This principle, if followed out, almost forces an over-development in the branches of special interest to the earlier employees—a departure from the ideal symmetry which is sure to be justified by the performance of more work in these hypertrophied specialties, with reference to the sum invested, than in other directions. From this may also be drawn the seemingly just inference that where the means are limited it is far better to concentrate the entire equipment on the specialties of the persons who can use it than to allow them to work at a disadvantage through an effort, however commendable it may at first appear, to secure a symmetrical equipment.

With the evolution of centers of pure research will appear new problems. Just as the attendance of a large number of students in the botanical department of a college has heretofore been found to justify the acquisition of facilities beyond the power of their immediate use, it will be found that where research institutions exist in close connection with a university of recognized standing, their equipment will be utilized more or less fully in post-graduate work done toward the acquisition of the Doctor's degree, so that, like the undergraduate equipment, it will be more or less satisfactorily accounted for by the number of candidates for such degree; but with broadly grounded and well endowed research institutions not so situated, it is inevitable that as they take permanent form on the lines calculated to make them available for advanced research in any line of botany, they will sooner or later come to represent a very large sum of invested money, of which only a part is usefully employed at any given time, the remainder being held as a necessary but temporarily unproductive reserve. The same thing is seen, to a certain extent, in all large libraries and museums; but, unlike the general library, of interest to the entire reading public, or the collection of historical or political works, referred to by many people of ordinary intellectual attainments, the advanced equipment in botany, for the most part, is useful and interesting only to botanists, so that, while it may possess a passing interest for the general student, its serious use is limited to a very restricted class. How to increase this use to the maximum may well demand our best thought.

No doubt, just as many colleges now offer scholarships, making their advantages available to men who otherwise could not enjoy them, and some of our universities offer fellowships, opening their own post-graduate courses or those of foreign universities to deserving students, the evolution of research institutions will witness some such provision for enabling students who have partially completed pieces of research work to visit and utilize these centers without encroaching too far on the limited savings from the small salaries which, as a rule, are drawn by the botanists of the country. After all, however, the great opportunity of attainment, for such institutions, whether or not connected with colleges or universities, lies in the performance of research work by their own employees; and while, except in the few instances already referred to, and notably in the National Department of Agriculture, to-day there is some hesitancy in recognizing the employment of a staff of investigators as a legitimate part of the maintenance expense of an establishment which does not use a large part of their time in instruction or necessary curator's routine, it is quite certain that within a very few years opinion will have so changed that a considerable number of salaried positions for research work in pure or applied botany will exist; and as these positions will compete with the professorships in the best universities, it seems probable that the salaries pertaining to them will be approximately those paid by the larger colleges.

In addition to bringing together facilities for research and rendering them easily accessible to competent investigators, and maintaining their own corps of workers, engaged in such study, institutions of research have no small field of usefulness opened up as publishers of the results of the work they have promoted. I shall have occasion later to speak of the means of publication from the standpoint of the student who is seeking to bring out his work in the best form; but it also demands consideration from the point of view of the institution. Much difficulty is experienced in looking up the literature of a subject because of the large number of journals, etc., in which references must be sought, and it is probable that at some time or other most workers have impatiently wished that publication could be confined to one or a few channels. Simple as this would render the bibliography of botany, it is obviously impossible; and the amount of work deserving or demanding publication is so great and so rapidly increasing as to leave no doubt that means of effecting the latter must be considerably augmented. To publish the results of good work well is no less commendable or helpful than to facilitate or perform such work. Nor is it less appropriate to an institution such as I have in mind. The object of publication being the adequate preservation and diffusion of a record of the results of research, however, it is easily seen that harm may be done by injudicious or ill-considered publication. While a volume of homogeneous contents may be so published almost anywhere as to accomplish its purpose, a serial publication ought to be started only when there is reasonable probability that it will persist for a considerable length of time. Granting this probability, a research institution with adequate funds forms one of the most satisfactory and effective agencies of publication, since it can place its proceedings or reports in all of the principal libraries of the world, a thing which the journals do not always accomplish; and not only can it thus amplify its field legitimately, but almost of necessity it must assume the duty of publication if it is to accomplish the greatest results possible from its direct investigation.

One has only to pass a short time in the library of one of the larger scientific institutions to be convinced that a great deal of activity is manifested in the botanical world. Each month and each week brings many additions to the literature of the science, and so numerous, varied and widely scattered are these contributions that one feels the greatest hesitancy in publishing on even the most restricted subject, lest others should have antedated his discoveries. Yet, notwithstanding the variety and number of botanical publications, and the great progress which is undeniably made every year, it is a matter of frequent comment that the progress made is by no means so much greater than that of our predecessors as might be expected, considering the greater advantages under which work is prosecuted to-day. While it must be borne in mind that the seizing of the general features of a landscape is far easier than the working out of its detailed topography, that the outlining of the field of botany or of its principal divisions could not fail to proceed more rapidly, even under unfavorable conditions, than the elaboration of the details of the many specialties into which it is now broken up, so that less prompt and voluminous results are naturally to be expected now than a generation ago, there is reason to question whether the present returns cannot be increased. How to secure the greatest possible results from the large number of trained men and of men holding or soon to hold salaried positions, and from the large equipment in laboratories, libraries, herbaria and gardens, is a subject deserving of the most careful study, whether viewed from the standpoint of the endower or administrator of an institution of education or research, or from that of the botanist whose reputation is built up in the performance of the duties assigned to him in such an institution.

While there is every reason to expect large returns from the endowment of such independent departments of research, freedom from the duties of the class room, while leaving more time available for investigation, will not prove an unmixed blessing. I believe it to be the experience of the best investigators in this country that research is promoted by the necessity of imparting some or all of its results in the class room. In no other way, after specializing to the small field in which it seems necessary for most of us to confine ourselves, can one make sure of preserving the breadth of view needed for the investigation of even a limited specialty in the most successful manner. It must be admitted further that the power of application and concentration varies with different men, so that up to a certain point the interruptions introduced by limited teaching or looking after collections in many cases may give fresh zest to the pursuit of knowledge in the time remaining for research. And it may be that at this very point lies the greatest difficulty to be met and surmounted in the development and management of research institutions.

Though there is no doubt that some supervision and pressure are conducive to the performance of the greatest possible amount of investigation, as of other work, since they insure consistent planning and close application, it cannot be overlooked that this is the extent to which scientific work can profitably be crowded. To require more of an investigator than that he shall be reasonably busy with thoughtfully planned study is and has always been antagonistic to the performance of his best work; and the requirement of some institutions that a bulletin shall emanate from each department at stated intervals, while it insures quantity in publication, generally does so at the expense of quality of attainment. As a rule, genius, which, left to itself, now and then leaps to the most unexpected accomplishments, is most effectively repressed by close supervision. It is tolerant of guidance, but not of the goad; and yet, on the whole, perhaps, both guided and driven, if this is done wisely, it accomplishes most, for in harness it becomes plodding research, which is dull, to be sure, but if persevering, productive of cumulative results which become of incalculable importance. In fact, whether fortunately or unfortunately I shall not attempt to say, the world has come to recognize the slow, but sure progress of research as in the main more desirable than the irregular and intermittent leaps of genius, though the two are closely akin—patient labor over endless facts on the one hand, and broad observation and untrammeled thought on the other.

If, everything considered, it is slow and persistent investigation, rather than sudden inspiration, to which we must look for the accomplishment of the greatest collective results in botany, it is equally true that the individual student is more likely to build his reputation on the summation of the small accomplishments of many days of close application than to arrive at some great discovery by a leap—and this quite aside from the fact that the latter result is entirely impossible to many a man who in the other way may still hope to be of great utility. It has been said that there is a tide in the affairs of men, which, taken at the flood, leads on to fortune, and no doubt what is true in the military, literary and commercial world is equally true in the smaller realm of science. In fact, I fancy that each member of my audience has in mind some one preëminent occasion which may have looked small or large at the moment, but the seizing or neglect of which he now sees marked a turning point in his scientific career. But, it will be seen, it is not of the one great opportunity that I would now speak. Improving it always has marked and always will mark the turning point of life, but unfortunately the bridge cannot be crossed before it is reached, and great as the value of a true and wise friend's counsel then is, it cannot be replaced by any generalities in advance; therefore it is to the countless lesser opportunities, repeated with almost every day that dawns for us, that I turn, in the hope that something helpful may be said of them, and in the firm belief that in them lies the making of any intelligent and indefatigable young man.

To the investigator, breadth of foundation is even more necessary than to the institution founded for his use, for while the latter should endure for centuries, and may be remodeled and improved at any time, he is limited to a single lifetime and can rarely in mid-life or later repair the deficiencies of ill-advised or defective training. Not only should his powers of observation be well developed, but he should be given more discipline in reasoning than is now customary—though the botanists of a generation ago counted among their number several men who are even more widely known as philosophers.

Equipped for the work, and enabled to use the material facilities that others have brought together against the day of his need, much depends on an early and wise formulation of the investigator's plans. Except for the tasks set by a teacher, and really long contemplated by him and carried out by his intelligence, if through the eyes and hands of pupils, few pieces of valuable research are taken up on the spur of the moment, without previous thought on the part of the investigator. They are usually the outgrowth of reflection started, perhaps, by some casual observation or the remark of another, and turning and returning until it ultimately shapes itself into a definite plan. Simple as it may be in theory, few things are more difficult in practice than the formation and inception in early life, inexperienced, and often without certainty of the power of continuance for any length of time, of a plan for a single piece of research work worthy of the devotion of a lifetime; and few and fortunate are the men, even among those who have outlined and entered upon such a task, who are not forced from the path by side issues, or whose lives are not unduly short. More commonly one must be content to choose several smaller subjects, for their own sakes somewhat closely related to one another, if possible, and to follow these up in succession. It is surprising how blind even the sharpest-eyed among us are to all that does not directly interest us, and it is an equal surprise to see how quickly one's eyes open to things which he has once begun to think of and look for. If for no other reason than this, I would again urge breadth of early training, as giving the first impulse to many a series of special observations to be followed up in later life.

Once a subject is chosen, observations accumulate with surprising rapidity, and next to the selection of a subject nothing is so important as system in pursuing it. If we do not see it in ourselves, each one of us can see in others a great waste of energy, resulting from shiftless and ill-considered methods of procedure, by which the mind is so distracted and the memory so overloaded with unessentials and dissociated fragments that those which belong together are not matched, nor the missing bits, in plain view, gathered. How often do we have to return, time after time, and review partial work that we have had to dismiss temporarily from the mind, in which, meantime, has been lost the connection between the completed portion and the continuation awaiting our leisure. A phenomenal memory may enable one to work in this disjointed fashion without the production of scrappy results or the review of all that has been done each time that the task is resumed ; but for those not so gifted, order and method are absolutely necessary, and next to a clear idea of the end aimed at, I should place the immediate making of full and exact notes as their most essential part. Some years since I was privileged to assist Dr. Gray in collecting and republishing the botanical writings of Dr. Engelmann, and it was a matter of surprise to us both, as it has been to others, to see how voluminous these were. Had Dr. Engelmann devoted his entire life to botany, they would have been as creditable in quantity as in quality, but for the leisure-hour productions of a busy professional man, they were truly marvelous. Some years later, when, his herbarium and library having found a resting place at the botanical garden in the development of which he had felt an interest for many years, it fell to my lot to arrange in form for permanent preservation Dr. Engelmann's manuscript notes, sketches, etc., I was far more surprised at the extent of these than I had been on collecting his printed works, for when mounted and bound they form sixty large volumes. In addition to their intrinsic value, these are of more than usual interest as showing the methodical manner in which Dr. Engelmann worked. On his table seems to have been always a bundle of plants awaiting study. As each specimen was examined, its salient features were noted and sketched on the back of an ever-ready prescription blank. When interrupted, he laid his unfinished sketch away with the specimen, to resume his observation and complete his study at the first opportunity, without any doubt as to what had been seen in the first instance. And so from individual to variety, from variety to species, from species to genus, and from genus to family, his observations were preserved in memoranda that facilitated the resumption of interrupted work at any time and after any lapse of time. In no other way could the odd moments between the daily calls and occupations of a busy physician have contributed so much to botanical knowledge. In no other way could his seemingly small opportunity for investigation have been converted into a great one.

Almost as important as the early selection of a worthy subject for study and the adoption of a method insuring the preservation and use of even the most trivial information bearing on it, is the adoption of suitable library methods. The student whose specialty is small and little explored has mainly the task of observing and reasoning from the facts before him; but in the departments that have long been the subject of study, while a part of the work is already done to his hand, and the prospect is that he can go much further than on entirely new ground, the task of ascertaining and profiting by what his predecessors have done is often a difficult one. Not infrequently the literature of a subject is so scattered as to make it next to impossible to pass it all in review, and at best the task of finding the fragments is one calling for a special faculty. One or more attempts have been made to form general bureaus of scientific information, to which one need only turn if he would be possessed of references to the principal literature of any subject in which he chanced to be interested. Perhaps, as library facilities accumulate at the great centers of research, some method may be found of supplementing them with the skill of expert librarians who shall be able and willing to carry the contents of the library, at least in skeleton form, to those who cannot come to it; but the time has hardly yet come when any American library is complete enough in all branches to offer this aid with a reasonable chance of doing what it promises, or so manned as to make such assistance possible except at the sacrifice of more valuable direct research.

For the present, then, the investigator must be content to do his own delving into the literature of his predecessors. Fortunately, much of the earlier literature has been sought out by some of the writers on any branch that has been the subject of earlier study, so that, starting with a memoir of recent date, one is guided to others, each of which may bring further references, until, if he have access to the works, almost the entire earlier literature is unearthed. On the other hand, the most recent literature of a subject is always the most difficult to find and use. After a study has been gotten well under way, so that the student is keenly alert to every observation or published item in any way bearing on it, if he have access to a library receiving the principal current journals, he is not likely to overlook any important publication on his specialty which then appears. As a rule, all of the larger papers, at least, are noticed in *Just's Jahresbericht*, generally not more than a year later than that for which the volume purports to be compiled; but as the *Jahresbericht* is always some three years in arrears, it is difficult to prevent notes extending over a period of this duration from being defective, at least for the earlier part of the time, and there is, at present, no means of removing this difficulty, though the plan proposed to zoologists a year ago, and, I presume, tested during the present season, if successful, would be equally applicable to botany.

So far as the final result is concerned, perhaps the manner in which one's work is published is almost as important as the subject selected or the method adopted for its investigation. Alphonse De Candolle, in one of the most helpful treatises ever published in the hope of rendering botanical work methodical and productive,* lays a great deal of stress on the early selection of a form of publication for the results of each important study. This done, the work continually shapes itself to this end. Frequently there is much difficulty in securing the publication of a monograph or memoir in precisely the form and place desired by the author, but there is seldom an insuperable obstacle in the way of publishing any really meritorious work in about the manner wished, provided it is suitably prepared.

In general, it is desirable that works of a given class should be so published that, in seeking one, a reader is likely to learn of another. This appears less important for books than for shorter papers, since the arrangement of independently issued volumes in a library, and the fact that they are catalogued by authors, render it relatively easy to learn of and have access to them; but even here one finds no little convenience in the recognition that a book by a given author on a given subject is quite likely to be listed in the catalogue of a certain publishing house. Smaller papers, which are usually published in the proceedings of some society, or in a scientific journal, may almost be said to be made or ruined by the place selected for their publication. Probably as library facilities increase and are more thoroughly classified and subject-indexed, this will become less true than it now is, though the underlying reason for it will remain. Usually a reader turns to the popular journals only when looking for popularized science, and is not likely to seek the original results of research there, so that such papers are nearly or quite lost for a long time if published in these journals. As research has now become specialized, the journals devoted to the publication of its results have gradually fallen into line as special journals. Except where they are chiefly devoted to digests and abstracts, few nominally general journals now exist which do not lean so strongly toward a specialty that one unconsciously classes them with it, notwithstanding the extraneous matter that they contain. While nothing once published is ever absolutely lost, all of this extraneous matter is likely to be overlooked by the persons most interested in the subjects considered. No small part of the present confusion and strife in botanical nomenclature arises from the comparatively recent unearthing of descriptions and names of plants published in such improbable or inaccessible places as to have escaped the attention of those whom they might have helped most, to be brought to light at a later date as great mischief makers. From now on, then, it may be concluded that a decreasing number of special papers are likely to be published in general journals, which will become more and more popular or bibliographic in their nature, with the exception that the necessarily slow differentiation of learned societies into special sections will for a long time cause the proceedings of many of the older to continue of the most miscellaneous character. Where papers are lengthy, though not adapted to publication in book form, such proceedings virtually offer the only means of printing them, and except by the comparatively few botanists who enjoy the privilege of membership in purely botanical societies with publishing facilities, they must be accepted for the present, notwithstanding the attendant disadvantages. Shorter papers, however, can usually find room in the journals, and except in cases where they possess a temporary and exceptional value for the columns of a popular or general journal, or one devoted to another subject to which in some manner they are relevant, they are best published in a periodical devoted exclusively to botany, and

* La Phytographie, ou l'art de décrire les végétaux considérés sous différents points de vue. Paris, 1880.

in most cases in one devoted as closely as may be to their particular branch of botany, provided it have a fair general circulation, and especially provided it reach the principal botanical libraries.

Especially in the earlier years of their work writers are sometimes given to distributing their papers among a number of journals. Except for the purpose of specialization just referred to, this is usually a mistake. Knowledge that a certain student has published on a given subject is often first obtained through incidental reference, lacking every element of precision. The probability that all of his writings are to be found in one or a few journals or series of proceedings greatly simplifies the completion and use of such references, since the *Royal Society's Catalogue*, though perhaps more complete as to titles, is necessarily even farther behind than the *Jahresbericht*. Where the subject of an earlier paper is again passed in review by the author, only the gravest necessity should lead to the selection of a new medium for the publication of the later paper.

Whether the medium of publication selected or accepted be a journal or the proceedings of a society, the possibility of having separates struck off for the mere cost of press work, paper and stitching, makes it possible for almost any paper to appear as an independent pamphlet, accredited, to be sure, to the journal from which it is an excerpt, but, like a book, necessitating author's citation in catalogues, and admitting of more ready arrangement in its proper place where the works of a library are disposed on the shelves according to subject. The time was when a pamphlet was considered of little value and quite certain not to be preserved, but one of the characteristics of the modern librarian is a great and growing appreciation of the value of this class of works, leading to their careful preservation.

No small part of the volume of M. De Candolle, already referred to, is devoted to very explicit and well considered directions for preparing the record of one's observations for the press; and the general conclusion is reached, after a careful analysis of the subject, that the maximum value of any manuscript exists at the exact moment of its completion, indicating this as the most suitable time for its publication. Though it is probable that the publishing of any important work should not be unnecessarily delayed after it has been pushed to what the author considers completion—at least so far as he can carry it,—there may be reasons in some cases for publishing a preliminary statement considerably in advance of the completion of the work. Neglecting the publication of an early abstract of unfinished work as a means of securing priority—too often a purely personal matter—I may say that such abstracts, coupled with a request for material or data, not infrequently bring to the advanced student the means of greatly increasing the completeness and value of his work.

Time does not permit me to go into a detailed analysis of the many ways in which an investigator may use his time so as to make it productive of important results for himself and others. Having passed in somewhat comprehensive, though hasty, review, the main factors in the question, I desire, in closing, to repeat that for most of us the opportunity of life does not lie in a great and abrupt change of condition, but that it is composed of countless minor chances which are great only when viewed collectively. To see and use them calls for alert senses, a knowledge and use of the means of ascertaining what has already been done, and, by exclusion, something of what remains to be done, facilities adequate to the task in each case, and indomitable perseverance and ceaseless activity. Great as the value of facilities is, they are merely means to an end. They accomplish nothing themselves. Hence, though it is certain that the most voluminous and, perhaps, the most comprehensive results, and those resulting from the performance of coherent experiments extending through a long series of years, will come from the great centers of research, there is no reason why qualitative results equal to the best may not continue to come, as they have in the past, from isolated workers, to the rounding out and completion of whose studies the facilities of the larger institutions will be more and more applicable as the problems of equipment are worked out.

William Trelease.

Botanical Garden of Missouri.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SECTION E.—GEOLOGY AND GEOGRAPHY.

Section E of the American Association this year virtually included the Geological Society of America. The latter organization held only a short meeting for routine business on the Saturday evening previous to the meeting of the American Association, and referred all its papers to Section E of the A. A. A. S. The total number of papers offered in Section E was 42. The last day of the meeting the Section was divided into two subsections, one dealing with Pleistocene Geology, and the other taking the remainder of the field of the science. Even with this division, the time did not suffice for the full reading of all the papers, and a considerable number of papers whose authors were absent were read by title. While none of the papers recorded any discoveries of epoch-making significance, nearly all of them contained the results of solid and valuable work, contributing, in an important degree, to the advancement of science.

The following is a list of the papers presented:—

Notes on the Artesian Well sunk at Key West, Florida, in 1895. By Edmund Otis Hovey.

The Hydraulic Gradient of the Main Artesian Basin of the Northwest. By J. E. Todd.

The true Tuff-beds of the Trias, and the mud enclosures, the underrolling, and the basic pitchstone of the Triassic Traps. By B. K. Emerson.

Volcanic Ash from the North Shore of Lake Superior. By N. H. Winchell and U. S. Grant.

The "Augen-gneiss," Pegmatite Veins, and Diorite Dikes at Bedford, Westchester Co., N. Y. By Lea McI. Luquer and Heinrich Ries.

The Tyringham (Mass.) "Mortise Rock," and Pseudomorphs of Quartz after Albite. By B. K. Emerson.

The Succession of the Fossil Faunas in the Hamilton group at Eighteen Mile Creek, N. Y. By Amadeus W. Grabau.

Development of the Physiography of California; Synopsis of California Stratigraphy. By James Perrin Smith.

Ancient and Modern Sharks, and the Evolution of the Class. By E. W. Claypole.

Observations on the Dorsal Shields in the Dinichthyids. By Charles R. Eastman.

The Discovery of a new Fish Fauna, from the Devonian Rocks of Western New York. By F. K. Mixer.

Interglacial change of course, with gorge erosion, of the St. Croix River, in Minnesota and Wisconsin; The Cuyahoga Preglacial Gorge in Cleveland, Ohio. By Warren Upham.

A Revision of the Moraines of Minnesota. By J. E. Todd.

Notes on certain Fossil Plants from the Carboniferous of Iowa. By Thomas H. Macbride.

Origin of the High Terrace Deposits of the Monongahela River. By I. C. White.

The making of Mammoth Cave. By Horace C. Hovey.

The Colossal Cavern. By Horace C. Hovey.

James Hall, Founder of American Stratigraphic Geology. By W J McGee.

Professor Hall and the Survey of the Fourth District. By John M. Clarke.

Sheetflood Erosion. By W J McGee.

Glacial Flood Deposits in the Chenango Valley. By Albert P. Brigham.

Origin of Conglomerates. By T. C. Hopkins.

Origin of Topographic Features in North Carolina. By Collier Cobb.

The Cretaceous Clay Marl Exposure at Cliffwood, N. J. By Arthur Hollick.

Post-Cretaceous Grade-Plains in Southern New England. By F. P. Gulliver.

The Algonquin River. By G. K. Gilbert.

The Whirlpool-Saint David's Channel. By G. K. Gilbert.

Profile of the bed of the Niagara in its Gorge. By G. K. GILBERT.
The Niagara Falls Gorge. By GEORGE W. HOLLEY.
Origin and Age of the Laurentian Lakes and of Niagara Falls. By WARREN UPHAM.
Correlation of Warren Beaches with Moraines and Outlets in Southeastern Michigan. By F. B. TAYLOR.
Notes on the Glacial Succession in Eastern Michigan. By F. B. TAYLOR.
The Operations of the Geological Survey of the State of New York. By JAMES HALL.
The Eocene Stages of Georgia. By GILBERT D. HARRIS.
The Origin and Age of the Gypsum Deposits of Kansas. By G. P. GRIMSLEY.
Geomorphic Notes on Norway. By J. W. SPENCER.
The Slopes of the Drowned Antillean Valleys. By J. W. SPENCER.
Notes on Kansan Drift in Pennsylvania. By E. H. WILLIAMS.
Preliminary Notes on the Columbian Deposits of the Susquehanna. By H. B. BASHORE.
Pre-Cambrian Base-leveling in the Northwestern States. By C. W. HALL.

The address of the Vice-President, Prof. B. K. Emerson, has been published in full in this JOURNAL, and requires, therefore, only brief reference here. It was a remarkably bright and interesting address, and was listened to with delight by a large audience.

Two sessions of the Section were occasions of especial interest, dependent in one case upon the time, and in the other upon the place, of the meeting. The former of these sessions, occurring on Wednesday afternoon, was devoted chiefly to exercises in commemoration of the sixtieth anniversary of Prof. James Hall's work on the Geological Survey of the State of New York. It is, indeed, a fact well worthy of commemoration, that the great geologist who is now at the head of the New York Survey, has completed a period of sixty years of continuous service, and still possesses a physical and mental vigor which promises years of fruitful work in the future. In some respects, the survey of the State of New York has been of more importance in the history of American geology than that of any other part of the country. The remarkably complete exhibition of the Paleozoic strata in that state, the relatively early date of the commencement of their study, and the sagacity with which the true principles of stratigraphical classification were conceived by Prof. Hall and his associates, have made the State of New York the standard of comparison in the study of Paleozoic formations for the whole region of North America east of the Cordillera. The work of Prof. Hall holds, therefore, a relation to the stratigraphical geology of North America somewhat similar to that which the work of William Smith in England holds to the general stratigraphical geology of the world. The New York Survey has a special interest for the members of the American Association, by reason of the fact that the Association of American Geologists, first organized by the State Geologists of New York and a few other states, was the germ which developed into the American Association for the Advancement of Science. The exercises were introduced by Vice-President Emerson in a brief and appropriate address. Prof. Joseph Le Conte, President of the Geological Society of America, spoke in behalf of that Society with rare eloquence. Prof. Hall responded gratefully to the congratulations of his fellow geologists. The papers by W J McGee and John M. Clarke, in which was given an appreciative history of Prof. Hall's work, were worthy of their theme. A letter of congratulation was read from Dr. George M. Dawson, Director of the Geological Survey of Canada; and appropriate remarks were made by a number of gentlemen who, in various ways, had been associated with Prof. Hall and his work. The meeting, as a whole, was an appropriate and worthy commemoration of an epoch-making work.

The other occasion of especial interest

was the meeting of the sub-section of Pleistocene Geology on Friday afternoon, when the papers were read relating to the history of Niagara Falls. Mr. Gilbert's three papers were of extraordinary interest. In the paper on the Algonquin River, evidence was given of an outlet of Lake Algonquin, heading at Kirkfield, Ontario, and following the Trent River to Lake Ontario. This outlet for the drainage of the upper lakes belonged to an earlier date than the outlet through Lake Nipissing and the Ottawa River. There is, therefore, evidence of two epochs, after the birth of the Niagara River, in which it lost the waters of the upper lakes, and was reduced to the condition of an outlet merely for the Erie basin. In the paper on the Profile of the Bed of Niagara in its Gorge, evidence was given to show the correlation between these epochs of low water and the excavation of particular parts of the gorge. In the swifter and more turbulent parts of the Niagara, a determination of the depth by sounding is, of course, impracticable; but an approximate estimate of the depth has been reached indirectly by determining the velocity of the water, since obviously the same volume of water must pass in a unit of time through every cross section of the gorge. The Niagara gorge shows two stretches of narrow and shallow channel, in which the current is swift and tumultuous, one extending from the railroad bridges to the Whirlpool, the other extending for some distance below Foster Flats. The latter was apparently excavated during the low-water epoch in which the drainage of the upper lakes was through the Algonquin River, while the former is correlated with the later epoch in which the upper lakes discharged their waters by way of Lake Nipissing and the Ottawa River. In the discussion of Mr. Gilbert's papers, Mr. F. B. Taylor gave important confirmation of the views advanced in regard to the history of Niagara, derived from his investigations upon the history of the lakes.

In his paper on the Whirlpool-St. David's Channel, Mr. Gilbert presented evidence for the belief that that channel was excavated in preglacial times to a depth below the present level of the Niagara River. The outcrops of rock in Bowman's Creek were explained as due to the fact that Bowman's Creek is not in the middle, but at one side, of the ancient preglacial channel. The evidence of a deep, continuous channel between the Whirlpool and St. David's is acknowledged to be incomplete, since none of the wells in that region are in the line of the middle of the channel, and none of them, therefore, reveal its full depth.

In the discussion of this paper, Prof. I. C. White suggested that at moderate expense an experimental boring could be made in the direct line between the Whirlpool and St. David's, and the question of the existence of a deep channel in that vicinity conclusively settled. The suggestion was favorably received, and a committee, consisting of Prof. White and Messrs. Gilbert and Spencer, was appointed to carry out the proposed investigation. Subscriptions of twenty-five dollars each towards the expense of the investigation were made by Prof. White, Prof. H. S. Williams, and Mr. F. B. Taylor.

Besides the papers relating to Niagara, a number of other interesting papers relating to Pleistocene Geology were presented. Mr. F. B. Taylor, in his paper on the Glacial Succession in Eastern Michigan, described a series of fifteen terminal moraines between Cincinnati and the Straits of Mackinaw, and pointed out interesting correlations between the Quaternary history of Michigan and that of western New York.

Mr. Warren Upham, in his paper on the St. Croix River, gave evidence that in preglacial times the upper St. Croix River left the present St. Croix valley near the mouth of the Sunrise River, and emptied into the Mississippi between Anoka and Minneapolis, while the lower St. Croix Valley was occupied only by the waters of the Apple River. The intermediate portion of the present St. Croix River, including the picturesque gorges called the Dalles, is attributed to the Aftonian and Wisconsin stages of the Glacial period. In his paper on the Cuyahoga Preglacial Gorge, Mr. Upham presented evidence that that valley was deeper than had been indicated by facts previously known, new reports of wells giving a depth of 350 to 470 feet below the surface of Lake Erie.

Prof. J. E. Todd gave an interesting review of the Moraines in Minnesota. These moraines were mapped by Mr. Upham as extending east and west in nearly straight lines without regard to the topography of the country. Such a position seems *a priori* improbable; and, according to Prof. Todd's observations, the morainic accumulations may be considered as forming a series of concentric curves around lobes of the ice sheet.

Prof. I. C. White, in his paper on the High Terrace Deposits of the Monongahela River, attributed them to a Monongahela Lake, made by the ice sheet damming up the Monongahela River, whose outlet in preglacial time was northward into the Erie basin. In the discussion of this paper, Mr. Gilbert called attention to the remarkable fact that the two main tributaries of the Mississippi, the Ohio on the east and the Missouri on the west, are both in large part streams of postglacial origin.

While the subject of Pleistocene Geology occupied a large part of the attention of the Section, other departments of geology were by no means neglected. Dr. E. O. Hovey gave an interesting account of an artesian boring at Key West, Fla., reaching a depth of 2000 feet. The boring was in limestone for the whole distance, although the rock exhibited considerable variation in texture. By the evidence of characteristic fossils, the summit of the Vicksburg formation was recognized 700 feet below the surface.

Prof. I. E. Todd presented interesting data from the numerous artesian wells in Dakota and the adjacent regions, whose abundant water supply is derived from the Dakota formation. In general, the water pressure in these wells is found to diminish eastward, but with local variations which it is by no means easy to explain.

Rev. H. C. Hovey, D. D., presented a paper on the Making of Mammoth Cave, which he attributed purely to the solvent action of water upon the limestone. Neither seismic disturbance, nor a supposed pot-hole action in the deep pits or depressions of the cave, can be considered to have had any considerable effect. Many measurements were given of different parts of the cave, which Dr. Hovey and his associates have most thoroughly explored. Dr. Hovey also described a newly discovered cave called the Colossal Cave.

Mr. W J McGee's paper on Sheet-flood Erosion called attention to the remarkable conditions existing in Papagueria, a district lying in southwestern Arizona and western Sonora, where an extensive area between mountain ranges has been planed off by the erosive action of water, and veneered with a thin sedimentary deposit. The erosion and deposition are due, not to streams concentrated in definite channels, but to the flowing of waters in broad sheets over the region after violent rains.

Prof. B. K. Emerson, in his paper on the Tuff Beds and other features of the Connecticut Valley Trias, called attention to some very remarkable phenomena. In some localities the broken surface of the extrusive trap sheets, with the calcareous or arenaceous deposits mingled with the trap, has been rolled under in the onward flow of the trap, so that the same phenomena appear both at the top and bottom of the trap sheet. In certain localities the wet mud of the estuary bottom, over which the trap sheet flowed, has risen up into the trap, presenting an appearance very similar to that of true tuff beds. In these cases portions of the mud have been metamorphosed into a quartzite, and portions of the molten material of the trap, chilled by the ascending currents of mud and water, have solidified into a pitchstone or tachylite.

Prof. N. H. Winchell reported the discovery of fragmental volcanic deposits near Duluth, although no remains of craters had been recognized. It is remarkable that, amid the abundant interbedded igneous rocks of the Lake Superior region, only one find of fragmental volcanic deposits had hitherto been reported.

Prof. J. Perrin Smith gave a lucid account of the Physiography of California, illustrating it by a photograph of a relief map, which was projected on a screen. In discussing the causes of the present physiography, he dwelt especially upon the Tertiary and post-Tertiary uplifts and consequent erosion.

A number of interesting papers were presented in the department of Paleontology. Prof. E. W. Claypole's paper on Ancient and Modern Sharks gave an interesting account of the peculiarities of ancient sharks, as revealed by the recent discoveries of Dr. Clark and others in the Cleveland shale of northern Ohio. The remains referred to are remarkably well preserved, and throw much light upon the evolution of the Elasmobranchs.

Dr. C. R. Eastman gave a very interesting paper on the Dorsal Shields of the Dinichthyids. The median dorsal plate in these fishes bears a keel, which is comparatively slightly developed in Coccosteus, but attains a greater development in other genera of the group, reaching its maximum in Dinichthys and closely related genera, in which it is produced backward far beyond the margin of the plate. This keel is believed to serve for the attachment of muscles for swimming. Dinichthys livonicus, from Russia, first described by Pander as a species of Coccosteus, is the smallest and earliest species of Dinichthys, and the one most resembling Coccocteus. A comparison of the different species of Dinichthys shows that, as the genus moved westward from its starting point in eastern Europe, the species increased in size and in differentiation.

Mr. F. K. Mixer gave an account of recent discoveries of fossil fishes in the Hamilton and Portage formations of western New York. The discoveries indicate in the Portage of that region an abundant and varied fish fauna, including groups so diverse as those represented by Dinichthys, Holoptychius and Palæoniscus.

Mr. A. W. Grabau gave a detailed account of the succession of fossil faunas in the Hamilton group at Eighteen Mile Creek, near Buffalo. The comparison of the succession of faunas at Eighteen Mile Creek with that shown in the salt shaft at Livonia reveals a very interesting instance of migration, since the shale beneath the Encrinal Limestone at Eighteen Mile Creek contains essentially the same fauna found in a shale above the Encrinal Limestone at Livonia.

Prof. A. Hollick gave an account of the exposure of Cretaceous clay marl at Cliffwood, N. J. The fossils from this locality are poorly preserved, but are of great interest as marking a transition from the estuarine conditions of the Amboy clays to the marine conditions of the overlying marls. The deposit is considered to represent the Mattawan formation of Prof. W. B. Clark.

Prof. T. H. McBride exhibited microscopic sections of remains of Sigillarids and Conifers from the Carboniferous of Iowa.

The remains are so exquisitely preserved as to throw much light upon the nature of the Carboniferous flora.

In recent years a very important part of the work connected with the meeting of Section E and the summer meeting of the Geological Society has been in the line of excursions, under expert guidance, to interesting geological localities in the vicinity of the meeting. The geological excursions connected with the present meeting have been on a more extensive scale than ever before. For the week preceding the meeting of the Associotion, four excursions in different parts of the State of New York were proposed, but only two of them were carried out.

An excursion for the study of Pleistocene Geology commenced on Monday, August 17th, at Rochester, N. Y., under the direction of Prof. H. L. Fairchild. Monday was spent in the study of the phenomena of Lake Iroquois, in the vicinity of Rochester, and the kame moraine of the Pinnacle Hills. On Tuesday the party visited the high beaches lying east of the Genesee valley, arriving at Mount Morris for the night. On Wednesday the party visited the "High Banks" of the Genesee, near Mount Morris, and the Portage Falls, with the terraces above them, and the water-leveled drift which blocked the old valley. The night was spent at Portage. Thursday was spent in studying the beaches and moraines between Alden and Crittenden. Mr. Frank Leverett had intended to conduct the party the latter half of the week, but on account of sickness was unable to do so. The party accepted the invitation of Mr. B. W. Law to visit his home in the Cattaraugus valley; and Friday was spent in the study of the preglacial and postglacial channels of Cattaraugus Creek, the Warren glacial lake fillings, and the beaches at Eden Valley and Hamburg.

Another excursion, devoted especially to the study of Petrographic Geology, commenced on Monday, August 17th, at Port Henry, on Lake Champlain, under the direction of Prof. J. F. Kemp. Monday was spent in the study of the crystalline limestones, and the gabbros with their remarkable gneissoid modifications, in the immediate vicinity of Port Henry, and the great mines of magnetite at Mineville. Tuesday the party went by steamboat to Plattsburgh, studying on the way the titaniferous magnetites at Split Rock Mine and some of the numerous dikes along the shore. On Wednesday the party went by rail to Ausable Forks, and thence by stage through the Adirondacks to Lake Placid, passing through the magnificent fault valley of Wilmington Notch, and along the eastern foot of Whiteface Mountain. Thursday and Friday was spent at Gouverneur, under the direction of Prof. C. H. Smyth, Jr. The party studied the gneisses which form the prevalent rocks in the region, some of which seem to be granite dynamically metamorphosed, while others appear to have more the character of metamorphosed sediments. The crystalline limestones with their remarkable enclosures, the talc mines, the danburite locality in the town of Russell, and a remarkable instance of dynamic metamorphism in gabbro, were also studied.

During the meeting of the Association, the afternoon of Thursday was occupied by an excursion to Eighteen Mile Creek, and a study of the fossiliferous rocks, under the direction of Mr. Grabau, whose paper on the subject has been already mentioned.

Monday and Tuesday of the week following the meetings were occupied by an excursion for the study of the problems of Niagara, under the direction of Mr. G. K. Gilbert. The first day the party visited the Whirlpool, recognized the drift on the bank of the stream at that point as unmistakably in situ, climbed up through the ravine of Bowman's Creek, visited the remarkable precipice at Wintergreen Flats (where a small branch of the river seems once to have made a cascade like the present American Fall) and recognized in the gorge the alternation between the broad and deep stretches of quiet water, corresponding to the high-water epochs during the erosion of the gorge, and the narrow and shallow stretches with swift and tumultuous current, corresponding to the low-water epochs. On Tuesday the route led over the supposed buried channel to St. David's ; and the party proceeded thence along the edge of the escarpment to Queenstown, returning, at the close of the day, from Lewiston to Niagara Falls by the railway in the gorge.

William North Rice,
Wesleyan University. *Secretary.*

SECTION H.—ANTHROPOLOGY.

The Section of Anthropology at the Buffalo meeting, American Association for the Advancement of Science, August 23d–28th, met on Monday morning for the transaction of the usual business, in addition to which it was this year necessary to elect a Secretary, because of the death of Capt. J. G. Bourke, who was chosen at the Springfield meeting. The place was filled by the election of G. H. Perkins, of the University of Vermont. In the afternoon the address of Miss A. C. Fletcher, Vice-President of the Section, was read, a most interesting, suggestive and valuable contribution to our knowledge of the religious ideas of the Dakotan peoples. Its subject was 'The Emblematic Use of the Tree in the Dakotan Group.' This address will be published in full in Science.

On Tuesday morning Section H, as was the case with all the Sections, settled down to the regular reading of papers. The programme of this and the following days was made far more orderly and helpful than it has been heretofore by reason of certain preliminary arrangements. A provisional programme had been arranged before the opening of the session, which was possible because, through the energy of the Vice-President, notice of the meeting and request for early sending of abstracts of papers which members intended to present had been sent to all those especially connected with the Section. The response to this request had been so hearty that the provisional programme required very little change as it was used from day to day. Another and convenient change was the arrangement of all papers, the titles of which had been received, under various headings, as Archæology, Ethnology, Somatology, and assigning one or more sessions to each heading. In this way, although absolute order could not be brought about because of the late arrival of authors and for other reasons, a reasonable degree of unity in the papers presented at each session was secured, very greatly to the advantage of both hearers and readers.

A large number of papers were offered to the Section, most of which were read, occupying all the time up to the last day of meeting. The quality of the papers was fully equal to that at previous meetings, and at adjournment the members of Section H agreed that a very profitable and enjoyable session had been held. The courtesy and good humor which prevailed during all the numerous discussions was noticeable. Many of the papers presented opinions with which all could not agree, but differences of opinion were always expressed in a most kindly manner. It is to be remembered that space allows no account of these discussions and that the papers are reported simply as presented by the authors and give only their views of the question treated.

It is also to the credit of the Section of Anthropology that it is the only Section which has recognized the justice of giving equal honor for equal work to woman as to man, and that a woman who has done good work in the department which the Section represents is as fully entitled to recognition as a man. Years ago it elected a woman as its Secretary, and this year it honored itself in honoring Miss Fletcher by conferring upon her the position of presiding officer. And surely well deserved recognition of long and most important service in behalf of anthropology was never more satisfactorily bestowed than in this case. It is not flattery to say that no one could have presided over the meetings or attended to all the various duties which come to such a position with greater grace, fidelity or dignity, and it was well fitting that at the closing session a very hearty expression of appreciation of the delightful and efficient manner in which Miss Fletcher had filled her office should have been given by a rising vote.

Before the regular reading of papers a time had been set apart for the presentation of a resolution and a memorial concerning the late Capt. J. G. Bourke. On behalf of the Sectional Committee, W J McGee offered the following:

WHEREAS, This Section, the Association, the Nation and the scientific world have sustained an immeasurable loss in the death of John G. Bourke, scientist and soldier, and,

WHEREAS, The loss is peculiarly painful in the Section of Anthropology, to which he brought honor, long as a working member and later as Secretary; therefore,

Resolved, That this Section here assembled join in an expression of grief for the death, and of reverence for the memory of our associate and friend.

After the above had been read, Dr. D. G. Brinton read, in the absence of the author, a very appreciative and sympathetic memorial of Capt. Bourke, by his friend and fellow-laborer, Dr. Washington Matthews. Remarks expressing esteem for the work and character of our associate were made by Prof. Putnam, Prof. Perkins and Miss Fletcher, and the resolution was adopted by a rising vote.

The first paper on the programme was then read by Dr. H. C. Hovey, on 'Symbolic Rocks of Byfield and Newbury, Mass.' The author called attention to certain old monuments in colonial graveyards, and also to some milestones and stones in the foundations of some old houses which were carved in a manner wholly unlike that of Puritan monuments. The symbols upon these stones are pagan rather than Christian, being sun-disks, whorls, fleur-de-lis and rarely phallic signs. The masterpiece shows the sun god's bride, surrounded by symbolic invocations, and over all is delineated a rude sun-burst. Photographs were shown and reference was made to similar rocks in Ireland, Denmark and elsewhere.

The Secretary read for the author a brief paper by Mr. J. R. Chandler describing certain important ruins of Tzac Pokoma, Guatemala. These little known ruins are of very considerable importance and extent. "Numberless ruined temples, palaces, houses and walls are now visible." The ruins seem to be very ancient, and no sculptures or hieroglyphics have been found and very few implements.

Prof. Putnam read for Mr. C. C. Willoughby a very interesting 'Analysis of Decoration upon Pottery from the Mississippi Valley,' illustrated by numerous beautifully executed drawings. The author sought to show that much of the decoration was symbolic, the ornaments being religious in their nature.

Prof. G. F. Wright read a brief paper, in which he described a visit to the Lalor farm, near Trenton, N. J., where careful investigation revealed 'Fresh Geological Evidence of Glacial Man,' which was the title of his paper.

Prof. Putnam followed this paper with verbal statements as to the locality, methods of investigation and specimens found, many of which were exhibited, all going to corroborate the testimony given by Prof. Wright.

Prof. E. W. Claypole brought forward similar evidence from Ohio, with the exhibition of specimens, found in one case at a depth of 22 feet in gravel that apparently could not have been disturbed since glacial times.

With this closed the day assigned to Archæology, though other papers properly set for this time came later, through unavoidable conditions. On Wednesday, by recommendation of the Sectional Committee, a committee was appointed "For the purpose of advancing an acquaintance with the objects of Section H among both members and non-members." This committee consists of J. McK. Cattell, D. G. Brinton, Franz Boas.

Dr. D. G. Brinton presented the following:

WHEREAS, The influence which the environment of the New World has exerted upon the physical and mental development of the White Race is a question of the utmost scientific and practical importance, and,

WHEREAS, There appears to be no governmental or scientific bureau which is giving the subject attention at the present time; therefore,

Resolved, That the American Association for the Advancement of Science appoint a committee to organize an Ethnological Investigation of the White Race in the United States, with special reference to the influence exerted upon it in its new surroundings, said Committee to report annually.

According to rule this was, after adoption by the Section, referred to the Council by whom it was passed and the Section requested to nominate said committee. The Section did so, and by vote of the Council the following were appointed as such committee: D. G. Brinton, J. McK. Cattell, W. W. Newell, W J McGee, Franz Boas.

The programme of this day was especially given to Ethnology. Dr. McGee gave a very interesting account of a tribe of Indians, the Seri, living on Tiburon Island, in the Gulf of California, and exhibited specimens of their stone implements. He showed how very rude these people are in all their arts and conditions. His title was 'Seri Stone Art.'

This was followed by a carefully prepared paper by Horatio Hale on 'Indian Wampum Records.' The author referred to the use of wampum as money and as a method of recording events or transcribing messages. Wampum was used in very early times and by many peoples. This was an interesting and valuable paper.

Dr. Brinton read a paper on 'The Psychic Source of Myths,' which would have come on the following day, but the author being obliged to leave town it was read at this time. The author called attention to a common idea that by comparing numerous elements in different myths, and thus discovering that many are identical, a common origin is proved. But this method does not take into account the essential unity of the human mind, wherever it may be, and the laws which govern its activity. Because of the tendency of mind everywhere and in all conditions to act in the same manner we find myths of very similar sort in all parts of the world. Numerous examples illustrating this were given. Myths may, therefore, be very similar and yet very diverse in origin.

Dr. Boas then read a paper on 'The Limitations of the Comparative Method in Anthropology,' which will appear in full in SCIENCE.

Judge G. P. Thurston followed with a paper on 'Ceremonial Flint Implements and Shell Gorgets from Tennessee.' Most superb specimens of both classes of the objects named in the title were exhibited. No finer examples of aboriginal work have ever been found than these, both as to size and elegance of workmanship. On one of the circular gorgets was engraved a human figure, holding in one hand a head and in the other as a scepter or emblem a stone object, the duplicate of one exhibited.

Dr. W. M. Beauchamp gave a very careful account of 'Aboriginal Occupation of New York,' illustrated by a finely drawn map.

On Thursday the subject was Somatology and Psychology, but other papers were also read. Mr. Harlan I. Smith, in a paper on 'The Preservation of Local Archæological Evidence,' gave some very sensible and practical suggestions as to this subject. He also, in a following paper, gave a very interesting account of 'Ojibway Shamanistic Ceremonies' in treating sickness, and exhibited a bone tube used by the Shaman in sucking the diseased part in order to draw out the evil spirit.

Dr. J. McK. Cattell read a most suggestive paper on 'Physical and Mental Measurements of Students of Columbia University.' In this paper the importance of such investigation was shown, the methods employed and the results obtained.

Dr. Boas, in a paper on 'Anthropometry of the Shoshone Indians,' gave some interesting results from numerous physical measurements made among these people.

Mr. Haliburton gave an account of his studies upon dwarfs in a paper entitled 'Recent Discoveries as to Pygmy Races.' Pygmies as found in Guiana, Mexico, Honduras, Algeria, Spain and elsewhere were discussed and some interesting conclusions given.

'Onondaga Games' was the subject of a very interesting paper by Dr. Beauchamp, in which sundry games of ball, bone buttons, bow and arrow, etc., were briefly described.

Very peculiar ideas regarding time were described in a paper on 'Papago Time Concepts' by Mr. McGee.

A paper by Mrs. F. D. Bergen on 'The Theological Development of one Child' consisted of a curious account of the ideas of a child who was carefully guarded against receiving any teachings concerning spiritual matters until ten or twelve years old.

Miss Fletcher's valuable paper on 'Certain Beliefs Concerning the Will Power Among the Siouan Tribes' will be given to the readers of SCIENCE in full.

Mr. McGee's paper on the 'Beginnings of Zooculture' proposed an original and plausible theory to account for the domestication of animals.

Mr. W. W. Tooker presented a full discussion of the 'Meaning of the Name Manhattan,' to be published in the Brooklyn Almanac. He concluded that there was the best of evidence for believing Manhattan to mean 'The Island of Hills.'

At the close of Thursday's session, Mr. McGee, for the Sectional Committee, presented the following resolution:

WHEREAS, Horatio Hale, long an active member and at one time a Vice-President of this Association, has made contributions to Ethnology and Philology, entitling him to a place in the front ranks of American Anthropologists, and,

WHEREAS, It seems fitting that Mr. Hale's long and arduous labors in behalf of science should be recognized by the American Association for the Advancement of Science; therefore,

Resolved, That Section H recommend to the Council that Mr. Hale be made a Life Fellow of this Association.

This was adopted, and the Council received the recommendation and elected Mr. Hale a Life Fellow.

Friday was assigned to papers in General Anthropology. A paper from Mr. H. Saville on 'The Ruins of the Temple of Tepoztlan,' was read. These ruins, important for many reasons, are especially so as they are the only American ruins to which a definite date can be set. On one of two slabs in one of the walls is engraved the sign of Ahuizotl, the immediate predecessor of Montezuma, and on the other the date, ten Tochtli, which corresponds to 1502.

Other papers, of which no account can be given for lack of space, are: a long and most interesting account of 'Explorations in Honduras by the Peabody Museum,' given by

Prof. Putnam; 'Results of Recent Cave Exploration in the United States,' by H. C. Mercer; 'Kootenay Indian Place Names and Names of Implements,' by Prof. A. F. Chamberlain; 'Clan System of the Pueblos,' by F. W. Hodge. A very suggestive paper by Rev. Dr. Richert on 'Character and Food.' An account of 'Finland Vapor Baths,' by Mr. H. W. Smith, and an account of certain uses in religious ceremonies of the 'Mescal Plant,' by James Mooney.

The officers elected for next year for this Section are: *Vice President*, W J McGee, Washington, D. C.; *Secretary*, H. I. Smith, New York.

G. H. Perkins,
Secretary.

University of Vermont.

THE SOCIETY FOR THE PROMOTION OF AGRICULTURAL SCIENCE.

The seventeenth annual meeting of the Society for the Promotion of Agricultural Science was held at Buffalo, N. Y., in the Public Library Building, on August 21st and 22d. The meeting was the most successful one of recent years. Fifteen papers, on the following subjects, were read, most of the authors being present in person:

W. R. Lazenby. *Presidential address. The Relation of Science to Agriculture.*

A. D. Hopkins: On varieties of timothy and red clover.

Pollen-distributing insects observed on flowers of timothy and red clover.

V. A. Moore: The influence of animal experimentation upon agriculture.

C. C. Georgeson: Steer feeding experiments at the Kansas Experiment Station.

L. O. Howard: A biographical sketch of Dr. C. V. Riley.

B. M. Duggar (By invitation): *Sporotrichum globuliferum:* White muscardine of the chinch bug economically considered.

E. A. de Schweinitz: An anti-toxic serum for hog cholera and swine plague. The production of immunity to hog cholera by means of the blood serum of immune animals.

H. L. Bolley: The relation of the time of feeding and the period of development, to the development of rusts and smuts in oats. Also some further experiments on potato scab.

F. D. Chester: Protective inoculation against anthrax.

H. C. Irish (By invitation): Forcing cauliflower with lettuce and cucumbers.

W. A. Kellerman (By invitation): New experiments with fungicides for smuts of wheat and oats.

C. E. Bessey: A biographical sketch of Prof. C. L. Ingersoll.

F. Wm. Rane: Electro-Horticulture: range of incandescent lamps.

L. H. Pammel and F. L. Scribner: Notes on grasses collected between Jefferson, Iowa, and Denver, Colorado.

The old board of officers, composing the following persons, was reelected for the ensuing year: President, W. R. Lazenby, Ohio State University, Columbus, O.; Secretary and Treasurer, C. S. Plumb, Purdue University, LaFayette, Ind.; third member Executive Committee, L. O. Howard, Department of Agriculture, Washington.

C. S. Plumb,
Secretary.

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*BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

ADDRESS BY THE PRESIDENT TO THE MATHEMATICAL AND PHYSICAL SECTION.

There is a melancholy reminiscence connected with this meeting of our Section, for when the British Association last met in Liverpool the chair in Section A was occupied by Clerk-Maxwell. In the quarter of a century which has elapsed since that meeting, one of the most important advances made in our science has been the researches which, inspired by Maxwell's view of electrical action, confirmed that view, and revolutionized our conception of the processes occurring in the Electro-magnetic field. When the Association last met in Liverpool Maxwell's view was almost without supporters, to-day its opponents are fewer than its supporters then. Maxwell's theory, which is the development and extension of

*Liverpool meeting, beginning September 16, 1896.

Faraday's, has not only affected our way of regarding the older phenomena of electricity, it has, in the hands of Hertz and others, led to the discovery of whole regions of phenomena previously undreamt of. It is sad to think that his premature death prevented him from reaping the harvest he had sown. His writings are, however, with us, and are a storehouse to which we continually turn, and never, I think, without finding something valuable and suggestive.

'Thus ye teach us day by day,
Wisdom, though now far away.'

The past year has been rich in matters of interest to physicists. In it has occurred the jubilee of Lord Kelvin's tenure of the Professorship of Natural Philosophy at the University of Glasgow. Some of us were privileged to see this year at Glasgow an event unprecedented in the history of physical science in England, when congratulations to Lord Kelvin on the jubilee of his professorship were offered by people of every condition and country. Every scientific society and every scientific man is Lord Kelvin's debtor; but no society and no body of men owe him a greater debt than Section A of the British Association; he has done more for this section than any one else, he has rarely missed its meetings, he has contributed to the section papers which will make its proceedings imperishable, and by his enthusiasm he has year by year inspired the workers of this section to renew with increased vigour their struggle to penetrate the secrets of nature. Long may we continue to receive from him the encouragement and assistance which have been so freely given for the past half century.

By the death of Sir W. R. Grove, the inventor of Grove's cell, we have lost a physicist whose name is a familiar one in every laboratory in the world. Besides the Grove cell, we owe to him the discovery of the gas battery, and a series of researches on the electrical behavior of gases, whose importance is only now beginning to be appreciated. His essay on the correlation of the physical forces had great influence in promoting that belief in the unity of the various branches of physics which is one of the characteristic features of modern and natural philosophy.

In the late Prof. Stoletow, of Moscow, we have lost the author of a series of most interesting researches on the electrical properties of gases illuminated by ultra-violet light, researches which, from their place of publication, are, I am afraid, not so well known in this country as they deserve to be.

As one who unfortunately of late years has had only too many opportunities of judging of the teaching of science in our public and secondary schools, I should like to bear testimony to the great improvement which has taken place in the teaching of physics in these schools during the past ten years. The standard attained in physics by the pupils of these schools is increasing year by year, and great credit is due to those by whose labors this improvement has been accomplished. I hope I may not be considered ungrateful if I express the opinion that in the zeal and energy which is now spent in the teaching of physics in schools, there may lurk a temptation to make the pupils cover too much ground. You may by careful organization and arrangement ensure that boys shall be taken over many branches of physics in the course of a short time; it is indeed not uncommon to find boys of 17 or 18 who have compassed almost the whole range of physical subjects. But although you may increase the rate at which information is acquired, you cannot increase in anything like the same proportion the rate at which the subject is assimilated, so as to become a means of strengthening the mind and a permanent mental endowment when the facts have long been forgotten.

Physics can be taught so as to be a subject of the greatest possible educational value, but when it is so it is not so much because the student acquires a knowledge of a number of interesting and important facts, as by the mental training the study affords in, as Maxwell said, 'bringing our theoretical knowledge to bear on the objects and the objects on our theoretical knowledge.' I think this training can be got better by going very slowly through such a subject as mechanics, making the students try innumerable experiments of the simplest and, what is a matter of importance in school teaching, of the most inexpensive kind, but always endeavoring to arrive at numerical results, rather than by attempting to cover the whole range of mechanics, light, heat, sound, electricity and magnetism. I confess I regret the presence in examinations intended for school boys of many of these subjects.

I think, too, that in the teaching of physics at our universities, there is perhaps a tendency to make the course too complex and too complete. I refer especially to the training of those students who intend to become physicists. I think that after a student has been trained to take accurate observations, to be alive to those pitfalls and errors to which all experiments are liable; mischief may in some cases be done if he is kept performing elaborate experiments, the results of which are well known with the view of learning a knowledge of methods. It is not given to many to wear a load of learning lightly as a flower. With many students a load of learning, especially if it takes a long time to acquire it, is apt to crush enthusiasm. Now, there is, I think, hardly any quality more essential to success in physical investigations than enthusiasm. Any investigation in experimental physics requires a large expenditure of both time and patience; the apparatus seldom, if ever, begins by behaving as it ought; there are times when all the forces of nature, all the properties of matter, seem to be fighting against you; the instruments behave in the most capricious way, and we appreciate Coutts Trotter's saying, that the doctrine of the constancy of nature was never discovered in a laboratory.

These difficulties have to be overcome, but it may take weeks or months to do so, and unless the student is enthusiastic, he is apt to retire disheartened from the contest. I think, therefore, that the preservation of youthful enthusiasm is one of the most important points for consideration in the training of physicists. In my opinion this can best be done by allowing the student, even before he is supposed to be acquainted with the whole of physics, to begin some original research of a simple kind under the guidance of a teacher who will encourage him and assist in the removal of difficulties. If the student once tastes the delights of the successful completion of an investigation, he is not likely to go back, and will be better equipped for investigating the secrets of nature than if, like the White Knight in 'Alice of Wonderland,' he commenced his career provided with the means of measuring or weighing every physical quantity under the sun, but with little desire or enthusiasm to have anything to do with any of them. Even for those students who intend to devote themselves to other pursuits than physical investigation, the benefits derived from original investigation as a means of general education can hardly be over-estimated, the necessity it entails of independent thought, perseverance in overcoming difficulties, and the weighing of evidence gives it an educational value which can hardly be rivalled. We have to congratulate ourselves that through the munificence of Mr. Ludwig Mond, in building and endowing a laboratory for research, the opportunities for pursuing original investigations in this country have been greatly increased.

The discovery at the end of last year by Prof. Röntgen of a new kind of radiation from a highly exhausted tube through which an electric discharge is passing, has aroused an amount of interest unprecedented in the history of physical science. The effects produced *inside* such a tube by the cathode rays, the bright phosphorescence of the glass, the shadows thrown by opaque objects, the deflection of the rays by a magnet, have, thanks to the researches of Crookes and Goldstein, long been familiar to us, but it is only recently that the remarkable effects which occur outside such a tube have been discovered. In 1893, Lenard, using a tube provided with a window made of a very thin plate of aluminium, found that a screen impregnated with a solution of a phosphorescent substance became luminous if placed outside the tube in the prolongation of the line from the cathode through the aluminium window. He also found that photographic plates placed outside the tube in this line were affected, and electrified bodies were discharged; he also obtained by these rays photographs through plates of aluminium or quartz. He found that the rays were affected by a magnet, and regarded them as the prolongations of the cathode rays. This discovery was at the end of last year followed by that of Röntgen who found that the region round the discharge tube is traversed by rays which can affect a photographic plate after passing through substances such as aluminium or cardboard, which are opaque to ordinary light; which pass from one substance to another, without any refraction, and with but little regular reflection; and which are not affected by a magnet. We may, I think, for the purposes of discussion, conveniently divide the rays occurring in or near a vacuum tube traversed by an electric current into three classes, without thereby implying that they are necessarily distinctly different in physical character. We have (1) the cathode rays inside the tube, which are deflected by a magnet; (2) the Lenard rays outside the tube, which are also deflected by a magnet; and (3) the Röntgen rays, which are not, as far as is known, deflected by a magnet. Two views are held as to the nature of the cathode rays; one view is, that they are particles of gas carrying charges of negative electricity, and moving with great velocities which they have acquired as they travelled through the intense electric field which exists in the neighborhood of the negative electrode. The phosphorescence of the glass is on this view produced by the impact of these rapidly moving charged particles, though whether it is produced by the mechanical violence of the impact, or whether it is due to an electro-magnetic impulse produced by the sudden reversal of the velocity of the negatively charged particle—whether, in fact, it is due to mechanical or electrical causes, is an open question. This view of the constitution of the cathode rays explains in a simple way the deflection of those rays in a magnetic field, and it has lately received strong confirmation from the results of an experiment made by Perrin. Perrin placed inside the exhausted tube a cylindrical metal vessel with a small hole in it, and connected this cylinder with the leaves of a gold leaf electroscope. The cathode rays could, by means of a magnet, be guided so as either to pass into the cylinder through the aperture, or turned quite away from it. Perrin found that when the cathode rays passed into the cylinder the gold leaf of the electroscope diverged, and had a negative charge, showing that the bundle of cathode rays enclosed by the cylinder had a charge of negative electricity. Crookes had many years ago exposed a disc connected with a gold leaf electroscope to the bombardment of the cathode rays, and found that the disc received a slight *positive* charge; with this arrangement, however, the charged particles had to give up their charges to the disc if the gold leaves of the electroscope were to be affected, and we know that it is extremely difficult, if not impossible, to get electricity out of a charged gas merely by bringing the gas in contact with a metal. Lord Kelvin's electric strainers are an example of this. It is a feature of Perrin's experiment that since it acts by induction, the indications of the electroscope are independent of the communication of the charges of electricity from the gas to the cylinder, and since the cathode rays fall on the inside of the cylinder, the electroscope would not be affected, even if there were such an effect as is produced when ultra-violet light falls upon the surface of an electro-negative metal when the metal acquires a positive charge. Since any such process cannot affect the total amount of electricity inside the cylinder, it will not affect the gold leaves of the electroscope; in fact, Perrin's experiments prove that the cathode rays carry a charge of negative electricity.

The other view held as to the constitution of the cathode rays is that they are waves in the ether. It would seem difficult to account for the result of Perrin's experiment on this view, and also I think very difficult to account for the magnetic deflection of the rays. Let us take the case of a uniform magnetic field, the experiments which have been made on the magnetic deflection of these rays seem to make it clear that in a magnetic field which is sensibly uniform, the path of these rays is curved; now if these rays were due to ether waves, the curvature of the path would show that the velocity of propagation of these waves varied from point to point of the path. That is, the velocity of propagation of these waves is not only affected by the magnetic field, it is affected differently at different parts of the field. But in a uniform field what is there to differentiate one part from another, so as to account for the variability of the velocity of wave propagation in such a field? This could not be accounted for by supposing that the velocity of this wave motion depended on the strength of the magnetic field, or that the magnetic field, by distorting the shape of the boundary of the negative dark space, changed the direction of the wave front, and so produced a deflection of the rays. The chief reason for supposing that the cathode rays are a species of wave motion is afforded by Lenard's discovery, that when the cathode rays in a vacuum tube fall on a thin aluminium window in the tube, rays having similar properties are observed on the side of the window outside the tube; this is readily explained on the hypothesis that the rays are a species of wave motion to which the window is partially transparent, while it is not very likely that particles of the gas in the tube could force their way through a piece of metal. This discovery of Lenard's does not, however, seem to me incompatible with the view that the cathode rays are due to negatively charged particles moving with high velocities. The space outside Lenard's tube must have been traversed by Röntgen rays, these would put the surrounding gas in a state in which a current would be readily started in the gas if any electro-motive force acted upon it. Now, though the metal window in Lenard's experiments was connected with the earth, and would, therefore, screen off from the outside of the tube any effect arising from slow electrostatic changes in the tube, it does not follow that it would be able to screen off the electrostatic effect of charged particles moving to and from the tube with very great rapidity. For in order to screen off electrostatic effects, there must be a definite distribution of electrification over the screen; changes in this distribution, however, take a finite time, which depends upon the dimensions of the screen and the electrical conductivity of the material of which it is made. If the electrical changes in the tube take place at above a certain rate, the distribution of electricity on the screen will not have time to adjust itself, and the screen will cease to shield off all electrostatic effects. Thus the very rapid electrical changes which would take place if rapidly moving charged bodies were striking against the window, would give rise to electro-motive forces in the region outside the window, and would produce convection currents in the gas which has been made a conductor by the Röntgen rays. The Lenard rays would thus be analogous in character to the cathode rays, both being convective currents of electricity. Though there are some points in the behavior of these Lenard rays which do not admit of a very ready explanation from this point of view, yet the difficulties in its way seem to me considerably less than that of supposing that a wave in the ether can change its velocity when moving from point to point in a uniform magnetic field.

I now pass on to the consideration of the Röntgen rays. We are not yet acquainted with any crucial experiment which shows unmistakably that these rays are waves of transverse vibration in the ether, or that they are waves of normal vibration, or indeed that they are vibrations at all. As a working hypothesis, however, it may be worth while considering the question whether there is any property known to be possessed by these rays which is not possessed by some form or other of light. The many forms of light have in the last few months received a noteworthy addition by the discovery of M. Becquerel of an invisible radiation, possessing many of the properties of the Röntgen rays, which is emitted by many fluorescent substances, and to an especially marked extent by the uranium salts. By means of this radiation, which, since it can be polarized, is unquestionably light, photographs through opaque substances similar, though not so beautiful to those obtained by means of Röntgen rays, can be taken, and, like the Röntgen rays, they cause an electrified body on which they shine to lose its charge, whether this be positive or negative.

The two respects in which the Röntgen rays differ from light is in the absence of refraction and perhaps of polarization. Let us consider the absence of refraction first. We know cases in which special rays of the spectrum pass from one substance to another without refraction; for example, Kundt showed that gold, silver, copper allowed some rays to pass through them without bending, while other rays are bent in the wrong direction. Pflüger has lately found that the same is true for some of the aniline dyes when in a solid form. In addition to this, the theory of dispersion of light shows that there will be no bending when the frequency of the vibration is very great. I have here a curve taken from a paper by Helmholtz, which shows the relation between the refractive index and the frequency of vibration for a substance whose molecules have a natural period of vibration, and one only; the frequency of this vibration is represented by OK in the diagram. The refractive index increases with the frequency of the light until the latter is equal to the frequency of the natural vibration of the substance; the refractive index then diminishes, becomes less than unity, and finally approaches unity, and practically is equal to it when the frequency of the light greatly exceeds that of the natural vibration of the molecule. Helmholtz's results are obtained on the supposition that a molecule of the refracting substance consists of a pair of oppositely electrified atoms, and that the specific inductive capacity of the medium consists of two parts, one due to the ether, the other to the setting of the molecules along the lines of electric force.

Starting from this supposition we can easily see without mathematical analysis that the relation between the refractive index and the frequency must be of the kind indicated by the curve. Let us suppose that an electro-motive force of given amplitude acts on this mixture of molecules and ether, and start with the frequency of the external electro-motive force less than that of the free vibrations of the molecules; as the period of the force approaches that of the molecules, the effect of the force in pulling the molecules into line will increase, thus the specific inductive capacity; and therefore, the refractive index, increases with the frequency of the external force; the effect of the force on the orientation of the molecules will be greatest when the period of the force coincides with that of the molecules. As long as the frequency of the force is less than that of the molecules, the external field tends to make the molecules set so as to increase the specific inductive capacity of the mixture; as soon, however, as the frequency of the force exceeds that of the molecules, the molecules, if there are no viscous forces, will all topple over and point so as to make the part of the specific inductive capacity due to the molecules of opposite sign to that due to the ether. Thus, for frequencies greater than that of the molecules the specific inductive capacity will be less than unity. When the frequency of the force only slightly exceeds that of the molecules, the effect of the external field on the molecules is very great, so that if there are a considerable number of molecules, the negative part of the specific inductive capacity due to the molecules may be greater than the positive part due to the ether, so that the specific inductive capacity of the mixture of molecules and ether would be negative; no waves of this period could then travel through the medium, they would be totally reflected from the surface.

As the frequency of the force gets greater and greater, its effect in making the molecules set will get less and less, but the waves will continue to be totally reflected until the negative part of the specific inductive capacity due to the molecules is just equal to the positive part due to the ether. Here the refractive index of the mixture is zero. As the frequency of the force increases, its effect on the molecules gets less and less, so that the specific inductive capacity continually approaches that due to the ether alone, and practically coincides with it as soon as the frequency of the force is a considerable multiple of that of the molecules. In this case both the specific inductive capacity and the refractive index of the medium are the same as that of the ether and there is consequently no refraction. Thus the absence of refraction, instead of being in contradiction to the Röntgen rays, being a kind of light, is exactly what we should expect if the wave length of the light were exceedingly small.

The other objection to these rays being a kind of light is, that there is no very conclusive evidence of the existence of polarization. Numerous experiments have been made on the difference between the absorption of these rays by a pair of tourmaline plates when their axes are crossed or parallel. Many observers have failed to observe any difference at all between the absorption in the two cases. Prince Galitzine and M. de Karnogitsky, by a kind of cumulative method, have obtained photographs which seem to show that there is a slightly greater absorption when the axes are crossed than there is when the axes are parallel. There can, however, be no question that the effect, if it exists at all, is exceedingly small compared with the corresponding effect for visible light. Analogy, however, leads us to expect that to get polarization effects we must use in the case of short waves, polarizers of a much finer structure than would be necessary for long ones. Thus a wire bird-cage will polarize long electrical waves, but will have no effect on visible light. Rubens and Dubois made an instrument which would polarize the infra red rays by winding very fine wires very close together on a framework; this arrangement, however, was too coarse to polarize visible light. Thus, though the structure of the tourmaline is fine enough to polarize the visible rays, it may be much too coarse to polarize the Röntgen rays if these have exceedingly small wave-lengths. As far as our knowledge of these rays extends, I think we may say that though there is no direct evidence that they are a kind of light, there are no properties of the rays which are not possessed by some variety of light.

It is clear that if the Röntgen rays are light rays, their wave-lengths are of an entirely different order to those of visible light. It is, perhaps, worth notice that on the electro-magnetic theory of light we might expect two different types of vibration if we suppose that the atoms in the molecule of the vibrating substance carried electrical charges. One set of vibrations would be due to the oscillations of the bodies carrying the charges, the other set to the oscillation of the charges on these bodies. The wave-length of the second set of vibrations would be commensurate with molecular dimensions; can these vibrations be the Röntgen rays? If so, we should expect them to be damped with such rapidity as to resemble electrical impulses rather than sustained vibrations.

If we turn from the rays themselves to the effects they produce, we find that the rays alter the properties of the substances through which they are passing. This change is most apparent in the effects produced on the electrical properties of the substances. A gas, for example, while transmitting these rays, is a conductor of electricity. It retains its conducting properties for some little time after the rays have ceased to pass through it, but Mr. Rutherford and I have lately found that the conductivity is destroyed if a current of electricity is sent through the Röntgenized gas. The gas in this state behaves in this respect like a very dilute solution of an electrolyte. Such a solution would cease to conduct after enough electricity had been sent through it to electrolyze all the molecules of the electrolyte. When a current is passing through a gas exposed to the rays, the current destroys and the rays produce the structure which gives conductivity to the gas; when things have reached a steady state the rate of destruction by the current must equal the rate of production by the rays. The current can thus not exceed a definite value, otherwise more of the conducting gas would be destroyed than is produced.

This explains the very characteristic feature that in the passage of electricity through gases exposed to Röntgen rays, the current, though at first proportional to the electro-motive force, soon reaches a value where it is almost constant and independent of the electro-motive force, and we get to a state when a tenfold increase in the electro-motive force only increases the current by a few per cent. The conductivity under the Röntgen rays varies greatly from one gas to another, the halogens and their gaseous compounds, the compounds of sulphur, and mercury vapor, are among the best conductors. It is worthy of note that those gases which are the best conductors when exposed to the rays are either elements, or compounds of elements, which have in comparison with their valency very high refractive indices.

The conductivity conferred by the rays

on a gas is not destroyed by a considerable rise in temperature ; it is, for example, not destroyed if it be sucked through metal tubing raised to a red heat. The conductivity is, however, destroyed if the gas is made to bubble through water, it is also destroyed if the gas is forced through a plug of glass wool. This last effect seems to indicate that the structure which confers conductivity on the gas is of a very coarse kind, and we get confirmation of this from the fact that a very thin layer of gas exposed to the Röntgen rays does not conduct nearly so well as a thicker one. I think we have evidence from other sources that electrical conduction is a process that requires a considerable space—a space large enough to enclose a very large number of molecules.

Thus Koller found that the specific resistances of petroleum, turpentine and distilled water, when determined from experiments made with very thin layers of these substances, was very much larger than that determined from experiments with thicker layers. Even in the case of metals there is evidence that the metal has to be of appreciable size if it is to conduct electricity. The theory of the scattering of light by small particles shows that, if we assume the truth of the electro-magnetic theory of light, the effects should be different according as the small particles are insulators or conductors. When the small particles are nonconductors, theory and experiment concur in showing that the direction of complete polarization for the scattered light is at right angles to the direction of the incident light, while if the small particles are conductors, theory indicates that the direction of complete polarization makes an angle of 60° with the incident light. This result is not, however, confirmed by the experiments made by Prof. Threlfall on the scattering of light by very small particles of gold. He found that the gold scattered the light in just the same way as a non-conductor, giving complete polarization at right angles to the incident light. This would seem to indicate that those very finely divided metallic particles no longer acted as conductors. Thus there seems evidence that in the case of conduction through gases, through badly conducting liquids and through metals, electric conduction is a process which requires a very considerable space and aggregations of large numbers of molecules. I have not been able to find any direct experimental evidence as to whether the same is true for electrolytes. Experiments on the resistance of thin layers of electrolytes would be of considerable interest, as according to one widely accepted view of electrolysis conduction through electrolytes, so far from being effected by aggregations of molecules, takes places by means of the ion, a structure simpler than that of the molecule, so that if this represents the process of conduction, there would not seem room for the occurrence of an effect which occurs with every other kind of conduction.

In this building it is only fitting that some reference should be made to the question of the movement of the ether. You are all doubtless acquainted with the heroic attempts made by Prof. Lodge to set the ether in motion, and how successfully the ether resisted them. It seems to be conclusively proved that a solid body in motion does not set in motion the ether at an appreciable distance outside it; so that if the ether is disturbed at all in such a case, the disturbance is not comparable with that produced by a solid moving through an incompressible fluid, but must be more analogous to that which would be produced by the motion through the liquid of a body of very open structure, such as a piece of wire netting, where the motion of the fluid only extends to a distance comparable with the diameter of the wire, and not with that of the piece of netting. There is another class of phenomena relating to the movement of the ether which is, I think, deserving of consideration, and that is the effect of a varying electro-magnetic field in setting the ether in motion. I do not remember to have seen it pointed out that the electro-magnetic theory of light implicitly assumes that the ether is not set in motion even when acted on by mechanical forces. On the electro-magnetic theory of light such forces do exist, and the equations used are only applicable when the ether is at rest. Consider, for example, the case of a plane electric wave travelling through the ether. We have parallel to the wave-front a varying electric polarization, which on the theory is equivalent to a current; at right angles to this, and also in the wave-front, we have a magnetic force. Now, when a current flows through a medium in a magnetic field there is a force acting on the medium at right angles to the plane, which is parallel both to the current and to the magnetic force; there will thus be a mechanical force acting on each unit volume of the ether when transmitting an electric wave, and since this force is at right angles to the current and to the magnetic force, it will be in the direction in which the wave is propagated. In the electro-magnetic theory of light, however, we assume that this force does not set the ether in motion, as unless we made this assumption we should have to modify our equations, as the electro-magnetic equations are not the same in a moving field as in a field at rest. In fact, a complete discussion of the transmission of electro-magnetic disturbances requires a knowledge of the constitution of the ether which we do not possess. We now assume that the ether is not set in motion by an electro-magnetic wave. If we do not make this assumption we must introduce into our equation quantities representing the components of the velocity of the ether, and unless we know the constitution of the ether, so as to be able to deduce these velocities from the forces acting on it, there will be in the equations of the electro-magnetic field more unknown quantities than we have equations to determine. It is, therefore, a very essential point in electro-magnetic theory to investigate whether or not there is any motion of the ether in a varying electro-magnetic field. We have at the Cavendish Laboratory, using Prof. Lodge's arrangement of interference fringes, made some experiments to see if we could detect any movement of the ether in the neighborhood of an electric vibrator, using the spark which starts the vibrations as the source of light. The movement of the ether, if it exists, will be oscillatory, and with an undamped vibrator the average velocity would be zero; we used, therefore, a heavily damped vibrator, with which the average velocity might be expected to be finite. The experiments are not complete, but so far the results are entirely negative. We also tried by the same method to see if we could detect any movement of the ether in the neighborhood of a vacuum tube emitting Röntgen rays, but could not find any trace of such a movement. Prof. Threlfall, who independently tried the same experiment, has, I believe, arrived at the same conclusion.

Unless the ether is immovable under the mechanical forces in a varying electro-magnetic field, there are a multitude of phenomena awaiting discovery. If the ether does move, then the velocity of transmission of electrical vibrations, and therefore of light, will be affected by a steady magnetic field. Such a field, even if containing nothing but ether, will behave towards light like a crystal, and the velocity of propagation will depend upon the direction of the rays. A similar result would also hold in a steady electric field. We may hope that experiments on these and similar points may throw some light on the properties of that medium which is universal, which plays so large a part in our explanation of physical phenomena, and of which we know so little.

J. J. Thomson.

CURRENT NOTES ON ANTHROPOLOGY.

PATHOLOGY IN ANTHROPOLOGY.

In a note in Science, May 1st, I vindicated the importance of the study, in anthropology, of pathological traits and processes. In the *Revue Mensuelle de l'Ecole d'Anthropologie* for July 15th is an excellent article on the same theme from Prof. Capitan. He sets forth with brevity and precision the many applications of pathology in anthropologic investigations. For instance, the diseased conditions of bones throw much light on prehistoric society; the disturbances of nutrition and reproduction solve many a problem in ethnic biology; defects in the organs of the senses explain the traits of various tribes; endemic, epidemic and hereditary diseases control the development of nations; migrations and dispersions are governed by similar causes; mental maladies are fruitful of extraordinary results in ethnic history, and so on.

But he takes a step further, a bold one, and, one must say, not a false one. "The generally received notion that humanity at large is in a healthy condition, normal and physiological, is an utter error. There is not a single individual, still less a large number, who are thoroughly sound; we always study them in a more or less diseased condition." There is no doubt this is so, and its consequences deserve far more attention than they have received.

THE CROWD AS AN ANTHROPIC UNIT.

Ethnographers have been accustomed to deal with the 'race,' the 'tribe' and the 'nation' as social or anthropic units; but of late it has become evident that the 'crowd,' any crowd, anywhere, anytime, is just as specialized, has as many individual traits, and is quite as active in its influence, as either of those mentioned. The 'crowd' may be in the salon of a lady of fashion, on a corner in the slums, or at a meeting of a scientific association; it will have the same peculiarities and move according to the same laws. It will act on impulse and not on reason; its intelligence is that of its most inferior members; but its powers are prompt and far-reaching. Mental suggestion and mental contagion are its favorite stimuli. It loves catch-words, symbols, colors and costumes. It prizes a badge far above a syllogism, and can be captured by the former when the latter would fall powerless.

The study of this many-headed beast has very properly come into the scope of anthropology, and the little book of Dr. Gustave Le Bon, 'Psychologie des foules' (Alcan, Paris), as well as the lectures of Prof. Bernheim, of Nancy, on 'Suggestion collective,' enable the reader to appreciate how singularly the folly of the mass obscures the wisdom of the individual.

RECENT CRANIOLOGICAL STUDIES.

Dr. Rudolf Martin, already familiar to Americanists by his somatologic writings on the natives of Tierra del Fuego, has lately published in the quarterly journal of the *Naturforschende Gesellschaft*, of Zürich, an article on 'Old Patagonian Skulls.' The crania, twelve in number, were obtained from the left bank of the Rio Negro, about fifty kilometers above its mouth. He subjects them to a searching scrutiny and an analysis of their dimensions. They do not seem to show marked traits of degeneration. In form they are brachycephalic and prognathic, with prominent cheek bones. Two full-plate illustrations and several in the text accompany the paper.

In the proceedings of the Berlin Anthropological Society for January last, Dr. Felix von Luschan has a contribution in which he describes three trepanned skulls from Tenerife, and refers to seven other examples from the same locality. The operation seems to have been generally successful. Some others present cicatrices, which appear to have been from wounds intentionally inflicted for ceremonial purposes. He also gives examples of defective tympanic bones in artificially deformed skulls from Peru.

D. G. Brinton.

University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS.

THE BRITISH ASSOCIATION.

The British Association for the Advancement of Science, whose preeminence is borne witness to by the fact that it is always called simply 'The British Association' by British newspapers and the general public, is meeting at Liverpool during the present week. Since its first meeting in 1831, the Association has been an important factor in the progress of science in Great Britain and has set an example which has been followed by the nations showing the greatest scientific activity. It has to a considerable extent fulfilled its objects: "To give a stronger impulse and a more systematic direction to scientific inquiry, to promote the intercourse of those who cultivate science in different parts of the British Empire, with one another and with foreign philosophers, to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress."

The Liverpool meeting, presided over by Sir Joseph Lister, also president of the Royal Society and by common consent one of the greatest men of science now living, with men such as Prof. J. J. Thomson to preside over its sections, with a strong local committee, in a city offering many attractions, is sure to promote the objects of the Association and surpass in importance the similar meetings in other countries. Yet it is probable that the meeting will be less influential than that held in the same place 26 years ago, when, with an attendance of 2,878, Huxley as president gave his remarkable address on 'Biogenesis,' and the presidents of the sections included Clerk-Maxwell, Sir Henry Roscoe, Rollerson, Murchison and Jevons.

The British Association does not escape the criticism usual in such cases; it has been said that it has no further *raison d'être*, and even that it is only being kept alive long enough to make presidents of certain men who want this honor. Yet it is probable that such an association has never been more useful or more needed. The men active twenty-six years ago have since become more famous and are mostly no longer living. But new men have come and new problems. The advance of science has never before been so steady and so widespread. There has never been a time when it was more advantageous for men of science to meet together, and use their collective influence for the common good.

THE PASTEUR MEMORIAL.

We have on several occasions called attention to the monument in memory of Pasteur, to be erected in Paris. There is a strong committee, consisting of a number of the leading men of science in France and having as honorary members the President of the Republic and his cabinet, together with about one hundred and sixty of the most prominent officials, scientists and other distinguished citizens of France. It has been wisely decided to make the memorial international and a committee for the United States has been organized, consisting of Dr. D. E. Salmon, Chairman, Dr. E. A. de Schweinitz, Secretary, Dr. Geo. M. Sternberg, Dr. J. Rufus Tryon, Dr. Walter Wyman, Prof. S. F. Emmons, Prof. Lester F. Ward, Dr. Wm. B. French, Hon. Gardiner G. Hubbard, Mr. C. L. Marlatt, and Dr. Ch. Wardell Stiles. Dr. G. Brown Goode, active in so many useful works, was treasurer of the committee.

The committee has devoted much attention to the subject and has corresponded with many societies and individuals. It prefers to have each organization appoint one of its members as an associate member of this committee with authorization to collect and forward the subscriptions. No one is expected to subscribe an amount so large that it will detract in the least from the pleasure of giving. A large number of small subscriptions freely contributed and showing the popular appreciation of this eminent Frenchman is what is most desired.

GENERAL.

The American Society of Naturalists meets at Boston December 29th and 30th, 1896. The American Physiological Society, The American Morphological Society and The American Psychological Association have signified their intenion to hold their meetings at the same time and place. The program of the Naturalists' meeting will be announced at an early date.

The International Zoological Congress will hold its next meeting in September 1898, in Cambridge, England, which is also the place and time of meeting of the International Physiological Congress. The International Psychological Congress will next meet in Paris in 1900, as will also the International Congress of Electricians.

We are compelled this week to record a number of deaths among foreign men of science. Prof. Luigi Palmieri, the well-known meteorologist, has died at the age of eighty-nine years. He had been professor in the University of Naples since 1847, and was director of the Meterological Observatory of Mt. Vesuvius. Dr. Philipp Ludwig Ritter von Seidel, professor of mathematics in the University of Munich, died on August 13th at the age of seventy-five years. M. Carrière, an officer of the Jardin des Plantes, Paris, and the author of important contributions to the subject of variation in plants, died on August 18 at the age of seventy-nine years. The deaths are also announced of Ferdinand von Herder, formerly librarian of the botanic garden of St. Petersburg; of Cajétan de Kraszewski, a Polish astronomer and meteorologist; of Dr. Joh. Jak. Egli, professor of geography in the University of Zurich, and of Dr. Minnegerode, professor of mathematics in the University of Greifswald.

According to the daily papers, a despatch from Odessa, Russia, states that M. Kildischowsky, an electrician, has discovered an improvement in the telephone, by the use of which distance has no effect upon the hearing. In an experiment between Moscow and Rostoff, a distance of 890 miles, talking, music and singing were heard with perfect distinctness. For the purpose of this experiment an ordinary telegraph wire was used. M. Kildischowsky will go to London to experiment with his improvement on the Atlantic cables between London and New York.

A special laboratory for the study of diphtheria under the direction of Prof. Flügge has been opened in connection with the laboratory of hygiene in the University of Breslau.

The Electrical Standardizing Testing and Training Institution of London, has made arrangements to give instruction in medical electricity, including applications of the Röntgen rays to surgery.

M. Bijourdan proposes to determine, under the direction of M. Janssen, the force of gravity on Mt. Blanc. An observer at Chamonix in telegraphic communication with the observatory at Paris, will send the times to the summit of Mt. Blanc by an optical system.

The Leander McCormick Observatory of the University of Virginia, under the direction of Prof. Ormond Stone, has been engaged in the observation of the relative positions of the satellites of Saturn and valuable results have already been secured, from which it is hoped to obtain greatly improved orbits of those bodies.

The autumn meeting of the Iron and Steel Institution of Great Britain, was held this year at Bilboa, Spain, beginning on August 31st. There were special reasons for meeting at this place, as for the last 20 years the north of Spain has supplied the blast furnaces of South Wales, Middlesbrough, Scotland, and to a less extent of other districts, with the greater part of their raw materials, apart from a certain quantity of local ores. The exports of iron ores from Bilboa during the current year are estimated at over 6,000,000 tons, but the supply now threatens to become exhausted, and there is much competition among the iron and steel workers in Great Britain, France and Germany to secure control of what remains.

A DESPATCH to the daily papers from Portland, Ore., states that Mt. Hood has been in eruption. A party of twenty-one persons narrowly escaped being buried under an avalanche of rock and ashes.

A MONUMENT in memory of the mineralogist and poet, Franz von Kobel, was unveiled in Munich on July 19th. Franz von Kobel, who died in 1882, was for more than 50 years professor of mineralogy in the University of Munich and made many contributions to all departments of the science, and was also well-known among the people for his poems in the Bavarian dialects.

A COMMITTEE to forward the erection of the Pasteur monument has been formed in Bavaria, consisting of Professors v. Pettenkofer, v. Ziemssen and Buchner.

Electricity notes that it is proposed to erect a monument over the grave of Georg Simon Ohm. Subscriptions will be received by the Königliche Filiabank, Munich.

THE fiftieth anniversary of the Smithsonian Institution is made the occasion of an extended article on its history and present condition by Dr. Max Voretzsch in *Die Natur* for August 30th.

THE catalogue issued during August by Bernard Quaritch, 15 Piccadilly, London, offers for sale a large number of scientific books, some of them of great value, such as complete sets of the *American Journal of Science* (£110), *Curtis's Botanical Magazine* (£148), *Monthly Notices of the Royal Astronomical Society* (£24), etc.

THE Macmillan Co. announce the following new volumes in the Rural Science Series edited by Prof. Bailey, of Cornell University: 'The Apple,' by L. H. Bailey; nearly ready. 'Fertility of the Land,' by I. P. Roberts, of Cornell University; ready in October. 'Physiology of Plants,' by J. C. Arthur, of Purdue University. 'Grasses,' by W. H. Brewer, of Yale University. 'Bush Fruits,' by F. W. Card, of the University of Nebraska. 'Plant Diseases,' by B. T. Galloway, E. F. Smith and A. F. Woods, of the U. S. Department of Agriculture. 'Seeds and Seed Growing,' by G. H. Hicks, of the U. S. Department of Agriculture. 'Leguminous Plants,' by E. H. Hilgard, of the University of California. 'Feeding of Animals,' by W. H. Jordan, of Maine Experiment Station. 'Irrigation,' by F. H. King, of the University of Wisconsin. 'Milk and its Products,' by H. H. Wing, of Cornell University.

AMONG D. Appleton & Co.'s September publications are 'What is Electricity?' by Prof. John Trowbridge, of Harvard University, a new volume in the International Scientific Series, and 'Alterations in Personality,' by M. Alfred Binet, with an introduction by Prof. J. Mark Baldwin.

THE Royal Society of Sciences, of Saxony, celebrated the fiftieth anniversary of its foundation on July 1st. The King of Saxony was present and an address was made by the eminent chemist, Prof. Wislicenus.

A COMPANY has been organized at Little Rock, Ark., with a view to using horseless carriages in the place of, or in opposition to, the street cars. A franchise has been requested and a proposition made to the City Council to pay 5 per cent. of the net receipts to the city.

UNIVERSITY AND EDUCATIONAL NEWS.

THE Columbian University, Washington, has established a veterinary department, the faculty of which will include D. E. Salmon, who will be dean of the faculty, professor of sanitary medicine, control and eradication of contagious diseases and inspection of meats; John Lockwood, professor of theory and practice of medicine and surgery; William P. Carr, professor of general physiology; E. A. de Schweinitz, professor of chemistry; Charles F. Dawson, professor of physiology and pathology; A. M. Farrington, professor of obstetrics and zootechnics; D. E. Buckingham, professor of materia medica and therapeutics; James Carroll, professor of pathology and bacteriology; Cecil French, professor of canine patholoy; Albert Hassall, professor of parasitology. W. S. Washburn, professor of histology; Charles F. Hadfield, demonstrator of anatomy; C. Wardell Stiles, lecturer on zoology and Edwin Willitts, lecturer on medical jurisprudence.

A department of biology in the graduate school of Georgetown University has been organized and placed under the direction of Dr. C. W. Stiles. The instructors and lecturers include Merton B. Waite, professor of botany; Sylvester D. Judd, instructor in biology; Dr. Frank Baker, lecturer on anthropology; Dr. Leland O. Howard, lecturer on insects; Dr. T. S. Palmer, lecturer on mammals; Prof. James E. Benedict, lecturer on marine invertebrates; Prof. Charles T. Simpson, lecturer on mollusks: Prof. Chas. W. Richmond, lecturer on birds; Prof. Henry Olds, lecturer on songs of birds, and Prof. W. P. Hay, lecturer on amphibia and reptiles.

A committee of the graduate students of Bryn Mawr College has in preparation a handbook of courses open to women in foreign universities. It will contain a complete list of professors and lecturers at all colleges and universities where women are admitted; together with the subjects in which lectures are given, the entrance requirements, fees, beginnings and endings of terms, degrees granted to women, and other particulars of importance. In this connection it may be noted that the University of Durham will not only open the degree of B. A. to women, but will also throw open some eight scholarships and exhibitions, varying in value from £20 to £70 a year, besides various university prizes, and that Bonn has followed the example of several other German universities and now admits to the lectures women who can show proper preparation and secure the permission of the lecturer.

The Pope gave permission last year for laymen to attend the English universities, and the Duke of Norfolk has purchased for $65,000 a site on which it is proposed to erect a Roman Catholic college at Oxford.

Prof. W. L. Ames, who has been for some years at the head of the Department of Drawing and Designing at the Rose Polytechnic Institute, has recently resigned to accept a similar position in the Worcester Polytechnic Institute.

Miss Parker, a daughter of Prof. W. A. Parker, of the University of Alabama, has been appointed professor of natural sciences in the Georgia Industrial College at Milledgeville.

The correspondent of the N. Y. *Evening Post* from Colgate University writes that Mr. J. Fay Smith, a graduate student of Cornell University, will take charge of the department of physics until January, when Prof. Nichols, who has been for two and a half years at the University in Berlin, will return. Mr. H. E. Nims has charge of the department of chemistry during Prof. McGregory's absence in Göttingen, where he will remain until January.

The following appointments are announced in the *Naturwissenschaftliche Rundschau:* Dr. Lobry de Bruyn has been made full professor of general and pharmaceutical chemistry in the University of Amsterdam; Dr. W. H. Julius has been promoted to a full professorship of physics in the University of Utrecht; Dr. Wilhelm Fleischmann, of the University of Königsberg, has been made director of the agricultural institution at the University of Göttingen, and Dr. Emil Erlenmeyer has been appointed assistant professor of chemistry in the University of Strasburg.

SCIENTIFIC LITERATURE.

Ice Work Present and Past. T. G. Bonney, D. Sc., LL.D., F.R.S., F.S.A., F.G.S. International Scientific Series. D. Appleton & Company. 1896.*

In the introduction it is intimated that this work is written primarily for the student. There are many passages, however, which indicate that amateurs, teachers, general geologists, and even glacial specialists, were in the author's mind as he wrote. It is not, on the one hand, a strictly popular work adapted to those who are quite unfamiliar with the subject; nor is it, on the other, a thoroughgoing treatise especially serviceable to glacialists. It is not clear that the author has been altogether successful in the difficult task of adapting his method and matter to the intermediate class. A doubt arises whether he has been explicit and illustrative enough upon the glacial fundamentals, on the one hand, and, on the other, whether he has not entered so much into detail in the treatment of certain local phenomena, es-

* Reviewed by request.

pecially British phenomena, as possibly to be tedious to this class.

The author proposes to himself the avoidance of the special advocacy of particular interpretations, which he regards as the peculiar fault of most treatises on the subject. He professes to be a judge and not a lawyer, and in harmony with this there is an obvious effort throughout to be judicial in his attitude. The implication of partiality on the part of most authors will hardly be accepted by the admirers of 'The Great Ice Age' or of 'Handbuch der Gletscherkunde,' and the author's assumption of the functions of a judge, meting out the unbiased truth where specialists have failed, is embarrassed by the absence of that prolonged and profound study which is usually regarded as the prerequisite of the judicial office. Dr. Bonney has written chiefly on petrological subjects during the past twenty years, although previous to this he had studied and written considerably on glaciers. It follows from this long devotion to a fascinating specialty that his familiarity with the literature of glaciology is not altogether intimate, and this finds repeated expression throughout the book. Much of the material is taken from compilations rather than from original sources and errors of fact and of reference are not infrequent.

The work has an excellent tripartite plan, proceeding from the existing evidence of ice work in alpine glaciers and arctic and antarctic ice sheets (Part I.), to the traces of the glacial epoch (Part II.), and thence to theoretical questions (Part III.). This logical scheme is not closely adhered to however, and doubtless wisely, in the main. The illustrations in the first part are chiefly taken from the glacial drift of the past, while there are no illustrations of existing glaciers. In Part II. hypotheses and interpretations form a notable portion of the discussion.

The relation of lake basins to glaciers receives foremost attention under the head of Traces of the Glacial Epoch. The author's bias is obviously unfavorable to much glacial excavation, indeed he had previously announced the conclusion, based on observations near the ends of certain alpine glaciers, that ice 'has practically no power to excavate.' In the discussion of the lakes and elsewhere he manifests a hospitality to theories involving submergence. Eskers are treated at a reasonable length and are fairly described. Their origin is left more indeterminate than needful. It may be accepted as demonstrated that they are the direct product of glacial drainage. The only legitimate questions remaining undecided relate to details of special position and of relations to the ice. The discussion of drumlins is brief and unsatisfactory. The great phenomena of the till sheets and of the marginal moraines are almost ignored in the treatment of the traces of the glacial epoch, though moraines of the alpine type are frequently referred to in the discussion of the present glaciers.

Ice work in Great Britain is discussed with much elaborateness, which will doubtless make the work acceptable to the subjects of the Queen, but will seem to American students, in view of the limitation of the great deposits of this continent to ten pages, somewhat disproportionate. In the discussion of the American formations the selection of matter is not all that could be desired. There is no comprehensive sketch of the great features of this greatest of all glaciated regions. The map given is old and borrowed from a popular work, and fails to represent the latest delineations, much less the latest classifications. The map of the imaginary Lake Ohio has no place in such a work. The 1,700-foot beach lines of Spencer are cited as though unquestioned, though we think their author would not now insist upon the correctness of his identification.

The third part opens with an interesting and valuable discussion of the temperature of the glacial epoch, in which it is maintained that a very moderate fall of the average temperature would suffice for the glaciation that occurred. In discussing the probable causes of the glacial epoch, Dr. Bonney points out at length the difficulties that attach to all current hypotheses, and concludes that a complete solution of the problem is as yet undetermined, and in this we think he is altogether correct. In the treatment of the number of glacial epochs, the discussion turns, not upon the number of subdivisions of the Pleistocene glaciation (a subject much discussed in recent years), but on the number of cold periods in the whole history of the globe. He sketches the supposed evidences of pre-Pleistocene glaciation, and concludes that only in the late Carboniferous or early Permian period does the testimony for the prevalence of a low temperature over a large part of the globe seem at present satisfactory. He concludes that a glacial epoch is a rare episode in the history of the earth. In the discussion of general principles of interpretation the treatment is rather academic, as must needs be when undertaken by a specialist in petrology. The interpretation of glacial phenomena equals, if it does not transcend, in difficulty, that of most other classes of geological phenomena, and the true principles of interpretation are not likely to be determined except by long and critical trial in the field.

The work is very well written but very poorly illustrated.

T. C. Chamberlin.

University of Chicago.

Iowa Geological Survey, Volume V., Annual Report for 1895. Samuel Calvin, State Geologist; H. F. Bain, Assistant State Geologist. pp. 452, 7 maps, pls. 14, 72 figs. Des Moines. 1896.

The fifth volume of the publications of the Iowa Geological Survey presents the same excellent typographical appearance which characterizes the former volumes. These publications, which have appeared in rapid succession, indicate continued great activity on part of those engaged in the work. The title annual report is rather misleading, for the subject-matter contains nothing that is of temporary character except the administrative part which consists of a few pages only. As in the previous volumes of this survey there is carried out the highly commendable policy established at the beginning, of eliminating all matter from the reports that is of a preliminary nature, and of publishing only material that has been carefully digested and classified. In this way the total amount of matter published is not nearly so great as it otherwise would be. With great advantage all work of preliminary character which so often goes to make up the large bulk of geological publications is omitted. Thus, only the work in its ultimate form is made public. The set of volumes becomes the 'final' series, and only a single class of publications is issued.

The volume is devoted to areal geology, and six counties are carefully and fully described. One of these, Jones county, is by Prof. S. Calvin, State Geologist. Three, by Prof. H. F. Bain, Assistant State Geologist, are on Washington, Woodbury and Appanoose counties. One, by Dr. S. W. Beyer, is on Boone county; and another on Warren county is by Prof. J. L. Tilton.

In all the reports the economic aspects of the mineral resources are placed prominently in the foreground. Yet the purely geological phases of the various questions are given full consideration, and in a thoroughly scientific manner.

Charles R. Keyes.

NEW BOOKS.

What is Electricity? John Trowbridge. New York, D. Appleton & Co. 1896. Pp. vi+315.

Physics for University Students. Part I., Mechanics, Sound and Light. Part II., Heat, Electricity and Magnetism. Henry S. Carhart. Boston, Allyn & Bacon. 1895, 1896. Pp. iv+344 and 446.

Electrical Measurements. Henry S. Carhart and George W. Patterson, Jr. Boston, Allyn & Bacon. 1895. Pp. v+344.

The History of Mankind. Friedrich Ratzel. Translated from the second German Edition by A. J. Butler, with introduction by E. B. Tylor. Vol. I. London and New York, Macmillan & Co., Limited. 1896. Pp. xxiv+486. $4.00.

Navigation and Nautical Astronomy. F. C. Stebbing. London & New York, Macmillan & Co., Ltd. 1896. Pp. vii+328. $2.75.

Astronomical, Magnetic and Meteorological Observations made during the year 1890 at the U. S. Naval Observatory. Capt. Frederick V. McNair. Washington, Government Printing Office. 1895. Pp. lxiii+420.

Società degli Alpiniste Tridentini XIX. Annuario 1895. Rovereto, Tipografia Roveretana. 1896. Pp. 568.

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SCIENCE

FRIDAY, SEPTEMBER 25, 1896.

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

*BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

ADDRESS BY THE PRESIDENT.

MY Lord Mayor, my Lords, Ladies and Gentlemen, I have first to express my deep sense of gratitude for the great honor conferred upon me by my election to the high office which I occupy to-day. It came upon me as a great surprise. The engrossing claims of surgery have prevented me for many years from attending the meetings of the Association, which excludes from her sections medicine in all its branches. This severance of the art of healing from the work of the Association was right and indeed inevitable. Not that medicine has little in common with science. The surgeon never performs an operation without the aid of anatomy and physiology; and in what is often the most difficult part of his duty, the selection of the right course to follow, he, like the physician, is guided by pathology, the science of the nature of disease, which, though very difficult from the complexity of its subject-matter, has made during the last half-century astonishing progress; so that the practice of medicine in every department is becoming more and more based on science as distinguished from empiricism. I propose on the present occasion to bring before you some illustrations of the

* Liverpool meeting, beginning September 16, 1896.

interdependence of science and the healing art; and the first that I will take is perhaps the most astonishing of all results of purely physical inquiry—the discovery of the Röntgen rays, so called after the man who first clearly revealed them to the world. Mysterious as they still are, there is one of their properties which we can all appreciate—their power of passing through substances opaque to ordinary light. There seems to be no relation whatever between transparency in the common sense of the term and penetrability to these emanations. The glasses of a pair of spectacles may arrest them while their wooden and leathern case allows them to pass almost unchecked. Yet they produce, whether directly or indirectly, the same effects as light upon a photographic plate. As a general rule, the denser any object is, the greater obstacle does it oppose to the rays. Hence, as bone is denser than flesh, if the hand or other part of the body is placed above the sensitive film enclosed in a case of wood or other light material at a suitable distance from the source of the rays, while they pass with the utmost facility through the uncovered parts of the lid of the box and powerfully affect the plate beneath, they are arrested to a large extent by the bones, so that the plate is little acted upon in the parts opposite to them, while the portions corresponding to the muscles and other soft parts are influenced in an intermediate degree. Thus a picture is obtained in which the bones stand out in sharp relief among the flesh, and anything abnormal in their shape or position is clearly displayed.

I need hardly point out what important aid this must give to the surgeon. As an instance, I may mention a case which occurred in the practice of Mr. Howard Marsh. He was called to see a severe injury of the elbow, in which the swelling was so great as to make it impossible for him by ordinary means of examination to decide whether he had to deal with a fracture or a dislocation. If it were the latter, a cure would be effected by the exercise of violence, which would be not only useless, but most injurious, if a bone was broken. By the aid of the Röntgen rays a photograph was taken in which the bone of the upper arm was clearly seen displaced forwards on those of the forearm. The diagnosis being thus established, Mr. Marsh proceeded to reduce the dislocation; and his success was proved by another photograph which showed the bones in their natural relative position.

The common metals, such as lead, iron and copper, being still denser than the osseous structures, these rays can show a bullet embedded in a bone or a needle lodged about a joint. At the last conversazione of the Royal Society a picture produced by the new photography displayed with perfect distinctness through the bony framework of the chest a halfpenny low down in a boy's gullet. It had been there for six months, causing uneasiness at the pit of the stomach during swallowing; but whether the coin really remained impacted, or, if so, what was its position, was entirely uncertain till the Röntgen rays revealed it. Dr. Macintyre, of Glasgow, who was the photographer, informs me that when the presence of the halfpenny had been thus demonstrated, the surgeon in charge of the case made an attempt to extract it, and although this was not successful in its immediate object it had the effect of dislodging the coin; for a subsequent photograph by Dr. Macintyre not only showed that it had disappeared from the gullet, but also, thanks to the wonderful penetrating power which the rays had acquired in his hands, proved that it had not lodged further down in the alimentary passage. The boy has since completely recovered.

The Röntgen rays cause certain chemical

compounds to fluoresce, and emit a faint light plainly visible in the dark; and if they are made to fall upon a translucent screen impregnated with such a salt, it becomes beautifully illuminated. If a part of the human body is interposed between the screen and the source of the rays, the bones and other structures are thrown in shadow upon it, and thus a diagnosis can be made without the delay involved in taking a photograph. It was in fact in this way that Dr. Macintyre first detected the coin in the boy's gullet. Mr. Herbert Jackson, of King's College, London, early distinguished himself in this branch of the subject. There is no reason to suppose that the limits of the capabilities of the rays in this way have yet been reached. By virtue of the greater density of the heart than the adjacent lungs, with their contained air, the form and dimensions of that organ in the living body may be displayed on the fluorescent screen, and even its movements have been lately seen by several different observers.

Such important applications of the new rays to medical practice have strongly attracted the interest of the public to them, and I venture to think that they have even served to stimulate the investigations of physicists. The eminent Professor of Physics in the University College of this city (Prof. Lodge) was one of the first to make such practical applications, and I was able to show to the Royal Society at a very early period a photograph, which he had the kindness to send me, of a bullet embedded in the hand. His interest in the medical aspect of the subject remains unabated, and at the same time he has been one of the most distinguished investigators of its purely physical side.

There is another way in which the Röntgen rays connect themselves with physiology, and may possibly influence medicine. It is found that if the skin is long exposed to their action it becomes very much irritated, affected with a sort of aggravated sunburning. This suggests the idea that the transmission of the rays through the human body may be not altogether a matter of indifference to internal organs, but may, by long-continued action, produce, according to the condition of the part concerned, injurious irritation of salutary stimulation.

This is the jubilee of Anæsthesia in surgery. That priceless blessing to mankind came from America. It had, indeed, been foreshadowed in the first year of this century by Humphry Davy, who, having found a toothache from which he was suffering relieved as he inhaled laughing gas (nitrous oxide), threw out the suggestion that it might perhaps be used for preventing pain in surgical operations. But it was not till, on September 30, 1846, Dr. W. T. G. Morton, of Boston, after a series of experiments upon himself and the lower animals, extracted a tooth painlessly from a patient whom he had caused to inhale the vapor of sulphuric ether, that the idea was fully realized. He soon afterwards publicly exhibited his method at the Massachusetts General Hospital, and after that event the great discovery spread rapidly over the civilized world. I witnessed the first operation in England under ether. It was performed by Robert Liston in University College Hospital, and it was a complete success. Soon afterwards I saw the same great surgeon amputate the thigh as painlessly, with less complicated anæsthetic apparatus, by aid of another agent, chloroform, which was being powerfully advocated as a substitute for ether by Dr. (afterwards Sir James Y.) Simpson, who also had the great merit of showing that confinements could be conducted painlessly, yet safely, under its influence. These two agents still hold the field as general anæsthetics for protracted operations, although the gas originally suggested by Davy, in consequence of its rapid action and other advantages, has taken their place in short operations, such as tooth extraction. In the birthplace of anæsthesia ether has always maintained its ground; but in Europe it was to a large extent displaced by chloroform till recently, when many have returned to ether, under the idea that, though less convenient, it is safer. For my own part, I believe that chloroform, if carefully administered on right principles, is, on the average, the safer agent of the two.

The discovery of anæsthesia inaugurated a new era in surgery. Not only was the pain of operations abolished, but the serious and sometimes mortal shock which they occasioned to the system was averted, while the patient was saved the terrible ordeal of preparing to endure them. At the same time the field of surgery became widely extended, since many procedures in themselves desirable, but before impossible from the protracted agony they would occasion, became matters of routine practice. Nor have I by any means exhausted the list of the benefits conferred by this discovery.

Anæsthesia in surgery has been from the first to last a gift of science. Nitrous oxide, sulphuric ether and chloroform are all artificial products of chemistry, their employment as anæsthetics was the result of scientific investigation, and their administration, far from being, like the giving of a dose of medicine, a matter of rule of thumb, imperatively demands the vigilant exercise of physiological and pathological knowledge.

While rendering such signal service to surgery, anæsthetics have thrown light upon biology generally. It has been found that they exert their soporific influence not only upon vertebrata, but upon animals so remote in structure from man as bees and other insects. Even the functions of vegetables are suspended by their agency. They thus afford strong confirmation of the great generalization that living matter is of the same essential nature wherever it is met with on this planet, whether in the animal or vegetable kingdom. Anæsthetics have also, in ways to which I need not here refer, powerfully promoted the progress of physiology and pathology.

My next illustration may be taken from the work of Pasteur on fermentation. The prevailing opinion regarding this class of phenomena when they first engaged his attention was that they were occasioned primarily by the oxygen of the air acting upon unstable animal or vegetable products, which, breaking up under its influence, communicated disturbance to other organic materials in their vicinity, and thus led to their decomposition. Cagniard-Latour had, indeed, shown several years before that yeast consists essentially of the cells of a microscopic fungus which grows as the sweetwort ferments; and he had attributed the breaking up of the sugar into alcohol and carbonic acid to the growth of the micro-organism. In Germany Schwann, who independently discovered the yeast plant, had published very striking experiments in support of analogous ideas regarding the putrefaction of meat. Such views had also found other advocates, but they had become utterly discredited, largely through the great authority of Liebig, who bitterly opposed them.

Pasteur, having been appointed as a young man Dean of the Faculty of Sciences in the University of Lille, a town where the products of alcoholic fermentation were staple articles of manufacture, determined to study that process thoroughly; and, as a result, he became firmly convinced of the correctness of Cagniard-Latour's views regarding it. In the case of other fermentations, however, nothing fairly comparable to the formation of yeast had till then been observed. This was now done by Pasteur for that fermentation in which sugar is resolved into lactic acid. This lactic fermentation was at that time brought about by adding some animal substance, such as fibrin, to a solution of sugar, together with chalk that should combine with the acid as it was formed. Pasteur saw, what had never before been noticed, that a fine gray deposit was formed, differing little in appearance from the decomposing fibrin, but steadily increasing as the fermentation proceeded. Struck by the analogy presented by the increasing deposit to the growth of yeast in sweetwort, he examined it with the microscope, and found it to consist of minute particles of uniform size. Pasteur was not a biologist, but although these particles were of extreme minuteness in comparison with the constituents of the yeast plant, he felt convinced that they were of an analogous nature, the cells of a tiny microscopic fungus. This he regarded as the essential ferment, the fibrin or other so-called ferment serving, as he believed, merely the purpose of supplying to the growing plant certain chemical ingredients not contained in the sugar, but essential to its nutrition. And the correctness of this view he confirmed in a very striking manner, by doing away with the fibrin or other animal material altogether, and substituting for it mineral salts containing the requisite chemical elements. A trace of the gray deposit being applied to a solution of sugar containing these salts, in addition to the chalk, a brisker lactic fermentation ensued than could be procured in the ordinary way.

I have referred to this research in some detail because it illustrates Pasteur's acuteness as an observer and his ingenuity in experiment, as well as his almost intuitive perception of truth.

A series of other beautiful investigations followed, clearly proving that all true fermentations, including putrefaction, are caused by the growth of micro-organisms.

It was natural that Pasteur should desire to know how the microbes which he showed to be the essential causes of the various fermentations took their origin. It was at that period a prevalent notion, even among many eminent naturalists, that such humble and minute beings originated *de novo* in decomposing organic substances; the doctrine of spontaneous generation, which had been chased successively from various positions which it once occupied among creatures visible to the naked eye, having taken its last refuge where the objects of study were of such minuteness that their habits and history were correspondingly difficult to trace. Here again Pasteur at once saw, as if by instinct, on which side the truth lay; and perceiving its immense importance, he threw himself with ardour into its demonstration. I may describe briefly one class of experiments which he performed with this object. He charged a series of narrow-necked glass flasks with a decoction of yeast, a liquid peculiarly liable to alteration on exposure to the air. Having boiled the liquid in each flask, to kill any living germs it might contain, he sealed its neck with a blowpipe during ebullition; after which the flask being allowed to cool, the stream within it condensed, leaving a vacuum above the liquid. If, then, the neck of the flask were broken in any locality, the air at that particular place would rush in to fill the vacuum, carrying with it any living microbes that might be floating in it. The neck of the flask having been again sealed, any germs so introduced would in due time manifest their presence by developing in the clear liquid. When any of such a series of flasks were opened and re-sealed in an inhabited room, or under the trees of a forest, multitudes of minute living forms made their appearance in them; but if this was done in a cellar long unused, where the suspended organisms, like other dust, might be expected to have all fallen to the ground, the decoction remained perfectly clear and unaltered. The oxygen and other gaseous constituents of the atmosphere were thus shown to be of themselves incapable of inducing any organic development in yeast water.

Such is a sample of the many well-devised experiments by which he carried to most minds the conviction that, as he expressed it, '*la génération spontanée est une chimère*,' and that the humblest and minutest living organisms can only originate by parentage from beings like themselves.

Pasteur pointed out the enormous importance of these humble organisms in the economy of nature. It is by their agency that the dead bodies of plants and animals are resolved into simpler compounds fitted for assimilation by new living forms. Without their aid the world would be, as Pasteur expresses it, *encombré de cadavres*. They are essential not only to our well-being, but to our very existence. Similar microbes must have discharged the same necessary function of removing refuse and providing food for successive generations of plants and animals during the past periods of the world's history; and it is interesting to think that organisms as simple as can well be conceived to have existed when life first appeared upon our globe have, in all probability, propagated the same lowly but must useful offspring during the ages of geological time.

Pasteur's labors on fermentation have had a very important influence upon surgery. I have been often asked to speak on my share in this matter before a public audience; but I have hitherto refused to do so, partly because the details are so entirely technical, but chiefly because I have felt an invincible repugnance to what might seem to savor of self-advertisement. The latter objection now no longer exists, since advancing years have indicated that it is right for me to leave to younger men the practice of my dearly loved profession. And it will perhaps be expected that, if I can make myself intelligible, I should say something upon the subject on the present occasion.

Nothing was formerly more striking in surgical experience than the difference in the behavior of injuries according to whether the skin was implicated or not. Thus, if the bones of the leg were broken and the skin remained intact, the surgeon applied the necessary apparatus without any other anxiety than that of maintaining a good position of the fragments, although the internal injury to bones and soft parts might be very severe. If, on the other hand, a wound of the skin was present, communicating with the broken bones, although the damage might be in other respects comparitively slight, the compound fracture, as it was termed, was one of the most dangerous accidents that could happen. Mr. Syme, who was, I believe, the safest surgeon of his time, once told me that he was inclined to think that it would be, on the whole, better if all compound fractures of the leg were subjected to amputation, without any attempt to save the limb. What was the cause of this astonishing difference? It was clearly in some way due to the exposure of the injured parts to the external world. One obvious effect of such exposure was indicated by the odor of the discharge, which showed that the blood in the wound had undergone putrefactive change by which the bland nutrient liquid had been converted into highly irritating and poisonous substances. I have seen a man with compound fracture of the leg die within two days of the accident, as plainly poisoned by the products of putrefaction as if he had taken a fatal dose of some potent toxic drug.

An external wound of the soft parts might be healed in one of two ways. If its surfaces were clean cut, and could be brought into accurate apposition, it might unite rapidly and painlessly 'by the first intention.' This, however, was exceptional.

Too often the surgeon's efforts to obtain primary union were frustrated, the wound inflamed and the retentive stitches had to be removed, allowing it to gape; and then, as if it had been left open from the first, healing had to be effected in the other way which it is necessary for me briefly to describe. An exposed raw surface became covered in the first instance with a layer of clotted blood or certain of its constituents, which invariably putrefied; and the irritation of the sensitive tissues by the putrid products appeared to me to account sufficiently for the inflammation which always occurred in and around an open wound during the three or four days which elapsed before what were termed 'granulations' had been produced. These constituted a coarsely granular coating of very imperfect or embryonic structure, destitute of sensory nerves and prone to throw off matter or pus, rather than absorb, as freshly divided tissues do, the products of putrefaction. The granulations thus formed a beautiful living plaster, which protected the sensitive parts beneath from irritation, and the system generally from poisoning and consequent febrile disturbance. The granulations had other useful properties, of which I may mention their tendency to shrink as they grew, thus gradually reducing the dimensions of the sore. Meanwhile, another cause of its diminution was in operation. The cells of the epidermis, or scarfskin of the cutaneous margins, were perpetually producing a crop of young cells of similar nature, which gradually spread over the granulations till they covered them entirely, and a complete cicatrix or scar was the result. Such was the other mode of healing that, by granulation and cicatrisation, a process which, when it proceeded unchecked to its completion, commanded our profound admiration. It was, however, essentially tedious compared with primary union, while, as we have seen, it was always preceded by more or less inflammation and fever, sometimes very serious in their effects. It was also liable to unforseen interruptions. The sore might become larger instead of smaller, cicatrisation giving place to ulceration in one of its various forms, or even to the frightful destruction of tissue which, from the circumstance that it was most frequently met with in hospitals, was termed hospital gangrene. Other serious and often fatal complications might arise, which the surgeon could only regard as untoward accidents and over which he had no efficient control.

It will be readily understood from the above description that the inflammation which so often frustrated the surgeon's endeavors after primary union was, in my opinion, essentially due to decomposition of blood within the wound.

These and many other considerations had long impressed me with the greatness of the evil of putrefaction in surgery. I had done my best to mitigate it by scrupulous ordinary cleanliness and the use of various deodorant lotions. But to prevent it altogether appeared hopeless while we believed with Liebeg that its primary cause was the atmospheric oxygen which, in accordance with the researches of Graham, could not fail to be perpetually diffused through the porous dressings which were used to absorb the blood discharged from the wound. But when Pasteur had shown that putrefaction was a fermentation caused by the growth of microbes, and that these could not arise *de novo* in the decomposable substance, the problem assumed a more hopeful aspect. If the wound could be treated with some substance which, without doing too serious mischief to the human tissues, would kill the microbes already contained in it and prevent the future access of others in the living state, putrefaction might be prevented, however freely the air with its oxygen might enter. I had heard of carbolic acid as having a remarkable deodorising effect upon sewage, and having obtained from my colleague, Dr. Anderson, Professor of Chemistry in the University of Glasgow, a sample which he had of this product, then little more than a chemical curiosity in Scotland, I determined to try it in compound fractures. Applying it undiluted to the wound, with an arrangement for its occasional renewal, I had the joy of seeing these formidable injuries follow the same safe and tranquil course as simple fractures, in which the skin remains unbroken.

At the same time we had the intense interest of observing in open wounds what had previously been hidden from human view—the manner in which subcutaneous injuries are repaired. Of special interest was the process by which portions of tissue killed by the violence of the accident were disposed of, as contrasted with what had till then been invariably witnessed. Dead parts had been always seen to be gradually separated from the living by an inflammatory process and thrown off as sloughs. But when protected by the antiseptic dressing from becoming putrid and therefore irritating, a structure deprived of its life caused no disturbance in its vicinity; and on the contrary, being of a nutritious nature, it served as pabulum for the growing elements of the neighboring living structures, and these became in due time entirely substituted for it. Even dead bone was seen to be thus replaced by living osseous tissue.

This suggested the idea of using threads of dead animal tissue for tying blood vessels; and this was realized by means of catgut, which is made from the intestine of the sheep. If deprived of living microbes, and otherwise properly prepared, catgut answers its purpose completely; the knot holding securely, while the ligature around the vessel becomes gradually absorbed and replaced by a ring of living tissue. The threads, instead of being left long as before, could now be cut short, and the tedious process of separation of the ligature, with its attendant serious danger of bleeding, was avoided.

Undiluted carbolic acid is a powerful caustic; and although it might be employed in compound fracture, where some loss of tissue was of little moment in comparison with the tremendous danger to be averted, it was altogether unsuitable for wounds made by the surgeon. It soon appeared, however, that the acid would answer the purpose aimed at, though used in diluted forms devoid of caustic action, and therefore applicable to operative surgery. According to our then-existing knowledge, two essential points had to be aimed at: to conduct the operation so that on its completion the wound should contain no living microbes; and to apply a dressing capable of preventing the access of other living organisms till the time should have arrived for changing it.

Carbolic acid lent itself well to both these objects. Our experience with this agent brought out what was, I believe, a new principle in pharmacology—namely, that the energy of action of any substance upon the human tissues depends not only upon the proportion in which it is contained in the material used as a vehicle for its administration, but also upon the degree of tenacity with which it is held by its solvent. Water dissolves carbolic acid sparingly and holds it extremely lightly, leaving it free to act energetically on other things for which it has greater affinity, while various organic substances absorb it greedily and hold it tenaciously. Hence its watery solution seemed admirably suited for a detergent lotion to be used during the operation for destroying any microbes that might fall upon the wound, and for purifying the surrounding skin and also the surgeon's hands and instruments. For the last-named purpose it had the further advantage that it did not act on steel.

For an external dressing the watery solution was not adapted, as it soon lost the acid it contained, and was irritating while it lasted. For this purpose some organic substances were found to answer well. Large proportions of the acid could be blended with them in so bland a form as to be unirritating; and such mixtures, while perpetually giving off enough of the volatile salt to prevent organic development in the discharges that flowed past them, served as a reliable store of the antiseptic for days together.

The appliances which I first used for carrying out the antiseptic principle were both rude and needlessly complicated. The years that have since passed have witnessed great improvements in both respects. Of the various materials which have been employed by myself and others, and their modes of application, I need say nothing except to express my belief, as a matter of long experience, that carbolic acid, by virtue of its powerful affinity for the epidermis and oily matters associated with it, and also its great penetrating power, is still the best agent at our disposal for purifying the skin around the wound. But I must say a few words regarding a most important simplification of our procedure. Pasteur, as we have seen, had shown that the air of every inhabited room teems with microbes; and for a long time I employed various more or less elaborate precautions against the living atmospheric dust, not doubting that, as all wounds except the few which healed completely by the first intention underwent putrefactive fermentation, the blood must be a peculiarly favorable soil for the growth of putrefactive microbes. But I afterwards learnt that such was by no means the case. I had performed many experiments in confirmation of Pasteur's germ theory, not indeed in order to satisfy myself of its truth, but in the hope of convincing others. I had observed that uncontaminated milk, which would remain unaltered for an indefinite time if protected from dust, was made to teem with microbes of different kinds by a very brief exposure to the atmosphere, and that the same effect was produced by the addition of a drop of ordinary water. But when I came to experiment with blood drawn with antiseptic precautions into sterilized vessels, I saw, to my surprise, that it might remain free from microbes, in spite of similar access of air or treatment with water. I even found that if very putrid blood was largely diluted with sterilized water, so as to diffuse its microbes widely and wash them of their acrid products, a drop of such dilution added to pure blood might leave it unchanged for days at the temperature of the body, although a trace of the septic liquid undiluted caused intense putrefaction within twenty-four hours. Hence I was led to conclude that it was the goosser forms of septic mischief, rather than microbes in the attenuated condition in which they existed in the atmosphere, that we had to dread in surgical practice. And at the London Medical Congress, in 1881, I hinted, when describing the experiments I have alluded to, that it might turn out possible to disregard altogether the atmospheric dust. But greatly as I should have rejoiced at such a simplification of our procedure, if justifiable, I did not then venture to test it in practice. I knew that with the safeguards which we then employed I could ensure the safety of my patients, and I did not dare to imperil it by relaxing them. There is one golden rule for all experiments upon our fellow-men. Let the thing tried be that which, according to our best judgment, is the most likely to promote the welfare of the patient. In other words, do as you would be done by.

Nine years later, however, at the Berlin Congress in 1890, I was able to bring forward what was, I believe, absolute demonstration of the harmlessness of the atmospheric dust in surgical operations. This conclusion has been justified by subsequent experience ; the irritation of the wound by antiseptic irrigation and washing may therefore now be avoided, and nature left quite undisturbed to carry out her best methods of repair, while the surgeon may conduct his operations as simply as in former days, provided always that, deeply impressed with the tremendous importance of his object, and inspiring the same conviction in all his assistants, he vigilantly maintains from first to last, with care that, once learnt, becomes instinctive, but for the want of which nothing else can compensate, the use of the simple means which will suffice to exclude from the wound the coarser forms of septic impurity.

Even our earlier and ruder methods of carrying out the antiseptic principle soon produced a wonderful change in my surgical wards in the Glasgow Royal Infirmary, which, from being some of the most unhealthy in the kingdom, became, as I believe I may say without exaggeration, the healthiest in the world ; while other wards, separated from mine only by a passage a few feet broad, where former modes of treatment were for a while continued, retained their former insalubrity. This result, I need hardly remark, was not in any degree due to special skill on my part, but simply to the strenuous endeavor to carry out strictly what seemed to me a principle of supreme importance.

Equally striking changes were afterwards witnessed in other institutions. Of these I may give one example. In the great Allgemeines Krankenhaus, of Munich, hospital gangrene had become more and more rife from year to year, till at length the frightful condition was reached that 80 per cent. of all wounds became affected by it. It is only just to the memory of Prof. von Nussbaum, then the head of that establishment, to say that he had done his utmost to check this frightful scourge ; and that the evil was not caused by anything peculiar in his management was shown by the fact that in a private hospital under his care there was no unusual unhealthiness. The larger institution seemed to have become hopelessly infected, and the city authorities were contemplating its demolition and reconstruction. Under these circumstances, Prof. von Nussbaum dispatched his chief assistant, Dr. Lindpaintner, to Edinburgh, where I at that time occupied the chair of clinical surgery, to learn the details of the antiseptic system as we then practiced it. He remained until he had entirely mastered them, and after his return all the cases were on a certain day dressed on our plan. From that day forward not a single case of hospital gangrene occurred in the Krankenhaus. The fearful disease pyæma likewise disappeared, and erysipelas soon followed its example.

But it was by no means only in removing the unhealthiness of hospitals that the antiseptic system showed its benefits. Inflammation being suppressed, with attendant pain, fever and wasting discharge, the sufferings of the patient were, of course, immensely lessened; rapid primary union being now the rule, convalescence was correspondingly curtailed ; while, as regards safety and the essential nature of the mode of repair, it became a matter of indifference whether the wound had clean-cut surfaces which could be closely approximated, or whether the injury inflicted had been such as to cause destruction of tissue. And operations which had been regarded from time immemorial as unjustifiable were adopted with complete safety.

It pleases me to think that there is an ever-increasing number of practitioners throughout the world to whom this will not appear the language of exaggeration. There are cases in which, from the situation of the part concerned or other unusual circumstances, it is impossible to carry out the antiseptic system completely. These, however, are quite exceptional; and even in them much has been done to mitigate the evil which cannot be altogether avoided.

I ask your indulgence if I have seemed to dwell too long upon matters in which I have been personally concerned. I now gladly return to the labors of others.

The striking results of the application of the germ theory to surgery acted as a powerful stimulus to the investigation of the nature of the micro-organisms concerned; and it soon appeared that putrefaction was by no means the only evil of microbic origin to which wounds were liable. I had myself very early noticed that hospital gangrene was not necessarily attended by any unpleasant odor; and I afterwards made a similar observation regarding the matter formed in a remarkable epidemic of erysipelas in Edinburgh obviously of infective character. I had also seen a careless dressing followed by the occurrence of suppuration without putrefaction. And as these non-putrefactive disorders had the same self-propagating property as ferments, and were suppressed by the same antiseptic agencies which were used for combating the putrefactive microbes, I did not doubt that they were of an analogous origin; and I ventured to express the view that, just as the various fermentations had each its special microbe, so it might be with the various complications of wounds. This surmise was afterwards amply verified. Prof. Ogston, of Aberdeen, was an early worker in this field, and showed that in acute abscesses, that is to say, those which run a rapid course, the matter, although often quite free from unpleasant odor, invariably contains micro-organisms belonging to the group which, from the spherical form of their elements, are termed micrococci; and these he classed as streptococci or staphylococci, according as they were arranged in chains or disposed in irregular clusters like bunches of grapes. The German pathologist, Fehleisen, followed with a beautiful research, by which he clearly proved that erysipelas is caused by a streptococcus. A host of earnest workers in different countries have cultivated the new science of Bacteriology, and, while opening up a wide fresh domain of Biology, have demonstrated in so many cases the causal relation between special micro-organisms and special diseases, not only in wounds, but in the system generally, as to afford ample confirmation of the induction which had been made by Pasteur that all infective disorders are of microbic origin.

Not that we can look forward with anything like confidence to being able to see the *materies morbi* of every disease of this nature. One of the latest of such discoveries has been that by Pfeiffer, of Berlin, of the bacillus of influenza, perhaps the most minute of all micro-organisms ever yet detected. The bacillus of anthrax, the cause of a plague common among cattle in some parts of Europe, and often communicated to sorters of foreign wool in this country, is a giant as compared with this tiny being; and supposing the microbe of any infectious fever to be as much smaller than the influenza bacillus as this is less than that of anthrax, a by no means unlikely hypothesis, it is probable that it would never be visible to man. The improvements of the microscope, based on the principle established by my father in the earlier part of the century, have apparently nearly reached the limits of what is possible. But that such parasites are really the causes of all this great class of diseases can no longer be doubted.

The first rational step towards the prevention or cure of disease is to know its cause; and it is impossible to over-estimate the practical value of researches, such as those to which I am now referring. Among their many achievements is what may be fairly regarded as the most important discovery ever made in pathology, because it revealed the true nature of the disease which causes more sickness and death in the human race than any other. It was made by Robert Koch, who greatly distinguished himself, when a practitioner in an obscure town in Germany, by the remarkable combination of experimental acuteness and skill, chemical and optical knowledge and successful micro-photography which he brought to bear upon the illustration of infective diseases of wounds in the lower animals; in recognition of which service the enlightened Prussian government at once appointed him to an official position of great importance in Berlin. There he conducted various important researches; and at the London Congress, in 1881, he showed to us, for the first time, the bacillus of tubercle. Wonderful light was thrown, by this discovery, upon a great group of diseases which had before been rather guessed than known to be of an allied nature; a precision and efficacy never before possible was introduced into their surgical treatment, while the physician became guided by new and sure light as regards their diagnosis and prevention.

At that same London Congress Koch demonstrated to us his 'plate culture' of bacteria, which was so important that I must devote a few words to its description. With a view to the successful study of the habits and effects of any particular microbe outside the living body it is essential that it should be present unmixed in the medium in which it is cultivated. It can be readily understood how difficult it must have been to isolate any particular micro-organism when it existed mixed, as was often the case, with a multitude of other forms. In fact, the various ingenious attempts made to effect this object had often proved entire failures. Koch, however, by an ingenious procedure converted what had been before impossible into a matter of the utmost facility. In the broth or other nutrient liquid which was to serve as food for the growing microbe he dissolved, by aid of heat, just enough gelatine to ensure that, while it should become a solid mass when cold, it should remain fluid, though reduced in temperature so much as to be incapable of killing living germs. To the medium thus partially cooled was added some liquid containing, among others, the microbe to be investigated; and the mixture was thoroughly shaken so as to diffuse the bacteria and separate them from each other. Some of the liquid was then poured out in a thin layer upon a glass plate and allowed to cool so as to assume the solid form. The various microbes, fixed in the gelatine and so prevented from intermingling, proceeded to develop each its special progeny, which in course of time showed itself as an opaque speck in the transparent film. Any one of such specks could now be removed and transferred to another vessel in which the microbe composing it grew in perfect isolation.

Pasteur was present at this demonstration, and expressed his sense of the great progress effected by the new method. It was soon introduced into his own institute and other laboratories throughout the world; and it has immensely facilitated bacteriological study.

One fruit of it in Koch's own hands was the discovery of the microbe of cholera in India, whither he went to study the disease. This organism was termed by Koch from its curved form the 'comma bacillus,' and by the French the cholera vibrio. Great doubts were for a long time felt regarding this discovery. Several other kinds of bacteria were found of the same shape, some of them producing very similar appearances in culture media. But bacteriologists are now universally agreed that, although various other conditions are necessary to the production of an attack of cholera besides the mere presence of the vibrio, yet it is the essential *materies morbi;* and it is by the aid of the diagnosis which its presence in any case of true cholera enables the bacteriologist to make, that threatened invasions of this awful disease have of late years been so successfully repelled from our shores. If bacteriology had done nothing more for us than this it might well have earned our gratitude.

I have next to invite your attention to some earlier work of Pasteur. There is a disease known in France under the name of *cholêra des poules*, which often produced great havoc among the poultry yards of Paris. It had been observed that the blood of birds that had died of this disease was peopled by a multitude of minute bacteria, not very dissimilar in form and size to the microbe of the lactic ferment to which I have before referred. And Pasteur found that, if this bacterium was cultivated outside the body for a protracted period under certain conditions, it underwent a remarkable diminution of its virulence; so that, if inoculated into a healthy fowl, it no longer caused the death of the bird, as it would have done in its original condition, but produced a milder form of the disease which was not fatal. And this altered character of the microbe, caused by certain conditions, was found to persist in successive generations cultivated in the ordinary way. Thus was discovered the great fact, of what Pasteur termed *attênuation des virus*, which at once gave the clue to understanding what had before been quite mysterious, the difference in virulence of the same disease in different epidemics.

But he made the further very important observation that a bird which had gone through the mild form of the complaint had acquired immunity against it in its most virulent condition. Pasteur afterwards succeeded in obtaining mitigated varieties of microbes for some other diseases; and he applied with great success the principle which he had discovered in fowl-cholera for protecting the larger domestic animals against the plague of anthrax. The preparations used for such preventive inoculations he termed 'vaccins' in honor of our great countryman, Edward Jenner. For Pasteur at once saw the analogy between the immunity to fowl-cholera produced by its attenuated virus and the protection afforded against small-pox by vaccination. And while pathologists still hesitated, he had no doubt of the correctness of Jenner's expression *variolæ vaccinæ*, or small-pox in the cow.

It is just a hundred years since Jenner made the crucial experiment of inoculating with small-pox a boy whom he had previously vaccinated, the result being, as he anticipated, that the boy was quite unaffected. It may be remarked that this was a perfectly legitimate experiment, involving no danger to the subject of it. Inoculation was at that time the established practice; and if vaccination should prove nugatory, the inoculation would be only what would have been otherwise called for; while it would be perfectly harmless if the hoped-for effect of vaccination had been produced.

We are a practical people, not much addicted to personal commemorations; although our nation did indeed celebrate, with fitting splendor, the jubilee of the reign of our beloved Queen; and, at the invitation of Glasgow, the scientific world has lately marked, in a manner, though different, as imposing, the jubilee of the life-work of a sovereign in science (Lord Kelvin). But while we cannot be astonished that the centenary of Jenner's immortal discovery should have failed to receive general recognition in this country, it is melancholy to think that this year should, in his native county, have been distinguished by a terrible illustration of the results which would sooner or later inevitably follow the general neglect of his prescriptions.

I have no desire to speak severely of the Gloucester Guardians. They are not sanitary authorities, and had not the technical knowledge necessary to enable them to judge between the teachings of true science and the declamations of misguided, though well-meaning, enthusiasts. They did what they believed to be right; and when roused to a sense of the greatness of their mistake, they did their very best to repair it, so that their city is said to be now the best vaccinated in Her Majesty's dominions. But though by their praiseworthy exertions they succeeded in promptly checking the raging epidemic, they cannot recall the dead to life, or restore beauty to marred features, or sight to blinded eyes. Would that the entire country and our Legislature might take duly to heart this object lesson!

How completely the medical profession were convinced of the efficacy of vaccination in the early part of this century was strikingly illustrated by an account given by Prof. Crookshank, in his interesting history of this subject, of several eminent medical men in Edinburgh meeting to see the to them unprecedented fact of a vaccinated person having taken small-pox. It has, of course, since become well known that the milder form of the disease, as modified by passing though the cow, confers a less permanent protection than the original human disorder. This it was, of course, impossible for Jenner to foresee. It is, indeed, a question of degree, since a second attack of ordinary small-pox is occasionally known to occur, and vaccination, long after it has ceased to give perfect immunity, greatly modifies the character of the disorder and diminishes its danger. And happily, in re-vaccination after a certain number of years we have the means of making Jenner's work complete. I understand the majority of the Commissioners, who have recently issued their report upon this subject, while recognising the value of importance of re-vaccination, are so impressed with the difficulties that would attend making it compulsory by legislation that they do not recommend that course; although it is advocated by two of their number who are of peculiarly high authority on such a question. I was lately told by a Berlin professor that no serious difficulty is experienced in carrying out the compulsory law that prevails in Germany. The masters of the schools are directed to ascertain in the case of every child attaining the age of twelve whether re-vaccination has been practised. If not, and the parents refuse to have it done, they are fined one Mark. If this does not prove effectual, the fine is doubled; and if even the double penalty should not prove efficacious, a second doubling of it would follow, but, as my informant remarked, it is very seldom that it is called for. The result is that small-pox is a matter of extreme rarity in that country; while it is absolutely unknown in the huge German army, in consequence of the rule that every soldier is re-vaccinated on entering the service. Whatever view our Legislature may take on this question, one thing seems to me clear: that it will be the duty of Government to encourage by every available means the use of calf lymph, so as to exclude the possibility of the communication of any human disease to the child, and to institute such efficient inspection of vaccination institutes as shall ensure careful antiseptic arrangements, and so prevent contamination by extraneous microbes. If this were done, 'conscientious objections' would cease to have any rational basis. At the same time, the administration of the regulations on vaccination should be transferred (as advised by the Commissioners) to competent sanitary authorities.

But to return to Pasteur. In 1880 he entered upon the study of that terrible but then most obscure disease, hydrophobia, or rabies, which from its infective character he was sure must be of microbic origin, although no micro-organism could be detected in it. He early demonstrated the new pathological fact that the virus had its essential seat in the nervous system. This proved the key to his success in this subject. One result that flowed from it has been the cause of unspeakable consolation to many. The foolish practice is still too prevalent of killing the dog that has bitten any one, on the absurd notion that, if it were mad, its destruction would prevent the occurrence of hydrophobia in the person bitten. The idea of the bare possibility of the animal having been so affected causes an agony of suspense during the long weeks or months of possible incubation of the disease. Very serious nervous symptoms aping true hydrophobia have been known to result from the terror thus inspired. Pasteur showed that if a little of the brain or spinal cord of a dog that had been really mad was inoculated in an appropriate manner into a rabbit, it infallibly caused rabies in that animal in a few days. If, therefore, such an experiment was made with a negative result, the conclusion might be drawn with certainty that the dog had been healthy. It is perhaps right that I should say that the inoculation is painlessly done under an anæsthetic, and that in the rabbit rabies does not assume the violent form that it does in the dog, but produces gradual loss of power, with little, if any, suffering.

This is the more satisfactory because rabbits in which the disease has been thus artificially induced are employed in carrying out what was Pasteur's greatest triumph, the preventive treatment of hydrophobia in the human subject. We have seen that Pasteur discovered that microbes might under some circumstances undergo mitigation of their virulence. He afterwards found that under different conditions they might have it exalted, or, as he expressed it, there might be a *renforcement du virus*. Such proved to be the case with rabies in the rabbit; so that the spinal cords of animals which had died of it contained the poison in a highly intensified condition. But he also found that if such a highly virulent cord was suspended under strict antiseptic precautions in a dry atmosphere at a certain temperature, it gradually from day to day lost it potency, till in course of time it became absolutely inert. If now an emulsion of such a harmless cord was introduced under the skin of an animal, as in the subcutaneous administration of morphia, it might be followed without harm another day by a similar dose of a cord still rather poisonous; and so from day to day stronger and stronger ejections might be used, the system becoming gradually accustomed to the poison, till a degree of virulence had been reached far exceeding that of the bite of a mad dog. When this had been attained, the animal proved incapable of taking the disease in the ordinary way; and more than that, if such treatment was adopted after an animal had already received the poison, provided that too long a time had not elapsed, the outbreak of the disease was prevented. It was only after great searching of heart that Pasteur, after consultation with some trusted medical friends, ventured upon trying this practice upon man. It has since been extensively adopted in various parts of the world with increasing success as the details of the method were improved. It is not, of course, the case that every one bitten by a really rabid animal takes the disease; but the percentage of those who do so, which was formerly large, has been reduced almost to zero by this treatment, if not too long delayed.

While the intensity of rabies in the rabbit is undoubtedly due to a peculiarly virulent form of the microbe concerned, we cannot suppose that the daily diminishing potency of the cord suspended in dry warm air is an instance of attenuation of virus, using the term 'virus' as synonymous with the microbe concerned. In other words, we have no reason to believe that the special micro-organism of hydrophobia continues to develop in the dead cord and produce successively a milder and milder progeny, since rabies cannot be cultivated in the nervous system of a dead animal. We must rather conclude that there must be some chemical poison present which gradually loses its potency as time passes. And this leads me to refer to another most important branch of this large subject of bacteriology, that of the poisonous products of microbes.

It was shown several years ago by Roux and Yersin, working in the Institut Pasteur, that the crust or false membrane which forms upon the throats of patients affected with diptheria contains bacteria which can be cultivated outside the body in a nutrient liquid, with the result that it acquires poisonous qualities of astonishing intensity, comparable to that of the secretion of the poison glands of the most venomous serpents. And they also ascertained that the liquid retained this property after the microbes had been removed from it by filtration, which proved that the poison must be a chemical substance in solution, as distinguished from the living element which had produced it. These poisonous products of bacteria, or toxins, as they have been termed, explain the deadly effects of some microbes, which it would otherwise be impossible to understand. Thus, in diptheria itself the special bacillus which was shown by Löffler to be its cause does not become propagated in the blood, like the microbe of chicken cholera, but remains confined to the surface on which it first appeared; but the toxin which it secretes is absorbed from that surface into the blood, and so poisons the system. Similar observations have been made with regard to the microbes of some other diseases, as, for example, the bacillus of tetanus or lockjaw. This remains localized in the wound, but forms a special toxin of extreme potency, which becomes absorbed and diffused through the body.

Wonderful as it seems, each poisonous microbe appears to form its own peculiar toxin. Koch's tuberculin was of this nature, a product of the growth of the tubercle bacillus in culture media. Here, again, great effects were produced by extremely minute quantities of the substance, but here a new peculiarity showed itself, viz., that patients affected with tubercular disease, in any of its varied forms, exhibited inflammation in the affected part and general fever after receiving under the skin an amount of the material which had no effect whatever upon healthy persons. I witnessed, in Berlin, some instances of these effects, which were simply astounding. Patients affected with a peculiar form of obstinate ulcer of the face showed, after a single injection of the tuberculin, violent inflammatory redness and swelling of the sore and surrounding skin; and, what was equally surprising, when this disturbance subsided the disease was found to have undergone great improvement. By repetitions of such procedures, ulcers which had previously been steadily advancing, in spite of ordinary treatment, became greatly reduced in size, and in some instances apparently cured. Such results led Koch to believe that he had obtained an effectual means of dealing with tubercular disease in all its forms. Unhappily, the apparent cure proved to be only of transient duration, and the high hopes which had been inspired by Koch's great reputation were dashed. It is but fair to say that he was strongly urged to publish before he was himself disposed to do so, and we cannot but regret that he yielded to the pressure put upon him.

But though Koch's sanguine anticipations were not realized, it would be a great mistake to suppose that his labors with tuberculin have been fruitless. Cattle are liable to tubercle, and, when affected with it, may become a very serious source of infection for human beings, more especially when the disease affects the udders of cows, and so contaminates the milk. By virtue of the close affinity that prevails between the lower animals and ourselves, in disease as well as in health, tuberculin produces fever in tubercular cows in doses which do not affect healthy beasts. Thus, by the subcutaneous use of a little of the fluid, tubercle latent in internal organs of an apparently healthy cow can be with certainty revealed, and the slaughter of the animal after this discovery protects man from infection.

It has been ascertained that glanders presents a precise analogy with tubercle as regards the effects of its toxic products. If the microbe which has been found to be the cause of this disease is cultivated in appropriate media it produces a poison which has received the name of mallein, and the subcutaneous injection of a suitable dose of this fluid into a glandered horse causes striking febril symptoms which do not occur in a healthy animal. Glanders, like tubercle, may exist in insidious latent forms which there was formerly no means of detecting, but which are at once disclosed by this means. If a glandered horse has been accidentally introduced into a large stable this method of diagnosis surely tells if it has infected others. All receive a little mallein. Those which become affected with fever are slaughtered, and thus not only is the disease prevented from spreading to other horses, but the grooms are protected from a mortal disorder.

This valuable resource sprang from Koch's work on tuberculin, which has also indirectly done good in other ways. His distinguished pupil, Behring, has expressly attributed to those researches the inspiration of the work which led him and his famous collaborateur, the Japanese Kitasato, to their surprising discovery of anti-toxic serum. They found that if an animal of a species liable to diphtheria or tetanus received a quantity of the respective toxin, so small as to be harmless, and afterwards, at suitable intervals, successively stronger and stronger doses, the creature, in course of time, acquired such a tolerance for the poison as to be able to receive with impunity a quantity very much greater than would at the outset have proved fatal. So far we have nothing more than seems to correspond with the effects of the increasingly potent cords in Pasteur's treatment of rabies. But what was entirely new in their results was that, if blood was drawn from an animal which had acquired this high degree of artificial immunity, and some of the clear fluid or serum which exuded from it after it had clotted was introduced under the skin of another animal, this second animal acquired a strong, though more transient, immunity against the particular toxin concerned. The serum in some way counteracted the toxin or was antitoxic. But, more than that, if some of the antitoxic serum was applied to an animal after it had already received a poisonous dose of the toxin it preserved the life of the creature, provided that too long a time had not elapsed after the poison was introduced. In other words, the antitoxin proved to be not only preventive but curative.

Similar results were afterwards obtained by Ehrlich, of Berlin, with some poisons not of bacterial origin, but derived from the vegetable kingdom; and quite recently the independent labors of Calmette, of

Lille, and Fraser, of Edinburgh, have shown that antidotes of wonderful efficacy against the venom of serpents may be procured on the same principle. Calmette has obtained antitoxin so powerful that a quantity of it only a 200,000th part of the weight of an animal will protect it perfectly against a dose of the secretion of the poison glands of the most venomous serpents known to exist, which, without such protection, would have proved fatal in four hours. For curative purposes larger quantities of the remedy are required, but cases have been already published by Calmette in which death appears to have been averted in the human subject by this treatment.

Behring's darling object was to discover means of curing tetanus and diphtheria in man. In tetanus the conditions are not favorable; because the specific bacilli lurk in the depths of the wound, and only declare their presence by symptoms caused by their toxin having been already in a greater or less amount diffused through the system; and in every case of this disease there must be a fear that the antidote may be applied too late to be useful. But in diphtheria the bacilli very early manifest their presence by the false membrane which they cause upon the throat, so that the antitoxin has a fair chance; and here we are justified in saying that Behring's object has been attained.

The problem, however, was by no means so simple as in the case of some mere chemical poison. However effectual the antitoxin might be against the toxin, if it left the bacilli intact, not only would repeated injections be required to maintain the transient immunity to the poison perpetually secreted by the microbes, but the bacilli might, by their growth and extension, cause obstruction of the respiratory passages.

Roux, however, whose name must always be mentioned with honor in relation to this subject, effectually disposed of this difficulty. He showed by experiments on animals that a diphtheritic false membrane, rapidly extending and accompanied by surrounding inflammation, was brought to a stand by the use of the antitoxin, and soon dropped off, leaving a healthy surface. Whatever be the explanation, the fact was thus established that the antitoxic serum, while it renders the toxin harmless, causes the microbe to languish and disappear.

No theoretical objection could now be urged against the treatment; and it has during the last two years been extensively tested in practice in various parts of the world, and it has gradually made its way more and more into the confidence of the profession. One important piece of evidence in its favor in this country is derived from the report of the six large hospitals under the management of the London Asylums Board. The medical officers of these hospitals at first naturally regarded the practice with scepticism, but as it appeared to be at least harmless they gave it a trial; and during the year 1895 it was very generally employed upon the 2,182 cases admitted, and they have all become convinced of its great value. In the nature of things, if the theory of the treatment is correct, the best results must be obtained when the patients are admitted at an early stage of the attack, before there has been time for much poisoning of the system, and accordingly we learn from the report that, comparing 1895 with 1894, during which latter year the ordinary treatment had been used, the percentage of mortality, in all the six hospitals combined, among the patients admitted on the first day of the disease, which in 1894 was 22.5, was only 4.6 in 1895; while for those admitted on the second day the numbers are 27 for 1894 and 14.8 for 1895. Thus for cases admitted on the first day the mortality was only one-fifth of what it was in the previous year, and for those entering on the second it was halved. Unfortunately, in the low parts of London, which furnish most of these patients, the parents too often delay sending in the children till much later, so that on the average no less than 67.5 per cent. were admitted on the fourth day of the disease or later. Hence the aggregate statistics of all cases are not nearly so striking. Nevertheless, taking it altogether, the mortality in 1895 was less than had ever before been experienced in those hospitals. I should add that there was no reason to think that the disease was of a milder type than usual in 1895; and no change whatever was made in the treatment except as regards the antitoxic injections.

There is one piece of evidence recorded in the report which, though it is not concerned with high numbers, is well worthy of notice. It relates to a special institution to which convalescents from scarlet fever are sent from all the six hospitals. Such patients occasionally contract diphtheria, and when they do so the added disease has generally proved extremely fatal. In the five years preceding the introduction of the treatment with antitoxin the mortality from this cause had never been less than 50 per cent., and averaged on the whole 61.9 per cent. During 1895, under antitoxin, the deaths among the 119 patients of this class were only 7.5 per cent., or one-eighth of what had been previously experienced. This very striking result seems to be naturally explained by the fact that these patients being already in hospital when the diphtheria appeared, an unusually early opportunity was afforded for dealing with it.

There are certain cases of so malignant a character from the first that no treatment will probably ever be able to cope with them. But taking all cases together, it seems probable that Behring's hope that the mortality may be reduced to five per cent. will be fully realized when the public become alive to the paramount importance of having the treatment commenced at the outset of the disease.

There are many able workers in the field of bacteriology whose names time does not permit me to mention, and to whose important labors I cannot refer; and even those researches of which I have spoken have been, of course, most inadequately dealt with. I feel this especially with regard to Pasteur, whose work shines out more brightly the more his writings are perused.

I have lastly to bring before you a subject which, though not bacteriological, has intimate relations with bacteria. If a drop of blood is drawn from the finger by a prick with a needle and examined microscopically between two plates of glass, there are seen in it minute solid elements of two kinds, the one pale orange bi-concave discs, which, seen in mass, give the red color to the vital fluid, the other more or less granular spherical masses of the soft material called protoplasm, destitute of color, and therefore called the colorless or white corpuscles. It has been long known that if the microscope was placed at such a distance from a fire as to have the temperature of the human body, the white corpuscles might be seen to put out and retract little processes or pseudopodia, and by their means crawl over the surface of the glass, just like the extremely low forms of animal life termed, from this faculty of changing their form, amœbæ. It was a somewhat weird spectacle, that of seeing what had just before been constituents of our own blood moving about like independent creatures. Yet there was nothing in this inconsistent with what we knew of the fixed components of the animal frame. For example, the surface of a frog's tongue is covered with a layer of cells, each of which is provided with two or more lashing filaments or cilia, and those of all the cells acting in concert cause a constant flow of liquid in a definite direction over the organ. If we gently scrape the surface of the animal's tongue we can detach some of these ciliated cells; and on examining them with the microscope in a drop of water we find that they will continue for an indefinite time their lashing movements, which are just as much living or vital in their character as the writhings of a worm. And, as I observed many years ago, these detached cells behave under the influence of a stimulus just like parts connected with the body, the movements of the cilia being excited to greater activity by gentle stimulation, and thrown into a state of temporary inactivity when the irritation was more severe. Thus each constituent element of our bodies may be regarded as in one sense an independent living being, though all work together in marvelous harmony for the good of the body politic. The independent movements of the white corpuscles outside the body were therefore not astonishing; but they long remained matters of mere curiosity. Much interest was called to them by the observation of the German pathologist Cohnheim that in some inflammatory conditions they passed through the pores in the walls of the finest blood vessels, and thus escaped into the interstices of the surrounding tissues. Cohnheim attributed their transit to the pressure of the blood. But why it was that, though larger than the red corpuscles, and containing a nucleus which the red ones have not, they alone passed through the pores of the vessels, or why it was that this emigration of the white corpuscles occurred abundantly in some inflammations and was absent in others, was quite unexplained.

These white corpuscles, however, have been invested with extraordinary new interest by the researches of the Russian naturalist and pathologist Metchnikoff. He observed that, after passing through the walls of the vessels, they not only crawl about like amœbæ, but, like them, receive nutritious materials into their soft bodies and digest them. It is thus that the effete materials of a tadpole's tail are got rid of; so that they play a most important part in the function of absorption.

But still more interesting observations followed. He found that a microscopic crutacean, a kind of water flea, was liable to be infested by a fungus which had exceedingly sharp-pointed spores. These were apt to penetrate the coats of the creature's intestine, and project into its body cavity. No sooner did this occur with any spore than it became surrounded by a group of the cells which are contained in the cavity of the body and correspond to the white corpuscles of our blood. These proceeded to attempt to devour the spore, and if they succeeded in every such case the animal was saved from the invasion of the parasite. But if the spores were more than could be disposed of by the devouring cells (phagocytes, as Metchnikoff termed them) the water flea succumbed.

Starting from this fundamental observation, he ascertained that the microbes of infective diseases are subject to this same process of devouring and digestion, carried on both by the white corpuscles and by cells that line the blood vessels. And by a long series of most beautiful researches he has, as it appears to me, firmly established the great truth that phagocytosis is the main defensive means possessed by the living body against the invasion of its microscopic foes. The power of the system to produce anti-toxic substances to counteract the poisons of microbes is undoubtedly in its own place of great importance. But in the large class of cases in which animals are naturally refractory to particular infective diseases the blood is not found to yield any antitoxic element by which the natural immunity can be accounted for. Here phagocytosis seems to be the sole defensive agency. And even in cases in which the serum does possess antitoxic, or, as it would seem in some cases, germicidal properties, the bodies of the dead microbes must at last be got rid of by phagocytosis, and some recent observations would seem to indicate that the useful elements of the serum may be, in part at least, derived from the digestive juices of the phagocytes. If ever there was a romantic chapter in pathology, it has surely been that of the story of phagocytosis.

I was myself peculiarly interested by these observations of Metchnikoff's, because they seemed to me to afford clear explanation of the healing of wounds by first intention under circumstances before incomprehensible. This primary union was sometimes seen to take place in wounds treated with water-dressing, that is to say, a piece of wet lint covered with a layer of oiled silk to keep it moist. This, though cleanly when applied, was invariably putrid within twenty-four hours. The layer of blood between the cut surfaces was thus exposed at the outlet of the wound to a most potent septic focus. How was it prevented from putrefying, as it would have done under such influence if, instead of being between divided living tissues, it had been between plates of glass or other indifferent material? Pasteur's observations pushed the question a step further. It now was, How were the bacteria of putrefaction kept from propagating in the decomposable film? Metchnikoff's phagocytosis supplied the answer. The blood between the lips of the wound became rapidly peopled with phagocytes, which kept guard against the putrefactive microbes and seized them as they endeavored to enter.

If phagocytosis was ever able to cope with septic microbes in so concentrated and intense a form, it could hardly fail to deal effectually with them in the very mitigated condition in which they are present in the air. We are thus strongly confirmed in our conclusion that the atmospheric dust may safely be disregarded in our operations, and Metchnikoff' researches, while they have illumined the whole pathology of infective diseases, have beautifully completed the theory of antiseptic treatment in surgery.

I might have taken equally striking illustrations of my theme from other departments in which microbes play no part. In fact any attempt to speak of all that the art of healing has borrowed from science and contributed to it during the past half-century would involve a very extensive dissertation on pathology and therapeutics. I have culled specimens from a wide field; and I only hope that in bringing them before you I have not overstepped the bounds of what is fitting before a mixed company. For many of you my remarks can have had little if any novelty; for others they may perhaps possess some interest as showing that Medicine is no unworthy ally of the British Association; that, while her practice is ever more and more based on science, the ceaseless efforts of her votaries to improve what have been fittingly designated *Quæ prosunt omnibus artes* are ever adding largely to the sum of abstract knowledge.

JOSEPH LISTER.

THE BUFFALO MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SECTION G—BOTANY.

THE Botanical Section, G, of the A. A. A. S., held very successful sessions during the the meeting at Buffalo. Monday, the 24th of August at 11:40 a. m., the Section was organized and at 4:30 p. m., listened to the address of Vice-President, N. L. Britton on 'Botanical Gardens.' Tuesday, Wednesday and Thursday were devoted to the reading of papers and discussions. The papers were as follows:

The forces determining the positions of leaves: By R. N. Day.

Specimens of Phaseolus, Taraxacum, Cucurbita, Nicotiana, Helianthus and Arisæma were grown under the following conditions:

In darkness and in light.

a. Upright position.

b. Horizontal.

c. Inverted.

d. Horizontal or planostat.

Without discussion of the experimental details, it may be said that the conclusion of Vines that photo-epinasty does not exist is confirmed, and it is also concluded that epinasty and hyponasty are inherent properties whose reactions may be suppressed but whose general nature is not influenced by external conditions. Secondly, the results obtained bear directly on the recent conclusions of Vines and the current and accepted generalizations.

Vines' statement that dorsiventral organs are never apogeotropic is by no means substantiated, nor is it by any manner of reasoning to be inferred from the developmental history of the leaf. It might well be applied, however, to stems or flower structures. It may be seen from the author's and other results that dorsiventral leaves may be diaheliotropic, diageotropic or apogeotropic, epinastic or hyponastic. The factor determining the position of the leaf in every instance is the heliotropic tendency, which so far overbalances the influence of the other two forces that their reactions are suppressed. The position of the leaf then is a physiological, not a mechanical resultant, and may not be expressed by the parallelogram of forces as designed by Krabbe in 1889.

The bacterial flora of cheddar cheese: By H. L. Russell and John Weinzirl.

The study made by the author determines quantitatively and qualitatively the bacterial flora of our American cheddar cheese at the various phases of the ripening process. The first change from that in the milk is a diminution in number for the first ten days. In this the different species all suffer loss. Soon there begins an enormous development of organisms that is confined to lactic acid group of bacteria. The digesting and gas-producing bacteria gradually decrease in numbers. Succeeding this stage of bacterial increase is a period of gradual decline, which continues throughout the life of the cheese, until it is almost sterile in the course of a year or two. The physical changes that mark the curing of the cheese begin to appear synchronously with the marked development of lactic acid bacteria. The authors hold that these facts cannot be reconciled with the theory that the digesting bacteria are the active agents in the curing.

The pollen and stigma of Arisæma: By W. W. Rowlee.

The author described the andrœcium and gynœcium of *Arisæma triphyllum* and *A. Dracontium*. He noted the peculiarities of the consolidation of the stamens, the open style with the stigmatic hairs not only on the surface of the stigma, but also on the inner surface of the tube and forming a stigma like tuft on the inner surface of the ovary. The pollen in one case was found to have already germinated within the anthers, and the tubes had folded back and forth upon themselves. Other cases examined did not show the same growth.

Studies in nuclear phenomena, and the development of the ascospores in certain Pyrenomycetes: By Mary A. Nichols.

The results of the author's study point to the conclusion that a sexual process may be present in some members of the *Sphæriaceæ*, and absent or very degenerate in others. In *Ceratostoma brevirostre* the origin of the ascospore is distinctly traceable to a fusion of differentiated gametes, while in *Teichospora* only possible rudiments of antheridia are present. The successive stages from the formation of the oosphere to the maturation of the ascospore reveal a process of development somewhat different from any heretofore suggested, but analogous to the development in *Sphærotheca*, described by Harper, and also somewhat similar to that in the *Florideæ*. The paper contains also an account of the discovery of nuclei in this family, their structure and behavior during division.

On the stem anatomy of the Onagraceæ: By FRANCIS RAMALEY.

As a result of the examination of specimens of seven genera of the tribe *Onagrariæ*, including thirteen species, the author found no marked anatomical specific or generic characters which could be used as a basis for classification.

Structures of the embryo-sac: By J. M COULTER.

The paper shows that the current statements concerning (1) egg apparatus, (2) primary endosperm cell and (3) antipodal cells should be modified as follows:

(1) *Egg apparatus:* two or three usually naked cells, the oosphere and one or two synergids, together representing a single archegonium, of which the synergids may represent canal cells.

(2) *Primary endosperm cell:* A cell formed by the fusion of two vegetative cells (the polar cells), which is stimulated normally by the act of fertilization to continue the vegetative development of the gametophyte, just as the adjacent sporophyte structures are stimulated to develop seed and fruit.

Antipodal cells: A group of cells, variable in number, evanescent or resistant; representing the vegetative region of the gametophyte not dependent for its development upon fertilization.

On Cratægus coccinea and its Segregates: By N. L. BRITTON.

The paper discussed the characters and distribution of *C. coccinea* and two probable varieties, *C. macracantha*, *C. rotundifolia* and *C. mollis* and was illustrated by specimens of all the forms described.

Notes on the genus Amelanchier: By N. L. BRITTON.

Specimens illustrating the five eastern species, *A. Canadensis*, *A. Botryapium*, *A. rotundifolia*, *A. spicata* and *A. oligocarpa*, were exhibited and their inter-relationships discussed.

Some Cyperaceæ new to North America, with remarks on other species: By N. L. BRITTON.

Record was made of seven species of sedges hitherto unknown to occur within United States, and specimens illustrating them were shown.

On the Cardamines of the C. hirsuta group: By N. L. BRITTON.

A discussion of the species *C. hirsuta*, *C. Pennsylvanica*, *C. flexuosa*, *C. parviflora* and *C. arenicola*, all of which were maintained as distinct. The paper was illustrated by specimens.

On the formation and distribution of abnormal resin ducts in Conifers: By ALEX. P. ANDERSON. The study shows that:

(1) Annual rings of *Pinus silvestris* and *Picea excelsa* containing frost rings have in cross sections fewer vertical resin ducts per sq. mm. than the normal rings.

(2) Regulatory tissue in hyponastic branches of *Pinus silvestris* has in cross sections fewer resin ducts per sq. mm. than the opposite side of the branch.

(3) In *Abies pectinata*, affected with *Æcidium elatinum*, the fungus mycelium is never found in the resin duct canals, nor in the epithelial cells surrounding the canals. Abnormal resin ducts are always found in

the wood of the thickened portion of the diseased branch.

(4) In *Pinus strobus* diseased at the root with *Agaricus melleus* an increase in the number of resin ducts of the wood takes place in the whole plant above the diseased part.

(5) In the wood of branches of *Abies pectinata* diseased with *Phoma abietina*, and in young seedlings of the same species, abnormal resin ducts are found only above the constricted portion of the branch.

An apparently undescribed Cassia from Mississippi: By C. L. Pollard.

This is a remarkable *Cassia*, allied to *C. chamæcrista*, but distinguishable by its virgate habit and strict pods, collected in northern Mississippi by S. M. Tracy. It proves, upon cultivation, to warrant its separation as a distinct species, for which the name *C. Tracyi* is proposed.

A discussion of the order Pesizineæ, Schröter: By E. J. Durand.

The author gave a brief history of the classification of the fleshy Discomycetes from the time of Linnæus, together with the ideas of modern systemätists regarding the same plants. Especial attention was given to those of Schröter. The latter's views were discussed in the light of investigations, made by the author during the two years, touching the structure of these plants, illustrating the bases of their division into families.

A Bacterial Disease of the Squash-bug (Anasa tristis): By B. M. Duggar.

The author gave in brief the characters of a contagious disease first observed in a laboratory breeding cage. Many successful experiments were reported with both squash-bugs and young chinch-bugs. Isolation of the pathogenic *bacillus* and its growth on various nutrient media were described, likewise the microscopic characters and the distribution of the bacteria within the tissues of the host. Mention was also made of a toxic principle excreted by the organism, in an infusion of which many insects die almost immediately on immersion.

Grass flora of Iowa: By L. H. Pammel.

In the absence of the author the substance of the paper was given by J. M. Coulter.

Iowa lying between the two great rivers, respectively the Mississippi and Missouri, embraces an area of 56,025, it is well watered by its numerous streams and small lakes, all of which are intimately concerned in the distribution of plants. Among the streams are some of considerable size. About two-thirds of the State is drained by rivers that flow into the Mississippi and its tributaries. The largest wooded area is confined to the Mississippi and its tributaries. These wooded areas offer conditions that have greatly modified the distribution of grasses in this State. The country is not broken, but northeastern Iowa is extremely rugged. Along the Missouri occur the loess hills, with steep embankments and a loose friable soil. Concerning our grass flora the State is not greatly diversified. We have north, south, east, west, extra-continental and introduced species. In the number of species the State has less representatives than Nebraska on the west, than Illinois on the east and Missouri on the south. The southern indigenous types predominate, fellowed by northern. Only eleven of our species are typical western; thirteen are extra-continental, and fifty-five are introduced. Blue grass is the most abundant of our grasses. This is followed by *Phleum pratense*, introduced grass, and *Hordeum jubatum*, and *Elymus Canadensis*, followed by two typical Southern plants *Andropogon provincialis* and *Andropogon scoparius*.

A Contribution to our knowledge of the relation between growth and turgor: By Edwin B. Copeland.

An account was given of the state of turgor of seedlings of *Vicia faba* grown at various temperatures, and an explanation of the high turgor when growth is slow and *vice versa*. He concludes that the rapidity of growth regulates the amount of turgor present, rather than that the reverse is the case.

The relation between Thysanella and Polygonella as shown by a hitherto unobserved character: By JOHN K. SMALL.

The genus *Thysanella* has generally persistently and apparently without reason been referred to *Polygonum*. Besides ample characters in the habits and reproductive parts already recorded, the branching in *Polygonella* and *Thysanella* is internodal, and not nodal, as in all other members of *Polygonaceæ*.

An apparently undescribed species of Prunus from Connecticut: By JOHN K. SMALL.

A relative of *Prunus maritima* growing in the immediate neighborhood with it. The new species differs from the beach plum in habit, leaf form, flower and fruit.

The flora of the summits of King's Mountain and Crowder's Mountain, North Carolina: By JOHN K. SMALL.

Two isolated peaks with a moderate altitude harboring a local fern (*Asplenium Bradleyi*) and several members of the Alleghenian flora which we should not expect to find there. Their floras are shrubby, with the exception of two perennial herbs; one fern and a sedge, and about one-half the shrubs on King's Mountain are ericaceous. All the normally large forest trees occurring there are in the form of small shrubs ranging from three to six feet in height.

Rheotropism and the relation of response to stimulus: By F. C. NEWCOMBE.

Rheotropism is the change in direction of movement or of growth of an organism, induced by flowing water as a stimulus. Those organs or organisms that move or bend against the stream are *positively rheotropic*, while those moving in the same direction with the stream are *negatively rheotropic*.

It is now shown that the roots of many plants are positively rheotropic, while the roots of others are non-responsive. Moreover, the phenomena are marked by characters indicating irritability, since there is a latent period preceding the response and an after-effect following the stimulus.

We need not necessarily assume that the response shows a close biological relation to the stimulus used, since it is certain that in some cases the causal mechanism connecting stimulus and response may be set in motion by stimuli which are not the usual stimuli calling forth the response.

Some adaptations of shore plants to respiration: By HERMANN VON SCHRENK.

A large number of plants growing on the borders of ponds and rivers have developed structures adapting them to more or less aquatic conditions. These modifications are of two kinds, either the development of a mass of spongy tissue ærenchyma or the formation of very much enlarged lenticels, termed water lenticels. *Decodon verticillata* may serve as an example of the first. This plant always develops ærenchyma when growing in water. A few cases have been observed where the plant grew in drained ponds, and in those cases no ærenchyma was present. It seems to be well proved that this tissue is simply for respiratory purposes. *Sambucus canadensis* illustrates the second class. It has a large number of water lenticels developed at its base. These structures, however, are not always present. The same is true of a large number of plants which can grow as well in dry and moist localities.

On the roots of a number of plants, such as *Bidens connata* or *Eupatorium perfoliatum*, etc., structures occur similar to water lenticels which serve the purpose of aëration.

They are found on roots growing near the surface and in great numbers, especially in very damp soil. In development they differ from ordinary lenticels, owing to absence of initial stomata. Plants growing in similar localities, such as *Impatiens fulva*, *Myrica gale*, etc., never show such adaptation. The question arises as to the significance of these changes, which appear to be constant in the cases mentioned, and experiments on plants grown in water may serve toward solving the question.

A comparison of the flora of Erie Co., Ohio, with that of Erie Co., N. Y.: By E. L. MOSELEY.

Though both counties are adjacent, the Ohio district, so far as now known, contains 265 native species of phanerogams, not known to occur within 50 miles of Buffalo. The causes are said to be mainly climatic, the average date of the last killing frost in spring at Sandusky being April 30th, at Buffalo May 20th; and the first frost in autumn at Buffalo being September 15th, at Sandusky October 24th. One of the causes of the later spring at Buffalo is the blowing of the ice to the east end of the lake.

Sporophyll-transformation in dimorphic ferns: By GEO. F. ATKINSON.

The author detailed the results of experiments conducted on *Onoclea sensibilis* and *O. struthiopteris*, showing that cutting off the vegetative leaves in the middle of May and again in June would cause the partial or complete transformation of the young sporophylls to vegetative leaves. The paper was illustrated by lantern views.

The significance of the compound ovary: By CHARLES E. BESSEY.

In the study of the gynœcium of Angiosperms we are forced to conclude that its primitive condition was apocarpous — in other words, that whether monocarpic or polycarpic there was at least no union of ovary with ovary. The original ovary was doubtless simple.

By a comparative study of the ovaries of existing plants we are led to the conclusion that the syncarpous gynœcium was derived from the apocarpous gynœcium. This is so plain that it is needless to dwell upon it. Both phylogenesis and ontogenesis furnish us with numerous illustrations of the truth of this statement.

It is to be observed that the compound ovary is a comparatively stable structure, and that it changes slowly within any natural group, or in passing from group to group. No part of the plant is more stable. Yet with all its stability it undergoes changes in certain directions. It is a common occurrence to find a pentacarpellary ovary reduced to four, three, or two carpels, and this may proceed until, as in some of the Caryophyllaceæ, we seem to have but one carpel remaining. In rare cases there appears to be a reversion from syncarpy towards apocarpy, as in the Apocynaceæ and Asclepiadaceæ, but as a rule it may be said that syncarpy once attained by a group is persistently maintained, however much of simplification it may otherwise have undergone.

The ultimate development of the compound ovary is in the direction of a simplification of structure. Thus the many carpels of most Thalamifloræ and Heteromoræ are gradually reduced to the two carpels of the Bicarpellatæ. In the Calycifloræ the Rosales and Myrtales have generally several to many carpels, while in the Umbellales there are but two. Likewise in Inferæ the ovary in the lower group, Rubiales, have more carpels than we find in the highest group, Asterales. A similar simplification occurs in the Monocotyledons, as we pass from the Caronarieæ to the sedges and grasses.

This simplification of structure results in increased parental care of offspring. Thus while many embryos are to be nourished in the earlier cases, there are but one or two in the later. The biological significance of this result is so well known as to need no discussion here.

When we come to an application of what we know of the compound ovary to systematic botany, it appears to me that the following conclusions are warranted:

(a) The apocarpous plants are to be regarded as lower than those which are syncarpous, and in a natural arrangement the former must precede the latter.

(b) We must carefully distinguish between ovaries which are primitively simple and those which have become simplified from a more complex structure. In these cases the first indicate a lower and the second a higher position in the natural system.

(c) Grasses, Sedges, etc., in which the ovaries are simplified from the compound type are not the lowest of the Monocotyledons.

(d) Willows, Oaks, Walnuts, etc., with their apparently simple flower structure, are not to be regarded as among the lowest of the Dicotyledons.

The influence of rainfall upon leaves: By D. T. MACDOUGAL.

The first recognition of the influence of rainfall upon leaf forms was that given by Ridley in his Flora of Rajang, and an exploitation of the subject was made by Stahl* in 1893. Since the publication of Stahl's work, Jungner has carried on a great amount of observational work of doubtful value and has made some attempts to produce rainfall characters in leaves experimentally. The rainfall characters of leaves recognized by these workers are as follows: Attenuated apices, entire margins, glossy appearance of the upper surface of the laminæ, coupled with a ready adhesion of water; deepened furrows above ribs, pendant positions of the laminæ and enlargement of the pulvini. It is to be noted, of course, that in no one species do all of the above characters appear, and furthermore that only a few of those named have been induced in leaves experimentally. Jungner was able to cause the glossy appearance of the upper surface of the laminæ and its adhesion to water, and a pendant position of the entire leaf in a few plants by experimental methods.

*Ann. d. Jard, bot. d. Bintenzorg, 1893.

The curvature of tendrils: By D. T. MACDOUGAL.

The curvature of tendrils in response to a contact stimulus is due to the contraction of certain cells on the concave side of the organ. These cells show great specialization in form, size and arrangement, and are markedly different from similar elements on the convex side. The protoplasm of the external cells exhibits some specializations and appears to correspond in density with the degree of sensitiveness. It has been found that the effects of a stimulus are not transmitted more than two centimeters from the point of its reception. The prevalent idea that the coiling of the free portion of a tendril is stimulated by the engagement of the tip with any solid object is found to be false, since the curvature of the organ in response to a stimulus and the coiling of the free portion are entirely independent processes; the latter ensues on maturity only, as may be seen if the tip of a young tendril is attached to a support.

Relation of the growth of leaves to the carbon dioxide of the air: By D. T. MACDOUGAL.

A large number of experiments were performed in which leaves of *Arisæma triphyllum*, *Calla palustris*, *Lilium splendidum*, *Trillium erectum* and *T. erythrocorpum*, *Isopyrum biternatum*, *Oxalis floribunda* and *O. vespertilionis*, *Justicea* sp. *Hibiscus rosa-sinensis*, *Zea mais* and *Phœnix dactylifera* were allowed to develop under conditions of functional inactivity in light and in darkness. The amount of development or existence which can be carried on by the leaves of any of these species will depend on the 'availability' of the stored food. Ordinarily the leaf depends on its own activity for a portion of the material used for constructive purposes. Many of the leaves die when inactive in light, due to an insufficient food supply, and the disintegration of the chlorophyll is a result not a cause of the death.

The removal of concurrent members has a different effect on the remaining member when in light from that in darkness, a fact due in part to the intervention of the regulatory processes attendant on this condition.

In a series of experiments in my own laboratory, in which specimens of *Arisœma triphyllum*, *Trillium erectum* and *T. recurvatum* were subjected to a continuous spray of water for a period of 10 to 20 days, the author was able to produce the characters obtained by Jungner and also the additional one of diminution of the marginal teeth and deepening of the furrows above the ribs. In leaves of *Arisœma* the laminæ assumed an upwardly convexed form not to be confused with the rolling and twisting of leaves when subjected to abnormally cold water, and which is undoubtedly a new rainfall character.

It was found that the glossy appearance of the 'rain' leaves was due to the flattening of the outwardly convexed papillose ends of the epidermal cells of the upper side of the lamina, with a possibility of accompanying chemical changes in the character of the outer walls.

A comparative study of the development of some anthracnoses in artificial cultures: By BERTHA STONEMAN.

Seven different species of *Gloeosporium* and *Calletotrichum* and the allied genera *Vermicularia* and *Volutella* present in artificial cultures distinct characters varying to a certain extent with varying conditions of light, temperature and nutrient media. Under uniform conditions of growth the characters have been found sufficiently constant to be of value in distinguishing or uniting species whose similarity in morphological structure or variations resulting from the character of the host would render their systematic position uncertain. Of about thirty species studied, five (three *Colletotrichum* and 2 *Gloeosporium*), have been definitely connected with an ascigerous form; the transition from one stage to the other occurring without the intervention of a pycnidial stage. The ascigerous stages of each, two of which have been found as saprophytes in nature, bear a close resemblance to each other, and would fall in a genus near *Gnomomella*.

The habitats of the rarer ferns of Alabama: By L. M. UNDERWOOD.

A brief account of visits to Winston county, the type locality of *Trichomanes petersii*, was given, with some account of the habit of growth of that rare fern; also to Havana Glen, where *Asplenium ebenoides* grows in considerable abundance. This fern, which has been regarded as a hybrid, is shown by its habit to be a species entirely distinct from either of its supposed parents. The Southern fern-ally for a long time considered as a variety of *Botrychium ternatum*, is shown to be an entirely distinct species in form, habit and time of producing spores as originally shown by Lamarck.

Notes on the allies of the sessile Trillium: By L. M. UNDERWOOD.

Several species have been confused under this group name. Even Linnæus confused two species in the original description of *Trillium sessile*. One of these, an Alabama species figured by Catesby, was exhibited and attention was called to its value as an ornamental plant.

The Distribution of the Species of Gymnosporangium in the South: By L. M. UNDERWOOD and F. S. EARLE.

The distribution of the six species of *Gymnosporangium* parasitic on *Juniperus virginiana* was noted. An undescribed species was announced as most common in Alabama aside from *G. macropus* and *G. clavipes*.

Notes on the Pine-inhabiting Species of Peridermum: By L. M. UNDERWOOD and F. S. EARLE.

A revision of the species of the eastern United States, which number gives characters, distribution and hosts. The different character of the swellings produced by *Peridermum cerebrum* on *Pinus Tæda* and *Pinus echinata* were exhibited, the former with fusiform and the latter with globose swellings on twigs, branches or even trunks. The species produces much damage in some portions of the South.

The Terminology of Reproduction and of Reproductive Organs: By C. R. BARNES.

The speaker discussed first the distinction between vegetative and non-sexual reproduction. The reproduction of the earliest plants was undoubtedly vegetative reproduction. Non-sexual reproduction is not fairly differentiated from it until the *Bryophyta* are reached, and with them a clear alternation of generations. In *Bryophyta*, *Pteridophyta* and *Spermatophyta* the forms of vegetative reproduction, viz., by broodbuds, or gemmæ, by detached shoots and by proliferation (with detachment late when it occurs at all) are clearly distinguished from the non-sexual form, viz., by spores produced in a compound sporangium. The fundamental distinction lies in this, that vegetative reproduction *repeats the same phase*, while non-sexual reproduction *gives rise to the alternate phase.*

In the second topic discussed the classification of sporangia and gametangia into *simple* and *compound* was suggested. The simple gametangium or sporangium is one consisting of a single cell, whose contents become respectively the gametes or spores. The compound gametangium or sporangium is an aggregate of several or many (rarely reduced to one) simple gametangia or sporangia surrounded by one or more layers of sterile protection cells. Oogonia and carpogonia are simple; archegonia are compound gametangia. Simple sporangia occur below the *Bryophyta*; compound in *Bryophyta* and above.

What is the Bark? By C. R. BARNES.

Attention was called to the varying use of this term by different botanists. The Germans use *Borke* and *Rinde* to denote respectively the external tissue of the root or stem which dries up, and the entire mass of tissue outside the cambium. In this they are followed by the English. The American usage, except as modified by foreign influence, assigns the name bark to the entire mass of tissue outside the cambium. In this use they are followed by the French, and the author advocated the use of bark in this sense, and cortex to designate certain parts of the bark, indicated by a preceding adjective.

The Development of the Vascular Elements in the Primary Root of the Indian Corn: By W. W. ROWLEE.

As a result of the author's investigation he finds that the large cells in the central portion of the root tip, which are usually stated to give rise to the vessels, pass over into parenchyma and that the first vessels are differentiated from cells nearer the surface.

Remarks on Chalazogamy: By J. M. COULTER.

In this paper the author considered: (1) Chalazogamy as a basis of classification. It was used at first by Treub in 1891. As the basis of grouping all angiosperms, chalazogams and parogams. It proves to be of no value even in the most minor classifications. (2) Chalazogamy as an indication of phylogeny. Nawaschin has maintained that chalazogamy is a transition stage between gymnosperms and angiosperms, in which the pollen tube seeks to adapt itself gradually to traversing cavities. Adaptation to cavities is shown by the author of this paper to be largely unnecessary, and chalazogamy gives no more suggestion of gymnosperms.

Ceres-pulver; Jensen's new fungicide for the treatment of smuts: By W. A. Kellerman.

The speaker gave an account of the above. The material consists of Potassium sulphide, to which are added in small quantity some other ingredients, regarded as important by Jensen. A solution of two pounds in 125 liters of water is poured on the grain, the latter being stirred thoroughly in the meantime. This fungicide is found by Jensen to be effectual in case of oat smut and barley smut. Prof. Kellerman has the past season tested the ceres-pulver, and corroborates Jensen's claim. He also stated that Jensen has recently published the fact that the experiments made in 1890 by himself and Mr. Swingle and reported in a bulletin of the Kansas Experiment Station, were the 'starting point' for the ceres-pulver. These experiments showed that potassium sulphide was an efficient fungicide for these smuts. The hot-water treatment has no superior, but farmers do not use it. Prof. Kellerman, therefore, recommends the use of ceres-pulver, and also of potassium sulphide.

Parthenogenesis in Thalictrum fendleri: By David F. Day.

In August, 1883, the author found in one of the cañons of Pike's Peak, Colorado, a seedling specimen of Thalictrum fendleri, and the plant was sent home for cultivation. The plant bore only pistillate flowers and matured seed. These seeds were the following year planted, and, in the judgment of the author, with no possibility of pollination, since there were no staminate plants, seed was matured. These results have been obtained for several successive years, and the phenomenon is regarded as an example of parthenogenesis.

What should constitute a type-specimen? By S. M. Tracy.

The speaker called attention to the want of uniformity in the term 'type,' 'duplicate of type,' 'co-type,' etc., and urges the necessity for the adoption of some uniform method of expression.

Remarks on the northern species of Vitis: By L. H. Bailey.

A discussion of the systematic position of certain native grapes. (In the absence of the author, read by title.)

The point of divergence of Monocotyledons and Diocotyledons: By Charles E. Bessey.

In discussing this question the speaker assumed that it is unnecessary to bring forward proofs as to the common origin of the two sub-classes, Monocotyledonæ and Dicotyledonæ. It is possible, but in his opinion improbable, that some plants are now included in them which have had an independent origin, but all will agree that after making the most liberal subtractions possible the two sub-classes must still remain as two very closely related groups, with essentially the characters now assigned to them.

We must bear in mind the well-known biological law that in general the relationship of allied groups is most marked between their lower members, that is, between those members which represent the primitive types, and that it is less marked between the higher members of the groups.

In other words, we recognize the fact that groups diverge as they are evolved. If we represent the phylogenesis of plants by lines we are compelled to arrange these lines so that they show repeated series of divergencies.

Another law which must be kept in mind, also, is that evolution for the most part has proceeded from the simple to the complex. The simpler plants of to-day represent to a large extent the types of the primitive plants of former periods, from which the complex plants of to-day were derived. In this connection, however, we must not overlook the fact, as pointed out elsewhere,* that in the evolution of the successive members of groups of plants there has often been a simplification of structure. Thus we often find apetalous derivatives from polypetalous types; bicarpellary ovaries from polycarpellary types; one-celled, one-seeded, compound ovaries from several-celled, many-seeded ovaries. But there is a great difference between these simplified structures, which have been derived from more complex structures, and those which are primitively simple. The former are nearer the end of a lengthened genetic line; the latter are nearer its beginning.

When we apply these principles to the system to Bentham and Hooker we find no contact points whatever between Monocotyledons and Dicotyledons. The lower Monocotyledons are very unlike any of the Apetalæ. What similarity, for example, is there between the Grasses and Sedges on the one hand, and the Oak, Walnut and Plane Trees on the other. It is only when we pass up to the *Apocarpæ in the Monocotyledons*, and to the *Micrembryeæ* and possibly *Piperaceæ* of the latter, there are many similarities of structure. To this reference must be made later, and it need only be said here that evidently the authors made no attempt to indicate by their arrangement of families any contact point between the Monocotyledons and Dicotyledons.

In the system of Engler and Prantl one might look for such a disposition of the families of the two sub-classes as to indicate a common point of origin, but in this we are disappointed. When we compare the structure of the families placed at the beginning of the Monocotyledons, viz: the *Typhaceæ*, *Pandanaceæ*, *Sparganiaceæ*, *Potamogetonaceæ*, *Naiadaceæ*, *Aponogetonaceæ*, *Alismaceæ*, etc., with those occupying a similar place in the Dicotyledons, viz: *Saururaceæ*, *Piperaceæ*, *Chloranthaceæ*, *Lacistemaceæ*, *Juglandaceæ*, *Myricaceæ*, *Leitneriaceæ*, *Salicaceæ*, etc., it is at once evident that here there is a great gulf between the two sub-classes. It is becoming more and more evident that this system, which promised so much, is little better as an expression of genetic relationship than the system of Bentham and Hooker, which it is now displacing. Its so-called lower families are for the most part composed of plants with not a simple, that is, a primitive structure, but a simplified structure. As a rational system, designed to express our ideas of genetic relationship, it is sadly disappointing.

It is evident that we must cease to confuse the simplified with the primitively simple structures, and that in the latter alone can we find the point of divergence of the plants of the two sub-classes under consideration. It is only when we do this that we are able to construct a system which shall suggest to us the solution of the problem. Our system must begin with simple pistils, not compound pistils—with really simple and simplified pistils. It matters little whether the flowers are perfect or not; whether they have many or few flowers-leaves, or even none at all. We have learned that these are minor matters, and that they change very readily even within narrow limits.

In accordance with these principles we may readily fix upon the apocarpous Monocotyledons (Bentham and Hooker's *Apocarpæ*) as the representatives of the primitive members of this sub-class. This struc-

* 'Evolution and Classification,' Proc. A. A. A. S., Vol. XLII., and 'The Significance of the Compound Ovary,' presented at this meeting.

ture will readily suggest the *Ranales* among the Thalamifloral Dicotyledons, and a closer examination shows a remarkable similarity of structure in not only the reproductive, but also in the vegetative organs of the plants of these two groups. After some years of study given to a comparison of these groups the author is more firmly convinced than ever of their genetic relationship. They show their relationship in their gross anatomy, the histology of their tissues and their embryology.

Allied to the *Ranales* are the *Rosales*, beginning with the Ranunculus-like *Potentilleæ*, and passing by easy steps to the simpler *Leguminosæ* on the one hand (*Cæsalpiniaceæ* and *Mimosaceæ*), and the *Saxifragaceæ* on the other, and through the latter to *Celastrales* and *Myrtales*.

Here then, in the author's opinion, is the point of divergence of the Monocotyledons and Dicotyledons, represented by the Apocarpæ of the former, and the *Ranales* and *Rosales* of the latter. The similarities in structure between some *Macrospermæ* and the *Naiadaceæ* in Bentham and Hooker's system, noticed above, as between some of the families (*Naiadaceæ*, *Alismaceæ*, *Chloranthaceæ*, etc.), placed by Engler and Prantl at the beginning of the two sub-classes, are hints as to a natural arrangement, which it is strange that these eminent systematists overlooked.

The development of the cystocarp of Griffithsia bornetiana: By Anna Arma Smith.

The development of the cystocarp of *Griffiithsia bornetiana* was described, and it was shown to agree in the main with that in *G. corallina* as described by Janczewski, except only one peripheral cell bears a carpogenic branch. The spores arise from a cell cut off from the supporting cell of the carpogenic branch after fertilization, the influence of which is transmitted, apparently, through the cells of the carpogenic branch. Since the paper was published in the July number of the *Botanical Gazette*, and because of the author's absence, it was read by title.

Morphology of the canna flower: By L. H. Bailey.

The speaker called attention to the prevailing asymmetry in the Scitamineæ, and remarked that groups of plants which show marked irregularities in forms are nearly always fertile subjects for plant-breeding. The most nearly symmetrical flowers of this order are found in the banana tribe, in which 5 stamens are present and the 6th is represented by a sterile filament. He exhibited a banana fruit to show its 5-angled form, and remarked that it is probable that somewhere in its phylogeny this fruit had lost its symmetry. He also called attention to the three seedless loculi of the fruit, and remarked that, although the plant is seedless, it still varies or it is the subject of evolution, thus discrediting Weismann's hypothesis that all progressive or permanent variation arises through sexual union.

In the ginger tribe the stamen is reduced to one normal member. In the canna tribe the stamen is presented by what is apparently but a single loculus of the anther, the other loculus being apparently developed into a foliaceous organ. The remaining stamens are represented by petal-like staminodia, and these members make up the showy part of the flower. The speaker exhibited specimens of canna flowers, and also charts, to show the very marked evolution in the form and size of the flower, and more especially of the staminodia, and the gradual increase in the size of the petal-like appendage of the one fertile stamen. There seems to be a considerable decrease in seed-production in the modern cannas as compared with the types of a generation and more ago, and this decrease is probably associated with less pollen, or less efficient pollen, in the modern flowers. This tendency toward seedlessness is seen in many cultivated plants, of which the potato is a good example. Since new varieties come mostly from seeds, many persons have supposed that plant-breeding must eventually cease in these plants; but the speaker pointed out that the constant choice of seeds for sowing is itself a powerful agent in conserving the seed-producing power of the plant. So long as we select seeds, so long we may expect the effects of this selection to give seeds in at least a part of the individuals of every generation.

Distribution of plants on fresh-water islands: By CONWAY MACMILLAN.

The islands in Lake of the Woods were selected for study and description, and, after a general account of the geology and physiography of this body of water and its surroundings, a classification of islands was proposed as follows: 1. Floating bog islands; 2. Scirpus-bar islands; 3. Sand-dune islands; 4. Irregular rock islands; 5. Dome-shaped rock islands.

The paper proposed a classification of strand plants and surf plants, and laid particular stress upon an interesting zonal distribution of plants which characterized the dome-shaped islands. In these it was shown that an outer ring of shrub was succeeded towards the center by a zone of trees, an inner zone of shrub and a central meadow or shrub. This distribution was explained as resulting from the silting off of soil, until a thicker ring of soil was formed at the periphery of the islands.

The paper was illustrated by fifty lantern slides, showing island landscapes and calculated to bring out the points made concerning strand plants and zonal distribution, together with views of islands in which irregularity of surface prevented zonal and promoted crevice distribution.

GEO. F. ATKINSON,
Secretary.

CORNELL UNIVERSITY

THE THIRD SUMMER MEETING OF THE AMERICAN MATHEMATICAL SOCIETY.

THE Third Summer Meeting of the American Mathematical Society was held in the lecture hall of the Buffalo Society of Natural Sciences, at Buffalo, N. Y., on August 31st and September 1st. Among those present were:

Dr. E. M. Blake, Prof. M. Bôcher, Mr. J. M. Brooks, Prof. F. N. Cole, Prof. J. E. Davies, Prof. A. T. DeLury, Prof. E. W. Davis, Dr. L. E. Dickson, Prof. W. P. Durfee, Prof. H. T. Eddy, Prof. T. S. Fiske, Miss Ida Griffiths, Dr. G. W. Hill, Dr. J. E. Hill, Dr. J. I. Hutchinson, Prof. E. W. Hyde, Prof. T. F. Holgote, Mr. P. A. Lambert, Dr. G. H. Ling, Prof. J. McMahon, Prof. M. Merriman, Prof. E. H. Moore, Prof. W. F. Osgood, Prof J. P. Pierpont, Dr. V. Snyder, Mr. W. M. Strong, Prof. O. Schmiedel, Prof. L. G. Weld, Prof. H. S. White, Prof. C. B. Williams, Miss E. C. Williams, Miss M. F. Winston, Prof. F. S. Woods and Prof. A. Ziwet.

The President, Dr. G. W. Hill, occupied the chair. Two sessions were held each day, beginning respectively at 10 a. m., and 2:30 p.m. The following papers were read:

1. *Methods of defining monogenic functions.* DR. E. M. BLAKE.
2. *An existence theorem for a class of linear euthymorphic functions of a single variable.* DR. E. M. BLAKE.
3. *A geometric method for the study of uniform convergence and certain double limits.* PROF. W. F. OSGOOD.
4. *Non-uniform convergence and the integration of series term by term.* PROF. W. F. OSGOOD.
5. *Two triply-infinite systems of simple groups.* DR. L. E. DICKSON.
6. *Ternray algebras.* PROF. J. B. SHAW.
7. *The geometry upon three surfaces of the seventh order.* DR. J. E. HILL.
8. *A special form of a quartic surface.* DR. J. I. HUTCHINSON.
9. *Note on the integral and integro-geometric series.* PROF. E. D. ROE.
10. *The cross ratio group of $n!$ $(n-3)$–ic Cremona transportations of flat space of $n-3$ dimensions.* PROF. E. H. MOORE.
11. *Criteria for the reality of nodes in Dupin's cyclides, with a corresponding classification.* DR. V. SNYDER.
12. *Numerically regular reticulations upon surfaces of deficiency higher than 1.* PROF. H. S. WHITE.
13. *Loci of the equations $p=\varphi^x e$ and $p=\phi^x\psi^y e$* PROF. E. W. HYDE.

14. *On the hypothesis of the successive transmission of gravity and the possible perturbative effect on the earth's orbit.* PROF. J. MCMAHON.
15. *The continuity of chance.* PROF. E. W. DAVIS.
16. *A method of finding without a table the number corresponding to a given logarithm.* DR. ARTEMAS MARTIN.
17. *Table giving the first forty roots of the Bessel equation $J_0(x)=o$, and the corresponding values of $J_1(x)$* PROF. B. O. PEIRCE and MR. R. W. WILSON.
18. *On the projective group.* PROF. H. TABER.

Dr. Blake's first paper gave a classification of the methods which have been used for defining monogenic functions, with example, references and historical notes. His second paper contained a demonstration of the existence of monogenic functions satisfying a relation which had presented itself as a greatly generalized form of the addition theorem of elliptic functions.

Prof. Osgood's first paper gave a geometric method, consisting in the study of the approximation of curves $y=S_n(x)$, for discussing the manner in which $S_n(x)$ converges (uniformly or non-uniformly) toward its limit $f(x)$ when $n=\infty$. Applications were made to the allied problems in double-limits of integrating and differentiating a series term by term. Numerous examples served as illustrations. His second paper studied the most general manner of the convergence of $S_n(x)$ toward its limit $f(x)$, where $S_n(x)$, $f(x)$ are continuous functions, and treated the problem of determining when

$$\int_{x_0}^{x} f(x)\,dx = \lim_{n=\infty} \int_{x_0}^{x} S_n(x)dx.$$

Broader sufficient conditions than those generally known for the integration of a series of continuous functions term by term were obtained. The former of these papers will appear in the *Bulletin of the American Mathematical Society* and the latter in the *American Journal of Mathematics.*

Jordon's decomposition of the general linear group on m indices, and of the group of Abelian substitutions on $2m$ indices, leads to two doubly-infinite systems of simple groups. By generalizing to the Galois field of order p^n, p being prime, Dr. Dickson reaches two systems of simple groups whose orders depend on three independent parameters m, n and p. His paper is intended for the *Annals of Mathematics.*

Prof. Shaw considered, in his paper, all the algebras in which three independent units occur. Dr. Hill used the general cubo-cubic transformation in three cases where the principal systems of the two spaces degenerate, to pass from a general cubic surface to a septic surface. In the first case the surface is distinguished by three triple and three double lines; in the second by a triple line and a double quintic, and in the third by a triple conic and a double quartic of the second kind. The quartic surface discussed in Dr. Hutchinson's paper is the locus of the vertex of a cone of the second order passing through six given points. If these six points be in involution on the twisted cubic through them, the coordinates of a point of the surface can be expressed in terms of elliptic functions. The object of Prof. Roe's paper was to obtain general formulæ for the summation of the integral and integro-geometric series.

All the cross-ratios of n quantities are expressible rationally in terms of any $n-3$ independent ratios. Starting with a certain such system of $n-3$ rations, and permuting the quantities one obtains in all $n!$ systems of the same type. The expression of these $n!$ systems in terms of any one leads to the group studied in Prof. Moore's paper. For $n=4$ it is the well-known group of six linear practical substitutions generated by $\lambda'=1/\lambda$, $\lambda'=1-\lambda$. For $n \geqq 5$ it is holoedrically isomorphic to the symmetric group in n letters. It contains a sub-group of $(n-1)!$ collineations permuting amongst themselves certain $n-1$ fundamental points, and first given by Klein. Prof. Moore's group results from extending that of Prof. Klein by an 'inversion' having $n-2$ of the fundamental points as critical points and the remaining one as a fixed point. This paper is intended for the *Mathematische Annalen.*

In Dr. Snyder's paper Lie's haxaspherical coordinates were employed to define, without the use of line-geometry, a Dupin's cyclide. By associating the three simultaneous linear equations of definition with the point-complex and the plane-complex, one obtains determinants the signs of which indicate the reality of spheres common to the four complexes and thus show the presence of nodes. Dr. Snyder's paper will appear in the *Annals of Mathematics.*

On a convex surface of deficiency zero Euler's equation, together with the requirement of numerical regularity, gives three sets of integers for vertices, faces and edges of a polyedron. These by duality become five, corresponding to the five regular polyedra. On a surface of deficiency greater than unity the modified equation of Euler, together with similar limitations, gives again a finite number of sets of integers for vertices, faces and edges. These sets are of two sorts: 'derivative,' obtained from sets belonging to lower deficiencies; and 'special,' not so obtainable, but peculiar to the deficiency in question. These sets of characteristic numbers can be realized on concrete models. Prof. White discussed the subject in detail and exhibited models, constructed by Mr. O. H. Basquin, for deficiency 2 and for the 'special' sets of deficiency 3. For deficiency 2 there were 13 card models and 6 of plaster; for deficiency 3 there were 7 card models. Prof. White's paper will appear in the *Bulletin of the American Mathematical Society.*

In Prof. Hyde's paper, which is intended for the *Annals of Mathematics*, p is a variable point, e is a fixed point, x and y are scalars varying from $-\infty$ to $+\infty$, and φ and ψ are linear points, functions of the form:

$$\phi q = \Sigma\,(A_k e_k . e_k \mid q)\ ,\quad \psi q = \Sigma\,(B_k e_k . e_k \mid q).$$

The curve and surface represented by the equations given in the title of the paper are studied, and many interesting properties which they possess are described.

In Prof. McMahon's paper, also intended for the *Annals of Mathematics*, the sun is assumed to move in a straight line with constant velocity, which is shared by the whole solar system; and the gravitational influence is supposed to issue from the sun in waves that move outward with constant velocity (equals, perhaps, to that of light). When any wave reaches the earth the latter is attracted towards the wave center, or point of space from which the wave issued. This effective center of acceleration is at a distance from the sun which varies between the limits $ka\ (1-e)$ and $ka\ (1+e)$, where k is the ratio of the velocity of the sun to that of gravitation, a is the semi-axis major of the earth's orbit, and e the eccentricity. Thus the orbit of the earth relatively to the sun is that which would be due to a center of force that performs small oscillations about its mean position. The law of this oscillatory motion is first determined, and then the equations of acceleration of the earth in its orbit, along and perpendicular to the radius-vector, are corrected for this small disturbance; and appropriate solutions of these differential equations are given, correct as far as terms in ke^2. The most important perturbative terms are examined, and their effect on the orbit determined.

Prof. Davis maintained that there existed a necessary and intimate association between the notions of continuity and chance. His paper will be published in the *Nebraska University Studies.* Dr. Martin's paper contained several series suitable for calculating a number when its logarithm is given. He intends to publish the paper in the *Mathematical Magazine.*

The first ten values of x, for which Bessel's function of the zeroth order $J_0(x)$ vanishes, were given to ten places of decimals by Meissel. The next thirty roots of the equation $J_0(x)=o$, and the values of $J_1(x)$ corresponding to the first forty roots, have just been computed by Prof. B. O. Peirce and Mr. R. W. Willson by means of Vega's ten place table of logarithms, except in the few cases where a greater number of places was necessary, and then recourse was had to Thoman's tables. The computation has been done twice.

The total number of papers read was greater by two than the number read at last year's summer meeting. The attendance was the same as last year. The Council announced that the regular October meeting of the Society would be replaced by a special meeting to be held at Princeton, on October 17th, in honor of Profs. Felix Klein and J. J. Thomson, who would be in Princeton at that time as delegates to sesquicentennial celebration of Princeton University. THOMAS S. FISKE.

COLUMBIA UNIVERSITY.

A CURVE-TRACING TOP.

SOME time ago I constructed a top (since called the gyrograph) for directly mapping out the curves corresponding to the precessional and progressive motion of a spinning body. I have since found the instrument of service in teaching this rather troublesome subject, and I will, therefore, venture to give an account of some of its performances.

The instrument is exceedingly simple, and consists merely of a form of stably spinning top, not too heavy, having a socket at the bottom of the stem for the axial insertion of the pencil on which the top is to spin. Particular care must be taken, however, to have the top well balanced and the pencil centered, and I have, therefore, sketched in the annexed figure the form with which I obtained my best results. Here a is a thin disc or web of tin plate carrying a circular ring (b) of $\frac{1}{8}$-inch copper wire; c is a thin conical brace to sustain the brass tube (d), which holds the pencil (e) normally to the web. The whole

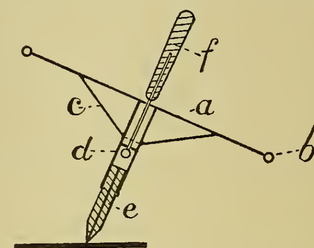

FIG. 1.—Sectional elevation of the top in position for curve tracing (reduced to one-fourth).

is revolvable around the handle (f), the round stem of which passes nicely through central perforations in the web and a diaphragm fixed within the brass tube. The string for spinning is wound around d. The figure is drawn to scale the diameter of the web, being about 6 inches. The weight should not exceed about 5 ounces. It is not desirable to hasten the precessional motion as the curve tracing is best shown with a leisurely swinging top. Furthermore, a tablet at least a foot square, preferably of plate glass, framed and provided with leveling screws, is needed for the accurate delineation of the curves. On this is placed a smooth sheet of white paper. The top, after being spun on the handle, is placed down with its *axis oblique* to the tablet, so that precessional motion may be initiated at the outset.

If the tablet is quite level the curves obtained are spiral with but very slight, if any, lateralness. Two cases are to be distinguished: If the pencil is hard and blunt (preferably cut square off at the lead with a sharp circular edge) precession is markedly accelerated; the top begins with a wide sweep and gradually rising from the oblique to the vertical position, describes a series of spires which converge rapidly from a wide circumference towards a center. If the point is hard and sharp, the top does not rise so fast, and the tendency is to retain small contracted figures. In both cases, however, the occurrence of spirals is chiefly the result decreasing angular velocity due to friction of the pencil on the tablet, as will be presently shown.

The most interesting results and by far the most beautiful curves are obtained when the tablet is not quite horizontal. In proportion as larger angles of dip are chosen, the spirals increase in lateralness until in an extreme case they merge more and more fully into contracting prolate cycloids. The figures are in the main cornucopia-like and the tracery at proper angles of dip is

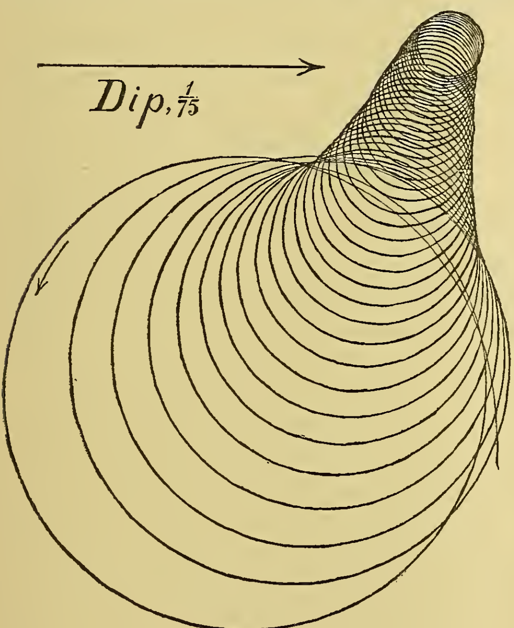

Fig. 2.

exceedingly delicate. Figure 2 is a type of these curves *, to which however an infinite variety may be given, a dip of $\frac{1}{4}$ to 1 inch in two feet being favorable.

One would at first thought suppose that a top on an inclined nearly smooth tablet would tend to describe elongated figures by sliding down the plane. Such, however, as is otherwise known, is only in small part the case. The top moves across the dip, tending to remain, if not quite, at least very nearly, on an average level. Moreover there is a necessary relation between the dip, the direction of rotation and the march of the top across the dip. If the tablet slopes downward from left to right parallel to the observer, the top moves away from him if spun counter-clockwise, and towards him if spun clockwise. If the dip be downward from right to left, the opposite relations of rotations and progression will hold. In other words, if the pivot or stylus of the top were to point in the direction of the dip, the rim or web would roll in the direction in which the top actually moves across the dip.

The reason for this curious behavior might perhaps most simply be looked for in the fact that precession* is relatively less accelerated when the end of the pencil moves up hill and relatively more accelerated when the end of the pencil rolls down hill. Hence if the dip be from left to right and the rotation counter-clockwise as seen from above, the pencil sweeps further out from the center, *i. e.*, away from the observer, because the obliquity of the top axis is being relatively increased. In rolling down hill the pencil sweeps nearer towards the center of motion (*i. e.*, also away from the observer), because the obliquity of the top axis is being relatively decreased. An inspection of the experiment and of the curves drawn by the top does not bear this out. It appears rather that the angular velocity of the top is continually decreased when the pencil rolls up hill and is continually increased again when the pencil rolls down hill. The tops of the spires therefore correspond to a rela-

* Unfortunately the photographic reproduction of these curves was not satisfactory. The above figure is made from a hand tracing of a coarsely drawn curve and does not convey the finish of the originals.

* Following Lord Kelvin's well known explanation.

tively *later*, and the bottoms of the spires to an *earlier* stage than the corresponding mean time of spinning on a plane tablet.

Now if the pencil is hard, so that its circular edge remains nearly constant in radius, the envelope of the cycloido-spirals will consist of two straight lines converging at the point where the top would cease to rotate if the other conditions of motion remained similar. In other words, supposing the period of precession to be nearly constant, the angular velocity of the top would vanish at the point of intersection in question. The cause of the gradual cessation of motion here, as in case of the horizontal tablet, is friction; but in case of the oblique tablet, if the period of percession remains nearly constant, the crests of the spires correspond to smaller angular velocities, and will therefore have smaller radii of curvature than the troughs of the spires where angular velocity passes through a maximum. In other words, the loops will be less obtuse at the top and more obtuse at the bottom of the dip. Part of the energy of rotation is periodically potentialized. To draw such curves the top must necessarily move across the dip.

If the end of the pencil is convex, so that the rolling on the pivot is relatively decreased as the top rises, the envelope of the spires will no longer be straight, but consist of two converging curved lines as shown in the figure.

In the preceding instances the direction of the progressive motion of the top, *i. e.*, the trend of the 'cornucopias,' is nearly a straight line at right angles to the dip. Suppose, however, that for the plane tablet a flat conical one be substituted, which may be either raised or depressed in the center. The dip is now everywhere radial. In this case the progressive motion of the top becomes orbital around the axis of the cone, if the dip be suitably chosen. We have then a very simple arrangement for simulating (except, of course, as to cause, and quantity) the orbital and precessional motion of the earth. Indeed, beautiful fluted curves corresponding to nutational movement may also easily be obtained by slightly destroying the balance of the top, though this interferes somewhat with the smoothness of motion.

C. Barus.
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Providence.

MEETING OF THE MAZAMAS AT CRATER LAKE, OREGON.

The annual field meeting of the 'Mazamas,' a club of mountain climbers with headquarters at Portland, Oregon, was held at Crater Lake, in the Cascade Mountains, during the latter part of August. This meeting was one of the most important and successful ever held and was a memorable one in many ways. Through the cooperation of local Crater Lake clubs, of Ashland, Medford and Klamath Falls, about 500 persons were present. There were also present members of four of the scientific bureaus of the government. The various parties arrived from the 14th till the 19th, and the camp began to break up about the 25th.

The Mazamas pitched their tents on an eminence overlooking the wonderful crater, and meetings were held evenings around a huge bonfire in front of the tents. On the evening of August 21st the ancient volcano, whose summit is occupied by Crater Lake, was christened Mt. Mazama. An appropriate address was read by the President, Mr. C. H. Sholes, of Portland. This was followed by a dedicatory poem by the Vice-President, Miss Fay Fuller, of Tacoma, Washington. Then the energetic Secretary, Rev. Earl M. Wilbur, of Portland, acting as 'toastmaster,' introduced the following toasts: To Mt. Mazama, responded to by Mr. J. S. Diller, of the U. S. Geological Survey; to the Poetry of Crater Lake, by Capt. Oliver Applegate, of Klamath

Falls; to the Forests of Crater Lake, by Dr. C. Hart Merriam, Chief of the U. S. Biological Survey; to 'That Tired Feeling,' by Prof. B. W. Evermann, of the U. S. Fish Commission; to the History of the Cascade Mountain National Forest Reservation, by Mr. W. G. Steel, of Portland, late President of the Mazamas. At the conclusion of the exercises a signal gun was fired and the crater of Wizard Island, a cinder cone rising 840 feet from the water of the lake, was illuminated by burning 20 pounds of 'red fire.'

On other evenings informal 'camp fire talks' were given by the government scientists present. Mr. J. S. Diller, of the Geological Survey, gave an account of the geological history of Crater Lake. Mr. F. V. Coville, Chief Botanist of the Department of Agriculture, spoke of the flora of the region and mentioned many facts of historic interest connected with early botanical explorations in the Northwest. Dr. C. Hart Merriam spoke on the fauna of the region and the geographic distribution of life in Oregon with special reference to the Cascade Range. Prof. B. W. Evermann, of the Fish Commission, spoke of the animal life of Crater Lake and its physical features with reference to the introduction of fish.

The government is doing a great deal of scientific work in Oregon this year. Mr. Diller is mapping the distribution of volcanic rocks in the Cascade Range and Rogue River Valley; Mr. F. V. Coville and his assistant, Mr. John Lieberg, have conducted extensive botanical explorations across the State; Dr. C. Hart Merriam, assisted by Messrs. Vernon Bailey, E. A. Preble, C. P. Streator and C. Allen, has carried the work of the biological survey over the greater part of Oregon; and Prof. B. W. Evermann, assisted by Prof. Cox, is engaged in studying the fish faunas of numerous waters in the Northwest. The officers in charge of these several parties were glad to avail themselves of the exceptionally favorable opportunity to study the natural history of the Crater Lake region afforded by the Mazama excursion. Two new boats were built and placed on the lake, and numerous courtesies were extended to the government men by the Mazamas.

Crater Lake is easily the jewel of the Northwest. It is hoped that means of reaching it will be perfected in the near future, so that it may be visited by the thousands of tourists and others who now content themselves with the Grand Cañon of the Colorado, the Yellowstone Park and the Yosemite. It can now be reached by good wagon roads from Ashland, Medford and Klamath Falls, but there are no regular conveyances or stopping places.

Crater Lake is a beautiful sheet of indigo-blue water, about 6 miles in length by 4½ in breadth. It occupies the crater or caldron of an extinct volcano and is completely surrounded by a precipitous wall, varying from 1,000 to something over 2,000 feet in height. A remarkably perfect and symmetrical cinder cone with a crater at its summit forms an island—Wizard Island—which rises 840 feet above the surface of the lake. The lake was sounded by Major C. E. Dutton in 1886 and found to be 2,000 feet in greatest depth. Its surface temperature is 59° or 60° Fahr. The altitude of the rim of the crater varies from about 7,000 to 8,200 feet.

Crater Lake Mountain is covered with a magnificent forest of conifers, arranged in well marked belts or zones, from base to summit. Beginning at the bottom (in the Transition Zone) is a relatively open forest of huge yellow pines (*Pinus ponderosa*), some of which measure 22 feet in circumference. Mixed with these are some sugar pines (*Pinus lambertiana*) and cedars (*Libocedrus decurrens*). At an altitude of about 5,000 feet, on the south and southwest slopes, the yellow pines give place to a dense forest of the lodge pole, or Murray pine (*Pinus murrayana*), more or less mixed with Douglas spruce (*Pseudotsuga taxifolia*), white fir (*Abies concolor*) and white pine (*Pinus monticola*). This belt is invaded by the hemlock (*Tsuga pattoniana*), and red-bark fir (*Abies nobilis*) of the zone above. At about 6,200 feet the trees of the middle or Canadian Zone fail, except on the warmer exposures, and one enters the superb forest of the Hudsonian or upper zone, a forest of splendid firs (*Abies nobilis*), and sombre hemlocks (*Tsuga pattoniana*), sparingly mixed with the sub-alpine fir (*Abies lasiocarpa*) and white-bark pine (*Pinus albicaulis*). The monstrous cones of the red-bark fir, with their bright red seed wings and exserted bracts, are among the wonders of the vegetable kingdom; while the dark hemlocks, with their drooping branches draped in the long hanging beards of a blackish lichen, rank among the giants, some of their trunks measuring 17½ feet around.

The Columbia black-tail deer (*Cariacus columbianus*) is common on the mountains and furnished our camp with fresh meat. Large trout abound in Klamath Lake, at the south foot of the Mountain, and afford excellent fishing. Klamath Lake is also the resort of thousands of ducks and other waterfowl. Hence the sportsman, as well as the tourist, naturalist, and lover of the grand and beautiful in Nature, is sure to find the Crater Lake region a place of unusual interest. For scenic beauty and grandeur Crater Lake, with its deep blue waters walled in by towering cliffs and rugged crags, ranks among the gems of American scenery.

C. H. M.

CURRENT NOTES ON PHYSIOGRAPHY.

DRUMLINS IN SWITZERLAND.

Dr. J. Früh, of Zurich, gives an account of '*Die Drumlins Landschaft*'—following by over twenty years Desor's *Paysage morainique*—with especial reference to the Alpine foreland (Jahresber. St. Gall. naturwis. Gesellsch., 1896). After a serviceable review of the distribution and description of drumlins in other countries, especially Ireland and the United States, the author describes in detail a number of localities, from Lake Constance to the Reuss. Not until 1893 were drumlins recognized in the Alpine foreland; Sieger then describing a group of them on the peninsula between the two arms of Lake Constance (Richthofen-Festschrift). It now appears that the Piedmont area overspread by the Rhine glacier in the latest glacial epoch contains a large number of radially arranged drumlins, whose attitude confirms the divergent direction of ice movement indicated by the dispersal of certain peculiar boulders in a district where striæ are almost wanting. The broad spreading of the glacier on the Piedmont area is shown by the deflection of the drumlins on the extreme right and left of Lake Constance, about 80° from the axis of the lake. The finest drumlin landscape of Switzerland is said to be a little south Pfäffikon, northeast of Lake Zurich, in the district of the Limmat glacier. Früh advocates the subglacial origin of drumlins, comparing them to sandbanks in rivers, as have other authors, but recognizing that some difficulties attend this explanation. In certain localities, the drumlins appear to be formed of overriden moraines.

TOPOGRAPHY OF SOUTHERN TUNIS.

Capt. E. de Larminat, of the geographical service of the French army, makes an interesting study of topographic forms in southern Tunis (Ann. de Géogr., v., 1896, 386–406). The initial form of the region appears to have been an extensive anticlinal dome; but this is now broadly unroofed. A ridge with an infacing escarpment, maintained on a resistant stratum, encloses an inner lowland, eroded on weaker internal strata. On the northeast the enclosing ridge is nearly lost; but on the southwest it constitutes a well defined semi-circular divide. Larminat describes with much detail the various elements of form thus developed. Outliers (témoins) in front of the escarpment are figured in various stages of breaking down under the cross-examination of the weather. Streams that once drained outward, down the dip of the dome, have been 'confiscated' by the headwater growth of the inner lowland streams. A good figure is given of a dry stream bed (oued=wady) on the outer slope of the enclosing ridge, that maintains a considerable breadth up to the present divide, thus plainly witnessing a transfer of great drainage area from consequent to obsequent streams.

The generality of these phenomena is not referred to by the author. The unroofed dome of the Weald, in southeast England, repeats nearly all of them, even to the broad beheaded valleys that notch the encircling ridge; the few unlikenesses of two regions depending more on the surface expression as determined by climate than on differences in structure or in stage of development. The region of the Swabian Alps, dividing the drainage areas of the Rhine and the Danube, exhibits escarpments, benches, outliers and shifting divides in remarkable perfection. One of the greatest examples of the kind is described by Dutton under the name of the 'San Rafael Swell' in his report on the High Plateaus of Utah. Less notable examples can be given in great number.

GUAYRÁ CATARACTS OF THE PARANÁ.

COUNT P. ANTONELLI gives a spirited narrative of his excursion in August, 1895, to the Guayrá cataracts of the Upper Paraná in southern Brazil (Mem. Soc. geogr. ital., vi., 1896, 80–102). His route eastward from Rosario on the Paraguay led for days through the virgin forests, passing occasional settlements where *yerba mate*, or Paraguay tea, was cultivated; then by canoe down the Yagatimi to the Paraná, just above the cataracts. Although visited by a number of travelers, accounts of the place vary greatly. Antonelli states that above the falls the river is expanded to a breadth of ten kilometers, flowing quietly among many islands; then it plunges suddenly down twenty-two channels over broken granite ledges, descending 25 or 30 meters into a gorge not more than 60 meters wide, through which all the waters are discharged in foaming rapids to the lower river. A route map by surveyor Mariotti and several views from photographs by San Martin are included. As is so often the case, personal narrative is prominently brought forward, technical geographical description is lightly touched, and physiographical relations do not seem to have been even dreamed of.

AUSTRALIAN EXPLORATION.

EXPLORATION in western interior Australia continues to reveal a great expanse of 'desert' having a varied topography, as summarized by several recent writers (Trans. Roy. Geog. Soc. Austr., Victorian branch, March, 1896). J. W. Jones outlines the geographical results of the Elder exploring expedition. J. A. Panton reviews 'Australia deserta.' A. J. Wright gives a narrative of his journey to Coolgardie, in the new gold field of western Australia. All tell of an arid region, broken by bare mountains of ancient rocks, attaining a height of three or four thousand feet; great intermediate areas of limestone and sandstone, much denuded, and holding salt lakes or dry lake beds in the depressions. Even when the surface of the basins is dry, salt water can usually be found a few feet below, 'so that the enterprising miner, with his condenser, can now depend upon the salt lake for a permanent water supply.' At the base of the impervious old-rock ridges, the local accumulation of ground water is known as a 'soak.' Much of the sandy surface is occupied by *Triodia irritans*, known as spinifex, or needle grass; a gray-green, hard spiny bush, growing so dense in places as to impede travelling. Elsewhere there are patches and belts of herbage fit for pasture, and of dense scrub forests. Trains of camels with Afghan drivers are often seen on the way to the gold fields.

NOTES.

The voyage of the Norwegian whaling steamer Antarctic in the South Polar seas, 1894–95, already familiar from the narrative of Borchgrevinck, one of the seamen, is described by the captain, L. Kristensen, in the transactions referred to in the preceding paragraph.

The *Geological Magazine* (London) for March contains an account by Preller of the Merjelen lake, enclosed by the Aletsch glacier, in Switzerland, with an excellent photographic plate.

La topographie aux Etats Unis is the title of an appreciative article by Gen. de la Noë, director of the geographical service of the French army (Ann. de Géogr., v., 1896, 143–155). He gives particular attention to Gannett's Manual of Topographic Methods, with especial praise to the advice on 'sketching,' for which, curiously enough, even the French army engineers have no equivalent expression.

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CURRENT NOTES ON ANTHROPOLOGY.

QUESTIONARIES FOR ETHNOGRAPHICAL RESEARCH.

Various anthropological societies and governments have from time to time published series of queries to guide travellers who desire to study the people in the countries they visit. One was issued in 1889 by the French Société d' Anthropologie, prepared by the able hands of a committee consisting of MM. Hamy, Hovelacque, Vinson and Letourneau. It is needless to add that it is thorough and well digested. Moreover, it is brief, covering only sixteen pages, and yet the committee claim with general justice that no really important points are omitted.

The latest publication of the kind is the 'Instrucktion für ethnographische Beobachtungen und Sammlungen in Deutsch Ost-Afrika.' It is published in the 'Mittheilungen aus den Deutschen Schutzgebieten' (Band IX., 1896, Heft 2), and was prepared by Dr. Von Luschan. The instructions are arranged in a series of questions, 88 in number, and are accompanied by a separate sheet or sheets, to be filled out with somatologic observations. The separata, which are intended for distribution, are interleaved, and contain a number of blank pages at the end for notes and are firmly sewed in linen covers. These minor precautions aid materially in the practical utility of such a publication.

THE TEACHING OF ETHNOLOGY.

In the 'Bastian Festschrift,' Dr. Ernst Grosse has a timely article on the teaching of ethnology in high schools and universities. It is to be regretted that he contrasts ethnology with anthropology, instead of making it a branch of that general science, which it properly is. However, he appreciates what ethnology is in itself, defining it as 'The science of the culture of peoples.' He also assigns it its just position, speaking of it as a 'science destined to open a new era in the whole history of civilization.'

Entertaining these views, he cannot understand why it is so neglected in institutions of education, but inclines to attribute this to its somewhat revolutionary character, and to the limited opportunities it at present offers for pecuniarily profitable employment. He suggests that in the higher schools one hour a week be given to ethnographic lectures, and that in university courses a double line of instruction be followed, one adapted to all students, setting forth the general principles and aims of the science, another suited to those who would take it as a major or make it a specialty. This plan would, he believes, soon result in that general appreciation of its value which the true ethnologist now claims for it. D. G. BRINTON.

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SCIENTIFIC NOTES AND NEWS.

THE SCIENTIFIC EXPERT.

UNDER the title 'The Imperiled Dignity of Science and the Law,' Prof. John Trowbridge contributes to the October number of *The Atlantic Monthly* an account of the difficulties of the expert witness before legislative committees and courts of justice. Scientific questions are usually too complex to be answered by 'yes' or 'no,' and the man of science is apt to become a partisan in the hands of the counsel who employs him, and then in turn to be discredited by the opposing counsel. There is often room for difference of opinion in regard to scientific questions that must be settled by legislatures and courts, but it is unfortunate for science and justice when experts can be found who will testify for money on the side for which they are paid As Prof. Trowbridge writes:

"The Judge, after hearing the arguments of the learned counsel, is left alone with the voluminous affidavits in which the scientific statements have been pared thin by the lawyers to enable one with no scientific training to see through them. One expert is balanced against another, and the Court is plunged into a state of great perplexity. What wonder that, in a recent case, a Judge remarked that one side having brought forward four experts and the other side five, and the learned professors on one side having testified in direct oppositlon to those on the opposing side, he would give a verdict to the side which brought the greater number of experts; and he therefore ordered an injunction to be issued in favor of the latter."

If the man of science is to be paid at all for expert opinion, it seems evident that he should be employed as a judge and not as an advocate. Prof. Trowbridge concludes:

"The most practical remedy, it seems to me, for the existing evils of expert testimony, would consist in making it customary for a Judge to call to his assistance any professor of science of high attainment who is not engaged by either of the parties in dispute. If the Judge appealed to the State to provide him with scientific advice, and if men eminent in science were selected by the State to aid the Judge in his endeavor to arrive at the truth on scientific points, both the bench and the professional chairs would gain in dignity, and the pursuit of truth would again be considered one of the chief characteristics of a scientific life."

THE U. S. S. 'BROOKLYN.'

THE performance of the U. S. S. 'Brooklyn,' on her recent trial trip, August 27th, admirably illustrates the high state of efficiency attained by our new navy, and, perhaps, even more satisfactorily, that reached by our naval constructors and engineers. The trial was made in deep water, outside Boston harbor, on a course eighty-three miles long, and well out at sea. It is only in water fifteen or twenty fathoms deep that the full sea speed of these heavy and fast vessels can be brought out.

The 'Brooklyn' is a ship of about 9,200 tons displacement—8,250 tons without armament or stores, as on the trial—and was designed, as to hull, by the Bureau of Construction of the Navy Department at Washington, and, as to machinery, by the Bureau of Steam Engineering, of which Commodore Melville, the famous Arctic explorer and no less distinguished naval engineer, is chief. On the trial so perfectly were the engines and boilers proportioned to each other that all the steam that could be made by the latter was worked off by the former, and enough was made at a pressure of 160 pounds per square-inch to drive the engine up to 135 revolutions per minute and to give the ship the unexampled mean speed of 21.92 knots —equivalent to over 25 miles an hour. This is claimed to be the highest speed ever attained by any iron-clad, of any type. It is only exceeded by some unarmored ships of our own navy, as the 'Columbia' and the 'Minneapolis,' and by no other war vessels of any navy in the world.

The 'Brooklyn' is 400 feet long, $64\frac{3}{4}$ feet beam, with a load draught of 24 feet. Her load displacement is computed at 9,153 tons and her engines are rated at 16,000 I. H. P. The contract speed was 20 knots at a displacement of 8,250 tons; but, as in the majority of later constructions, especially by the Cramps, the builders of the 'Brooklyn,' this speed is greatly exceeded on trial, and will undoubtedly even be somewhat exceeded when in sea-going trim. The contractors will make a bonus of $350,000 to $400,000 on the excess of trial speed over the minimum of the contract. This ship is considered unrivalled in conjoined power and speed.

The proposed armament consists in its principal battery, of eight 8-inch B. L. rifles with twelve 5-inch and some smaller ordnance. The armor is light—8-inch. This ship is a thousand tons heavier than the 'New York' and designed for one knot less speed; but she will probably fully equal that ship in this respect. The battery of the 'Brooklyn' is heavier, by two 8-inch and also by carrying 5-inch guns in place of 4-inch.

This is one of the most marvellous of all the examples of modern naval construction yet produced, all things considered, and its concentration of speed with offensive and defensive power is probably without equal. Perhaps we may also conclude that the performance of the 'Brooklyn' affords the best possible evidence of the wisdom of the policy of the creators of modern navies, and particularly of that of the United States, in securing that union of mathematical and scientific professional training with practical experience in the management of these intricate machines at sea which has placed our own engineer and construction corps on so high a plane and has given them the needed theoretical and practical ability to design such marvels of naval architecture as are the floating machines of which we now see our navy composed.

R. H. THURSTON.

CHEMISTRY.

IT is well known that all atomic weight determinations of tellurium have given results higher than would justify the place it holds in the periodic system, and have led to the supposition that some impurity of higher atomic weight may be present. Brauner's determinations give the figures 127.64; Staudenmaier using different methods has recently confirmed this, his number being 127.6. Acting upon the idea that both of these results were obtained on tellurium from the same or similar sources, Chikashigé has made determinations of a Japanese tellurium which occurs in a massive sulfur, uncontaminated with any of the heavy metals. The method he used is the same as that used by Brauner. The atomic weight found is 127.61 as a mean of three closely concordant experiments, and confirms the previous results. The anomaly of tellurium, as well as that of cobalt in the periodic system, thus remains as unexplained as before.

IN a recent Journal of the Chemical Society Herbert McLeod published further investigations on the liberation of chlorin in the making of oxygen from potassium chlorate and manganese dioxid. In opposition to the work of Dr. Brunck, he shows clearly that the active gas liberated is chlorin and that no ozone is evolved. The reaction taking place is probably

$$2MnO_2+2KClO_3=2KMnO_4+Cl_2+O$$
$$2KMnO_4=K_2MnO_4+MnO_2+O_2$$
$$K_2MnO_4+Cl_2=2KCl+MnO_2+O_2$$

The manganese dioxid is continuously reproduced, and only a very small quantity of chlorin ultimately escapes absorption by the manganate.

J. L. H.

GENERAL.

AMONG the public lectures to be given in connection with the sesquicentennial celebration of the founding of the College of New Jersey and the ceremonies inaugurating Princeton University will be four lectures by Prof. J. J. Thomson on 'The Discharge of Electricity in Gases,' on October 13th, 14th, 15th and 16th; four lectures by Prof. Felix Klein on 'The Mathematical Theory of the Top,' October 12th, 13th and 15th, and one lecture by Prof. A. A. W. Hubrecht on 'The Descent of the Primates,' on October 19th. Men of science in departments of study represented by the lectures are invited to attend, but should make application for tickets before October 5th to Prof. William Libbey.

Nature states that Dr. W. R. Gowers will deliver the Bradshaw Lecture at the Royal College of Physicians on November 5th. The title of the lecture will be 'Subjective Sensations of Sound.' The Lumleian lecturer for next year is to be Dr. Bastian, and Dr. Luff will be the Gulstonian lecturer. Prof. Sidney Martin is to deliver the Croonian Lecture in 1898.

THE lecturers before the Peabody Institute, of Baltimore, will include the following: Professors Young, of Princeton; Hale, of Kenwood Observatory, in the University of Chicago; Keeler, of the Allegheny Observatory; Michaelson, of the University of Chicago; Trowbridge, of Harvard University, and Rowland and Ames, of the Johns Hopkins University.

THE Sanitary Institute of Great Britain held its Congress at Newcastle on Tyne, during the week beginning September 2d. The Congress was opened by the Duke of Cambridge, President of the Institute, and an inaugural address was made by Earl Percy, President of the Congress. Addresses were made before the Section of Sanitary Science and Preventive Medicine by Professor Corfield; before the Section of Chemistry, Meteorology and Geology by Mr. W. H. Dives; before the Section of Engineering and Architecture by Sir Andrew Noble, and a large number of papers were presented.

THE eighteenth general conference of the American Library Association, held recently at Cleveland, was attended by 600 members. An address was made by the President, Mr. G. Dana, of the Denver Public Library, and a large number of papers were read during the four days the Association was in session.

PROF. MICHAEL FOSTER will give at St. Bartholomew's Hospital on October 5th the first Huxley lecture, his subject being 'Recent Advances in Science and their Bearing in Medicine and Surgery.'

PROF. LEBER, editor of Graefe's Archiv für Ophthalmologie, was presented with the Graefe medal at the recent German Ophthalmological Congress in Heidelberg.

DR. FORSYTH MAJOR, who for over two years has been engaged in an examination of the fossil and recent flora and fauna of Madagascar, has recently returned to London. The expedition was supported by the Royal Society and the British Museum, and the collections have been deposited in the British Museum. The French government are preparing a still more elaborate expedition to Madagascar under the direction of M. Milne Edwards and M. Grandidier. It is said that 600,000 fr. will be spent on this expedition.

IT is stated that of the six steamers with which Captain Wiggins sailed on the 18th of August from Glasgow, four—namely the Glenmore, Scotia, Dauphin, and Father John of Kronstadt—will remain for service on the rivers and lakes of Siberia. Although his flotilla was late in sailing, it is hoped that he will reach Yenisseisk, or at least Krasnoyarsk, before the season of extreme cold commences.

IT is stated in the daily papers that a test of Octave Chanute's Albatross flying machine, invented and constructed by William Paul, was made at Millers, Indiana, on September 18th, and that though the flight was less than a hundred feet the machine acted in a satisfactory manner.

WE learn from the *British Medical Journal* that the arrangements preliminary to the founding of a Pasteur Institute for India were discussed at a recent meeting in Simla, when Surgeon-Major-General Gore, Principal Medical Officer of Her Majesty's Forces, the Quartermaster-General, the Surgeon-General with the Government of India and Professor Haffkine were present. It is proposed that the Institute should be erected in Kasauli or Darjeeling, and be a general institute, and not one for antirabic work only.

THE two following items are taken from the last issue of *Nature*: "A block of granite bearing the following inscription has, says the *Academy*, been recently placed on the southern shore of the Lake of Sils, in the Engadine: 'In memory of the illustrious English writer and naturalist, Thomas Henry Huxley, who spent many summers at the Kursaal Hotel, Majola.'" "It is announced that the Royal Society of Canada has resolved to commemorate the five-hundredth anniversary of the first landing of Cabot in North America by holding a meeting at Halifax from June 30th to 26th of next year, and to erect, at a cost of not less than £200, a monument at Sydney, in Cape Breton."

We record with much regret the death of William Crawford Winlock, assistant in charge of the office of the Smithsonian Institution. He died at Bay Head, N. J., on September 20th, at the age of thirty-seven years. Mr. Winlock was the son of the eminent astronomer, Joseph Winlock, and had himself made valuable contributions to astronomy while occupied with executive work of much importance for the advancement of science.

Mr. Enoch Pratt, who endowed a free library in Baltimore with over $1,000,000, and had given other sums for educational and philanthropic purposes, died at Baltimore on December 17th, at the age of eighty-eight years.

M. Henri Resal died at Annemasse, Haute-Savoie, on August 22d, at the age of sixty-eight years. M. Resal was the author of many works on mining engineering, a member of the Paris Academy of Sciences and editor of the *Journal des mathématiques pures et appliquées.*

The Marine Biological Association, at Plymouth, England, is about to publish, through Macmillan & Co., a book on the natural history of commercially valuable sea fishes, entitled 'The Marketable Marine Fishes of the British Islands.' The work, which is now in press, has been prepared by Mr. J. T. Cunningham, with the assistance of Prof. E. Ray Lankester and the Council of the Association.

Mr. R. Ellsworth Call has in preparation a work on the Mammoth Cave of Kentucky which will be in large quarto with about 30 plates. The edition is limited to 200 copies, and will be sold only by subscription, which should be sent to the author, care of John P. Morton & Co., publishers, Louisville, Ky.

Messrs. D. Appleton & Co. make the following additional announcements: *Dynamic Sociology*, by Lester F. Ward; *Pioneers of Science in America*, edited by Dr. W. J. Youmans; *The Evolution of the Art of Music*, by C. Hubert H. Parry, new volumes in the International Scientific Series; *Our Juvenile Offenders*, by W. Douglas Morrison, a new volume in the Criminology Series; *Genius and Degeneration*, by Dr. William Hirsch.

A severe earthquake occurred in Iceland on August 26th and 27th, causing the destruction of many buildings.

Dr. Max Wolf discovered, at Heidelberg, on the evening of September 7th, four new minor planets; he had discovered one on September 3d, and their number now amounts to about 420.

Mr. Max Osterberg, of Columbia University, will give a lecture on the possibilities and limitations of the Röntgen Rays in Association Hall, New York, on the evening of September 25th. The proceeds will be devoted to securing apparatus with which to illustrate the instruction in the class room of the Y. M. C. A.

According to *Electricity*, in twenty-five years the total number of United States patents rose from 98,460 to 568,619. Of the latter number, electric generators claim 3,117; electric railways, 2,019; electric lighting, 3,622; electric power, 1,183; telegraphy, 3,205, and telephony, 2,459.

The Railway Gazette quotes, from the Bulletin of the Society of Engineers of France, experiments made on the use of pneumatic tires; the results obtained showed that with an empty carriage moving at a walk through the snow the draft was 35.9 lbs with the iron wheel, and but 25.2 lbs. with the pneumatic tire. At a trot, with a load of 660 lbs., the pull was 68.6 lbs. and 39.5 lbs. respectively. In the mud, under the same condition of load and speed, the pulls were 35.2 and 50.7 lbs. for the iron wheel, and 23.1 and 31.2 lbs. for the pneumatic tire. The other tests consisted of pulls of varying speeds over macadam, paved and ordinary roads, and in every instance the pneumatic tire showed a saving in pulling power of from 30 to nearly 50 per cent.

The Japan Mail Steamship Company proposes to run a line of steamships between Japan and Seattle, Washington. The company is said to be very successful and already to own fifty steamships, while twelve new steamships will be constructed for oceanic service.

'The Lounger' writes in *The Critic:* "Display headlines give the London *Daily Mail* quite the air of an American newspaper * * * That the sensational aspect imparted by the glaring headlines does not always belie the text, is clearly shown in its cablegrams from America. Under date of August 14th, for instance, its New York correspondent sent this dispatch:

> "Still the heat continues, and the odor of the charnel house reigns over the city. From hundreds of decomposing human bodies, and from the rotting carcasses of horses there exhales a stench that is positively sickening. Added to this horror is an epidemic of rabies. Mad dogs are running about the streets, and already more than a score of children have been bitten. The mortality due to the heat yesterday totals up 85 persons."

UNIVERSITY AND EDUCATIONAL NEWS.

MRS. EDWARD ROBY, Mr. E. A. Shedd and Mr. C. B. Shedd have offered the University of Chicago a large tract of land around Wolf Lake and the channel connecting it with Lake Michigan, for the purpose of a lake biological station, and it is also understood that they will erect the buildings for the purpose if the offer is accepted. The gift is valued at $500,000.

THE Lewis Institute, the new Chicago school of technology, the foundation stone of which was laid two years ago, has now been dedicated. The late Allan G. Lewis left, in 1877, $500,000 for the purpose, which has now accumulated so as to make the value of the endowment $1,600,000.

THE Ohio State University is now erecting three new buildings, viz: Townshend Hall, for the accommodation of agriculture and agricultural chemistry, to cost $75,000; a Gymnasium and Armory, to cost $65,000; and one for physiology, zoology and entomology, to cost $35,000.

AT Amherst College Mr. F. B. Loomis has been appointed assistant in biology and Mr. E. S. Newton assistant in chemistry. At Lafayette College Mr. W. O. Pennell has been appointed instructor in mathematics and drawing; P. C. Nugent, instructor in civil engineering, and R. E. Dennis, instructor in chemistry. At Wellesley College, Miss A. M. Claypole has been appointed instructor in zoology, and Miss J. Evans instructor in botany; Miss M. E. Maltby will be acting professor of physics during the absence abroad of Miss S. F. Whitinghead, of the department.

DR. TSCHERMAK, of the Military Medical Academy of St. Petersburg, has been appointed full professor of comparative anatomy and embryology in the University of Dorpat. Dr. Lynen, of Charlottenberg, has been appointed professor of mechanical engineering in the Polytechnic Institute at Aachen.

DISCUSSION AND CORRESPONDENCE.

MR. LOWELL'S BOOK ON 'MARS.'

THE strong title, "The Lick Review of 'Mars'" which Mr. Douglass prefixes to his paper is a misnomer. The book was read, the review was written, the MS. was forwarded to the editor and put in type, wholly in the absence of those of my colleagues who were specially interested in Mars. The responsibility for every statement lies with me and is cheerfully accepted. Nor are any changes now required.

It is a matter of extreme regret to me that Mr. Douglass' comments on my review are so largely personal. I had hoped that one or more of the scientific questions involved might be discussed. My review covered a very limited number of the points which I had desired to bring up; at many points in Mr. Lowell's argument the connection of cause and effect is not clear; and the subject is important. I sincerely hope that Mr. Douglass will write ananother paper and devote it to the scientific side of Mars.

I again wish to acknowledge my indebtedness for the quotations from one of Schiaparelli's papers translated at Flagstaff by Prof. W. H. Pickering, from which I quoted and to which I gave credit. But many of us had previously read Schiaparelli's *earlier* papers in *Himmel und Erde*, in Flammarion's *Mars* and in the transactions of the *Reale Accademia dei Lincei*, and had found them full of facts determined and theories faintly suggested to which the modern writer of a book on Mars could conscientiously give credit.

It is true, as Mr. Douglass suggests, that Schiaparelli claimed to have observed seasonal changes on Mars. It is also only too true that Mr. Lowell's book does not mention the eminent Italian's observations of such changes. For my pains in quoting Schiaparelli's own description of the seasonal changes observed by him, I am charged with an 'attempt to seize the credit,' and with taking part in a 'proceeding;' and the quotation is 'irrelevent!'

The Mt. Hamilton observations of canals within the dark regions were made in 1892. Mr. Douglass says that he and Prof. Pickering also observed them, at Arequipa, in 1892. What I objected to was the fact that Mr. Lowell's book speaks of them as if they were discovered at Lowell Observatory, in 1894, by Mr. Douglass and were absolutely new. The 1892 observations, by two other observers, are entirely overlooked by Mr. Lowell. For venturing to suggest that their history did not begin in 1894, I am charged with an 'act of appropriation.' Further, so long as Mr. Lowell considers the network of fine dark marking to be, not water, but *vegetation*, and persists in calling them 'canals,' he cannot object when another observer of a more scientific turn of mind chooses to call them 'streaks,' so long as no one knew, and no one even now knows, their real character.

The first projections on the terminator of Mars were observed at Mt. Hamilton in 1890. The first one was, as Mr. Douglass says, detected by a visitor on one of the public Saturday nights. All the facts there are in the case were published by the Lick Observatory staff on two or more occasions, and Mr. Douglass is indebted wholly to those published accounts for his information. The *morale* of this observatory is such that full credit is always given in such a case. If the other observatory in question had been equally disposed to give credit I should not now have to give the history of the subject. Mars was not regularly observed at Mt. Hamilton in 1890. The great telescope was devoted to other important work. On Saturday nights the telescope was directed upon Mars for the benefit of 100 to 300 visitors, and at such times the astronomer in charge very often did not place his eye to the telescope for several hours. It was on one of those occasions that a very prominent projection presented itself. For suggesting that the history of the prominences did not begin in 1894, I am charged with 'an attempt on the rights of property.'

About vegetation, what did Schiaparelli say? He said the variations observed might be the result of 'extensive agricultural labor and irrigation upon a large scale.' The observed appearances might be explained by 'changes of vegetation over a vast area.' And his comment on those theories is as follows: "For us, who know so little of the physical state of Mars, and nothing of its organic life, the great liberty of possible supposition renders arbitrary all explanations of this sort, and constitutes the gravest obstacle to the acquisition of well-founded notions." Nor is this all, for Prof. W. H. Pickering suggested the same theory many years ago.

About Mr. Douglass' paragraph 8, what are the facts and why does he not publish them? Here are the facts: In 1892 at Alleghany Observatory it was determined that the markings on Mars came to the central meridian 7 degrees (about 28 minutes) later than the predicted time and attention was called to the discrepancy. In 1894 Mr. Lowell at Flagstaff observed the same discrepancy, but estimated its value at 5 degrees (about 20 minutes). Here are two observations of the same discrepancy. One observer of long experience estimates it at 7 degrees; and the other observer at 5 degrees. In the book under review the 5-degree estimate is unfurled to the breeze from Flagstaff, whereas the 1892 results are not even displayed at half-mast, though the author was aware of their existence. And yet when my review called attention to the fact that the discrepancy was observed and commented upon in 1892, Mr. Douglass says that it 'will be seen to be an error.'

My remark "that there should be so many evidences of *apparent* lack of familiarity with the literature of the subject" was certainly the most *charitable* form in which I could speak.

W. W. Campbell.

SCIENTIFIC LITERATURE.

The Primary Factors of Organic Evolution. By E. D. Cope, Ph.D. Chicago, The Open Court Publishing Co. 1896.

In *Primary Factors of Organic Evolution*, Prof. Cope is no longer a setter-forth of new doctrines, but "the present book is an attempt to select from the mass of facts accumulated by biologists, those which, in the author's opinion, throw a clear light on the problem of organic evolution, and especially that of the animal kingdom." (p. v.) That he has well succeeded in this attempt Neo-Lamarckians will be likely to give cordial assent upon reading these pages. But those who believe that natural selection has played a chief and essential rôle in all evolution will not be so well pleased with Prof. Cope's account of the matter.

The book is a direct plea for the efficiency of those factors of evolution which were prominently set forth by Lamarck and further elaborated by later writers; and it will stand as the most concise and complete exposition of the doctrines of the Neo-Lamarckian school hitherto published; pervaded, however, by the extreme Copean doctrine that consciousness is the prime mover in all organic evolution. This latter doctrine, elaborated and brilliantly expounded by Cope in his 'Origin of the Fittest,' and called Archæsthetism, though barely suggested previously by Erasmus Darwin, constitutes the fundamental thesis of Cope's theory of organic evolution. He describes it in the following words:

"It maintains that consciousness as well as life preceded organism and has been the *primum mobile* in the creation of organic structure. This conclusion also follows from a due consideration of the nature of life. I think it possible to show that the true definition of life is: *Energy directed by sensibility, or by a mechanism which has originated under the direction of sensibility.* If this be true, the two statements that life has preceded organism, and that consciousness has preceded organism are coequal expressions." (P. 513. Quoted from 'Origin of the Fittest,' p. 428.)

That Prof. Cope regards this consciousness as distinct from the physical basis of protoplasm which it is conceived to influence is shown by the following quotation:

"The relation of consciousness to the physical basis is as yet a profound mystery, but that they exercise over each other a definite mutual control is unquestionable." * * * "In other words, the forms of thought, which have no weight, direct the movements of muscles, which have weight." (P. 506.)

In like manner another quotation indicates that his conception of consciousness distinguishes it from a form of energy, for he says: "Whether the intrinsic energies which accomplish evolution be forms of radiant or other energy only, acting inversely as the square of the distance, and without consciousness, or whether they be energies whose direction is affected by the presence of consciousness, the energy is a property of the physical basis of tridimensional matter, and is not outside of it, according to the doctrine we are about to consider." (P. 1.)

While the phenomena of life are thus conceived of as fundamentally influenced by this, may I call it unknown quantity, consciousness, Prof. Cope recognizes the fact that the actual phenomena themselves are the direct expression of some form of energy.

"The phenomena of growth are also evidently exhibitions of energy. The term energy is used to express the motion of matter, and the building of an embryo to maturity is evidently accomplished by the movement of matter in certain definite directions. The energy which accomplishes this feat is, however, none of those which characterize inorganic matter." (P. 475).

This energy peculiar to living organism is called Bathmism.

"All the mechanisms necessary to the mature life of the individual are constructed by the activity of the special form of energy known as growth-energy or Bathmism. It is the modifications of this energy which constitute evolution." (P. 479.)

Having constructed this conception of an energy which may be present in definite quantities in any particular individual, the energy or mode of motion is treated of as a measurable somewhat, which may be passed from one individual to another, as is illustrated by the following passages:

"All this means that a certain limited quantity of energy is at the disposal of each individual organism." (P. 481.) "The most rational conception of this inheritance of structural characters is the transmission of a mode of motion from the soma to the germ-cells. * * * The bathmic theory of heredity bears about the same relation to a theory of transmission of the pangenes of Darwin, or the ids of Weismann, as the undulatory theory of light and other forms of radiant energy does to the molecular theory of Newton." (P. 480.)

As one speaks of the absorption or dissipation of light or heat, so he speaks of the phenomena of organic growth as involving

"the absorption of energy and not its dissipation." (P. 483.)

In elaborating this theory energies are distinguished into two classes. The first class includes those which tend away from the phenomena of life, 'catagenetic,' some of which are exclusively organic, myism and neurism ; while others are both organic and inorganic, as gravitation, cohesion, chemism and radiant energy. The other class, 'anagenetic,' includes only those which tend toward the phenomena of life. The particular form of this "energy, which is displayed by the plant in the elaboration of living from non-living matter is called antichemism" (p. 483), the other growth-energies are called 'bathmisms.' Bathmisms are further subdivided according as they are influenced by the interference of energies which are derived from sources external to the germ plasma.

To the 'simple growth force,' which is directly inherited without interference of other forces is given the name 'emphytism,' to distinguish it from the modified forms of growth force called 'grade growth force,' to which the name bathmism is strictly applied. As the author remarks, "pure emphytism can only be observed in the embryos of sexless or parthenogenetic origin, and in the repair of tissues." (P. 485.)

We thus are left with bathmism as the mode of energy, and bathmogenesis as the process by which the phenomena of evolution are accomplished.

As the present writer understands the author, his idea is that it is through the interaction or interference between energies from without the germ, though not necessarily outside the soma, and the particular bathmic energy of the germ itself which determines the specific morphological characters of each organism.

Under Part II., 'The Causes of Variation,' the author discusses the ways by which these interferences are accomplished. These external influences are found to be of two classes, physicochemical (molecular) and mechanical (molar). The class of evolutional phenomena resulting from interference between the molecular energies and bathmism are given the name 'Physiogenesis,' those resulting from interference between molar energy and bathmism are called 'Kinetogenesis.'

In the chapter on physiogenesis are found illustrations quoted from various authors of cases of physiogenesis, as the conversion of Artemia into Branchinecta ; the production of colors in Lepidopterous pupæ ; the effect of feeding on color in birds ; the blindness of cave-animals, etc.

In illustration of the law of kinetogenesis the studies made by Dall on the origin of the plaits in the columella of the Gastropods, and by Jackson on the mechanical origin of characters in the Lamellibranchs, are cited from the Invertebrata.

Kinetogenesis in the Vertebrata is elaborately illustrated by numerous references to the work of other authors and his own researches, on the effects of 'impact' and 'strains,' in modifying osseous tissue, the form of limb articulations and vertebral center, on the increase of size through use, the size and number of digits and the modification of the shape of horns, etc. But perhaps the most interesting and satisfactory application of the law is seen in the explanation of the mechanical origin of dental types, in which the paleontological evidence has proven of the greatest value and has given powerful confirmation to the general neo-Lamarckian theories, which find their strongest supporters among the vertebrate paleontologists of the United States.

The effects of disuse are also exemplified in the cases of atrophy, abortion and modification of limb-bones in mammalia.

This 'use and disuse' of Lamarck, under the modes of physiogenesis and kinetogenesis, are the processes through which variation of form and structure are attained.

Natural selection is recognized as a means and mode of the accentuation and preservation of modifications found to be useful ; but the author is particular to note that natural selection does not induce variability, but simply preserves such variations as arise and are beneficial to the being under its conditions of life, quoting from Darwin in support of this view (p. 4). Thus he takes exception to the extreme Neo-Darwinian, or Wallacean doctrine, as it is called by Romanes, in so far as to deny that species and the distinctive characters of every species are due to natural selection.

In Part 1st the common phenomena of evolution are expounded by examples of a vivid nature under the three headings—variation, phylogeny and parallelism.

The chapter on phylogeny brings together a number of pertinent examples from the facts of vertebrate paleontology, while variation and parallelism are illustrated by both the Invertebrata and the Vertebrata.

Under the subject of heredity over thirty pages are devoted to the defense and proof of the reality of transmission of acquired characters, and for this purpose are cited a goodly array of evidences from both embryology and paleontology.

The particular memory theory of heredity, of which the general principles were stated by Sedgwick as early as 1863, and elaborated by Cope in 1889, formulated by Herring in 1870 and named 'Mnemnogenesis' by Hyatt in 1893, is adopted as best expressing the authors view. The following passage presents a characteristic definition of this factor of evolution.

"It appears to me that we can more readily conceive of the transmission of a resultant form of energy of this kind to the germ-plasma than of material particles or gemmules. Such a theory is sustained by the known cases of the influence of maternal impressions on the growing fœtus. Going into greater detail, we may compare the building of the embryo to the unfolding of a record or memory, which is stored in the central nervous organism of the parent, and impressed in greater or less part on the germ-plasma during its construction, in the order in which it was stored. This record may be supposed to be woven into the texture of every organic cell, and to be destroyed by specialization in modified cells in proportion as they are incapable of reproducing anything but themselves. The basis of memory is reasonably supposed to be a molecular (or atomic) arrangement from which can issue only a definite corresponding mode of motion." (P. 451.) "The somatic cells retain only the record or memory of their special function. On the other hand, the reproductive cells, which most nearly resemble the independent unicellular organisms, retain first the impressions received during their primitive unicellular ancestral condition; and second, those which they have acquired through the organism of which they have been and are only a part." (P. 453.)

To the question what are the primary factors of organic evolution from a causative point of view, the author's answer in brief seems to be as follows: *Bathmism* an intrinsic energy of living matter; *consciousness*, a guiding influence, 'intrinsic in the evolving matter,' but preceding organization; *molecular and molar forces* from without reacting upon bathmism in the processes of Physiogenesis and Kinetogenesis; and the effects of these interactions preserved and perpetuated in heredity through the agency of *memory* in the process called Mnemnogenesis. Viewed as a series of phenomena the author has summarized the particular form of doctrine defended in his book in the following words:

1. Variations appear in definite directions.
2. Variations are caused by the interaction of the organic being and its environment.
3. Acquired variations may be inherited.
4. Variations survive directly as they are adapted to changing environments (natural selection).
5. Movements of the organism are caused or directed by sensation and other conscious states.
6. Habitual movements are derived from conscious experience.
7. The rational mind is developed by experience, through memory and classification (p. 14).

Most, if not all of the particular views of the author found in this book have been more or less fully elaborated in previous papers; but in their connected systematic form, combined with the views of other workers to constitute a consistent doctrine of evolution, we have in 'Primary factors' a valuable text-book for teachers and students.

Whether they will be helped toward an intellectual comprehension of the true factors of evolution by this attempt to express them in terms of those highest of all, most complex and least understood of organic phenomena, consciousness and memory, may be seriously questioned.

H. S. WILLIAMS.

YALE UNIVERSITY.

The Manufacture of Explosives. By OSCAR GUTTMANN. 2 Vols., pp. 348 and 444 lg. 8vo. New York, Macmillan & Co. 1895.

As the sub-title of this book indicates, the author has sought to produce a theoretical and practical treatise on the history and the physical and chemical properties, as well as on the methods of manufacture of explosive substances, and he has followed for this purpose the plan adopted in the excellent treatises on Gunpowder by G. Upmann, and on Explosive Bodies and Fireworks, by E. von Meyer, published in Brunswick in 1874, and which were translated, revised and enlarged by E. Désortiaux in the admirable work published in Paris in 1878. Following Désortiaux's plan, Volume I. of Guttmann's work is devoted partly to a description of the sources, methods of production and properties of the raw materials used in the manufacture of explosives, and partly to the manufacture, properties and the chemical and physical tests of 'Black Powder,' while Volume II. treats of gun-cotton, nitro-glycerin, dynamite, blasting gelatine, nitro-substitution explosives, smokeless powders, caps, detonators and fuses; considerable space being given to the description of apparatus for testing the velocity, pressure and power of explosives, and to the discussion of methods for their storage and transportation and the construction of factories. There is in addition some seventeen pages of a bibliography which is far from being exhaustive.

From his occupation, for many years past, as a builder of works and inventor of apparatus for use in the manufacture of explosives, Mr. Guttmann has had unusually good opportunities for becoming familiar with the art, but owing to his confidential relations with his clients, it is not to be expected that much will be published that has not already been made accessible in periodical literature or patent publications, so that the work is to a large extent historical and suggestive. As a consequence of his occupation there is a lack of perspective in the work, his own inventions being given undue prominence.

Notwithstanding that Mr. Guttmann has been for many years the abstractor in this subject for *Dingler's Polytechnische Journal*, he shows a singular lack of familiarity with American methods and products, which differ materially from those in vogue in Europe, but as a treatise on European practice this work is a sound and trustworthy one. It is probably because of this lack of acquaintance with America that when the author is treating of the history of compressed powders, Professor Doremus, of New York, becomes transformed into General Doremus of Russia.

The chapter on smokeless powders is especially to be commended as probably the most detailed and exhaustive description of the processes of manufacture in use extant, but it is in error as regards indurite.

The style is usually clear but sometimes involved, as when, in discussing the errors of Kopp's Volumenometer and Say's Stereometer, the author says "so that the results obtained with this apparatus only show the atomic weight of the proportions of the various kinds of powder;" there is a lack of uniformity in the use of the chemical nomenclature which is likely to prove confusing; there is an uncertainty at times regarding the constitution of organic substances which is likely to prove misleading; and there are occasional errors, notably where the author after stating that nitro-glycerin freezes at +8° C. (46.4° F.) says "some experiments made by the author showed that pure nitro-glycerin, if suddenly exposed to a temperature of 25° C. (13° F.), produced by a freezing mixture, was not frozen even after some hours," yet on the whole the work is a very good one, and it is most liberally illustrated with 328 well executed cuts.

Charles E. Munroe.
Columbian University.

NEW BOOKS.

Humphrey Davy, Poet and Philosopher. T. E. Thorpe. New York, The Macmillan Co. 1896. Pp. vii+236. $1.25.

Elements of Geology. Joseph Le Conte. 4th edition, revised and enlarged. New York, D. Appleton & Co. 1896. Pp. xiv+670. $4.00.

Biological Lectures Delivered at the Marine Biological Laboratory of Wood's Holl, in the Summer Session of 1895. Boston and London, Ginn & Co. 1896. Pp. 188.

The Nursery Book. A complete guide to the multiplication of plants. L. H. Bailey. 3d edition. New York and London, The Macmillan Co. 1896. Pp. xi+365. $1.00.

Report of the Commissioner of Education for the Year 1893–1894. Volume I. Washington, Government Printing Office. 1896. Pp. xlvii+1061.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

*THE ACHIEVEMENTS OF PHYSICAL CHEMISTRY.**

'PHYSICAL chemistry is the chemistry of the future.' These words, quoted from an address by Prof. Du Bois-Reymond, were used by Ostwald ten years ago in the introduction to the first number of the *Zeitschrift für physikalische Chemie.* In using these words Du Bois-Reymond looked forward to a time when it shall be possible to give a mathematical expression to all forms of chemical knowledge. The picture in his mind seems to have been that of a sort of astronomy of the atoms, in which the motions and forces within the molecules shall be known very much as are the motions and forces within the planetary system.

So far as any practical realization is concerned, the thought is still only a poetic fancy, and whatever progress, if any, may have been made, comes to us from organic rather than from physical chemistry. Indeed, it seems to have become the fashion on the part of several leaders in physical chemistry to speak slightingly of the atomic and molecular theories. Their thought appears to be that it would be better to confine ourselves to the purely empirical and mathematical concept of the atom and molecule and leave the idea of particles

* Address by the Vice-President before Section C—Chemistry.

which have an actual independent existence entirely in abeyance. It would, doubtless, be possible to give such definitions of atom and molecule as shall include only the results of our actual empirical knowledge and mathematical deductions therefrom. Such definitions would stand on a basis which is incontrovertible, and it is inconceivable that even the overthrow of the atomic theory, or any knowledge which may be gained in the future as to the nature of matter, could change them.

That such definitions possess great value is certain; and that it is very important to distinguish sharply between our positive knowledge and speculations and theories based on that knowledge, every one will admit; but, after all, unless we join that school of philosophy which teaches that there is no real existence outside of our own minds, there is some reality at the basis of and behind all the phenomena which we investigate. And it is the province of science to find out the truth about every real existence of which we can secure any tangible evidence. Our knowledge of atoms and molecules as actually existing particles is, doubtless, a purely speculative deduction from a multitude of diverse phenomena, and yet the mental picture connected with the concept has been, and still continues to be, of very great value in the development of our science. These mental pictures are vague and in many respects incomplete, it is true, and they doubtless do not correspond closely to the real existences for which they are, at present, our best expression; but, to one familiar with the very practical results which have been obtained in the domain of structural chemistry, it is difficult to conceive how such results would have been possible without their use.

While physical chemistry has made little or no apparent progress toward the goal marked out by Du Bois-Reymond, its practical achievements during the last ten or fifteen years have been very considerable, and it is to these practical achievements that I wish to turn our attention.

Whenever the subject of physical chemistry is mentioned our thoughts naturally turn to the subject of solutions. Not that physical chemistry has to do only or chiefly with solutions, for, as I understand it, physical chemistry has to do with all of those physical properties of matter which can only be understood by taking into consideration at the same time its composition; but rather because some of the most valuable results of physico-chemical researches have been made in this field, and because diversity of views has made this the chief recent battle-ground in chemistry.

Up to about eleven years ago our knowledge of solutions was almost entirely of an empirical character. No great generalization, similar to those which had long been known for gases, had been discovered. In 1885 J. H. van't Hoff[1] proposed his theory of osmotic pressure. The empirical basis for this theory lay in the experiments of many different workers, some of them made many years before. Studies in osmose date from the early years of this century and, indeed, some experiments were made more than a century ago. It was not, however, till 1867 that the discovery of true semi-permeable membranes was made. In that year M. Traube[2] showed that membranes may be prepared which will readily allow the passage of water, but which are totally impervious to certain substances in solution. Ten years later W. Pfeffer[3] conceived the idea of preparing such membranes in the interior of a solid partition. By exposing a cup of porous porcelain to the action of a solution of copper sulphate on one side and of potassium ferrocyanide on the other, a precipitate is formed within the mass of the porcelain which is permeable to water, but which is impervious to the passage of sugar and of many other substances. With such cells the osmotic pressure was measured and was found to be surprisingly great. For a one and a-half per cent. solution of saltpetre it is more than three atmospheres. For sea water it would be about twenty atmospheres. Pfeffer's experiments were made with reference to their bearing on the action of organic cells and on other physiological questions, and it was eight years later before their extraordinary theoretical importance was pointed out by van't Hoff.

A careful study of the experimental data given by Pfeffer and others leads to the following conclusions:

First, the osmotic pressure is directly proportional to the concentration of the solution.

Second, the osmotic pressure is directly proportional to the absolute temperature. In establishing this law the experiments of Soret[4] are of especial interest. He subjected a solution of copper sulphate, contained in a vertical tube, to a temperature of 80° near the top and of 20° at the bottom. Under these circumstances the concentration increases below and diminishes above. After equilibrium was established it was found that the per cent. of copper sulphate in the two parts of the solution was inversely as the absolute temperature. The analogy with what would take place in a gas under the same conditions is clear.

Third, solutions which are isotonic at a given temperature contain in unit volume the same number of molecules of the dissolved substance. Another statement of the same law, which gives it also a quantitative expression, is that the osmotic pressure of a solution is the same as though the dissolved substance existed as a gas within the same space. The osmotic pressure of a one per cent. solution of sugar may be calculated by the same formula* which we should use to calculate the pressure exerted by one gram of a gaseous body having a molecular weight of 342 and contained in a volume of 100.6 cubic centimeters.

Every one recognizes, of course, that the laws which have been given for osmotic pressure are identical with the laws of Boyle, of Charles and of Avogadro for gases. Van't Hoff pointed out this analogy very clearly, but he did not give any clear explanation of what he considered as the real cause of the phenomena of osmose. He spoke, from the purely empirical side, of of the attraction which the solution exerts for pure water.[5] Ostwald in his Lehrbuch[6] is even more careful. He speaks of the cell as conducting itself as though there is within it a partial vacuum for water. These expressions are very similar to those of the older text-books, which speak of the expansion of gases as due to the repulsion of their particles for each other, and appear to me equally misleading and unsatisfactory. In a later paper,[7] in reply to a criticism by Lothar Meyer,[8] van't Hoff gives a clearer explanation in terms of the kinetic theory.

If we have a gas in a confined space and introduce into it a small amount of some volatile liquid the vapor of the liquid will rise and fill the space very nearly as though the gas were not present, and when equilibrium is reached the pressure will equal the original pressure of the gas plus the vapor pressure of the liquid. The explanation is that the pressure exerted on the surface of the liquid by the gas is not that of continuous matter, but is due to the

* $$P = \frac{760 \times T.}{342 \times 0.045 \times 0.1006 \times 273}$$

In this formula,

T = Absolute temperature.

342 = Molecular weight of cane sugar.

0.045 = One-half the weight of a liter of hydrogen.

0.1006 = Volume in liters of 100 grams of the solution.

bombardment of its surface by particles of discontinuous matter. The particles of the liquid find ample opportunity, therefore, to rise between the particles of the gas.

Let us take a second case, which has, however, as far as I am aware, never been realized. Suppose a vessel having a wall impervious to the molecules of one gas but previous to those of a second. If such a vessel containing the first gas is placed in an atmosphere of the second the molecules of the latter will pass the walls and enter the space occupied by the first, exactly as the molecules of the volatile liquid rise among the molecules of the gas above, and equilibrium will be established only when the pressure exerted by the second gas is equal within and without. The pressure within the vessel will then exceed that on the outside by exactly the pressure exerted by the gas whose molecules cannot pass the wall.

The case with osmotic pressure is very similar to that last mentioned. Here we have a semi-permeable wall actually realized. For instance, we may have a wall which will allow water to pass freely but which is impervious to the molecules of sugar. If pure water be on one side of such a wall, and a solution of sugar on the other, equilibrium can exist only when the pressure due to the water alone is equal on both sides; for the molecules of sugar, because of their discontinuous character, can exert no influence to cause the molecules of water to pass one way or the other, exactly as a gas can exert no permanent effect to prevent the vapor of a liquid from passing upward into it. In the end, therefore, the pressure on the side of the solution must exceed that on the side of the pure solvent by the amount of pressure due to the kinetic energy of the molecules of the dissolved substance. If we further suppose that this energy is the same in the liquid as in the gaseous state, and the laws of osmotic pressure give us every reason to believe that it is, the explanation is complete.

This explanation gives us a conception of liquids as very closely related to gases in many of their properties, the main difference being that in the liquid the molecule does not possess enough kinetic energy to separate it from the mass of neighboring molecules, although its motion within the confined space is very similar to that of the molecule of a gas.

But it is not only, nor indeed mainly, in his study of the phenomena of osmose that van't Hoff has rendered the greatest service. Very few perfect semi-permeable walls are known, and osmotic pressures are very difficult to measure directly, so that, if we were dependent on direct measurements, the theory would be of scarcely more than theoretical interest. Van't Hoff pointed out, however, that the concentration of a solution by the removal of the solvent, whether effected by a piston composed of a semi-permeable wall, by the evaporation of the solvent, or by the separation of crystals of the pure solvent by freezing, is in each case a reversible process analogous to the compression of a gas, and that, as with all other reversible processes, it is subject to the second law of thermo-dynamics. This made it possible to connect the lowering of the vapor pressure and the depression of the freezing point of solutions directly with their osmotic pressure. This has given an indirect determination of the osmotic pressure in thousands of different cases. As a practical result we have now at our disposal a large number of methods for the determination of the molecular weights of solid and liquid bodies.

The work of Raoult[9] in this field deserves especial mention, because he developed several methods of determining molecular weights from an empirical standpoint, before the theoretical development of the subject had been given by van't Hoff. Raoult's[7] work attracted the attention of Victor Meyer, who made use of his methods in the study of certain stereomeric bodies upon which he was at work. And it is in connection with stereoisomerism that the new methods of determining molecular weights have, perhaps, been of the greatest practical value in the development of chemical science; for, without the positive proof that the bodies studied are metameric and not polymeric, the foundation for the belief that they are stereomeric would be comparatively weak.

It is probably through articles published by Victor Meyer[10] and Auwers[11] that cryoscopic methods for the determination of molecular weights were first brought to the attention of a wide circle of chemists. Since then a large number of workers have busied themselves with the subject, partly in the development of suitable forms of apparatus and methods of manipulation, partly in the study of the scope and degree of accuracy of the laws and of exceptions to them. The most important of the methods developed are those dependent on the lowering of the freezing point of solutions,[12] on the raising of the boiling point,[13] on the lowering of the vapor pressure,[14] on the determination of isotonic solutions by vegetable membranes[15] and by blood corpuscles, and on the lessening of the solubility of ether in water or of phenol in water by the addition of substances soluble in ether or phenol but not in water. In the last case the determination is either direct in the case of phenol, or by the rise of the freezing point of the water[16] owing to the withdrawal of ether from it.

As was to be expected, the laws of osmotic pressure are subject to numerous exceptions, or rather modifications, for, strictly speaking, no true law of nature is ever subject to an exception. That which, by a figure of speech, we call an exception is really a modification due to the simultaneous application of some other law. The modifications in this case are very similar to the modifications of Avogadro's law, which retarded its acceptance for nearly a half century. Vapor densities are abnormally high on account of the associative tendency of molecules, as in the case of acetic acid, or when too near the boiling point of the liquid, or low on account of dissociation, as in the case of ammonium chloride or of phosphorus pentachloride. In a similar manner the molecular weights of most acids when determined in solution in benzene are twice their normal value, while the molecular weights of electrolytes dissolved in water, and sometimes when dissolved in other solvents, are less than we should expect. In addition to the modifications of the law due to association and dissociation are other modifications similar to the modification of the laws of Boyle and Charles for gases which are highly compressed. These cases have been studied and formulæ for the deviation, based on the formulæ of van der Waals for compressed gases, have been given by Ostwald, Bredig and A. A. Noyes.[17] These formulæ give a satisfactory expression for the deviation in many cases of concentrated solutions. When we consider that strong solutions often give osmotic pressures of many atmospheres, and that the molecules of the bodies in solution are often much more complex than the molecules of most gases, it is readily seen that deviations of considerable amount may be expected.

In 1884 Arrheneus[18] published the results of researches on the electrical conductivity of solutions, on which he had been engaged for two years. In the course of his studies he was led to the conclusion that only a part of the molecules of an electrolyte are concerned in conveying the electrical current, and that it is necessary to distinguish between 'active' and 'inactive' molecules in this regard. The conductivity is greater, in proportion to the amount of the electrolyte present, for dilute than for concentrated solutions, and for an infinite dilution the molecules would, presumably, become all 'active.' Arrheneus pointed out, also, that there is a close connection between the number of 'active' molecules as determined by the electrical conductivity of solutions and the 'avidity' of acids as determined by the thermo-chemical researches of Thomsen. His first explanation of the cause of the difference between the 'active' and 'inactive' molecules, was, however, unsatisfactory and was not well received.

Shortly after, in his first development of his theory of solutions, van't Hoff was compelled to admit that many substances in aqueous solutions cause a depression of the freezing point much greater than they should in proportion to their molecular weights. He expressed the deviation by use of a factor, 'i,' which is, for electrolytes, always greater than unity and expresses the number of times the depression exceeds the theoretical depression as calculated from the molecular weight. This factor was at first considered to be a constant, but it is now known that it is variable and that it increases with the dilution. The obvious meaning of this factor is that the molecules of electrolytes are separated into two or more parts when dissolved in water, or other liquids which have a similar effect in causing electrical conductivity. But, just as chemists were very slow to see that the abnormal densities of ammonium chloride and of many other substances are due to dissociation, so van't Hoff did not draw a conclusion which seemed to be so contradictory to all preconceived notions about the bodies in question. Arrhenius, however, saw the logical conclusion, and his studies had prepared him for its acceptance. As a result, he proposed, in 1887, his theory of electrolytic dissociation.[19]

This theory, which seemed at first very improbable, has shown itself capable of coordinating the facts of many diverse fields of work and has proved more valuable in the incentive which it has given to research and more prolific of results than any other theory proposed during the last decade. According to the theory, an electrolyte when dissolved in water, and sometimes when dissolved in other solvents, is separated more or less completely into its ions.

The empirical basis for the theory lies in the correspondence between electrolytic conductivity and the divergence from the normal depression of the freezing point and lowering of the vapor pressure; in the correspondence of both with the 'avidity' of acids which has already been referred to; in the quantitative connection between each of these and the chemical effect of acids as shown in the inversion of cane sugar and saponification of methyl acetate; in the satisfactory explanation which it gives for the independent migration of ions during electrolyses as established by the work of Hittorf, Kohlrauch and others; in the fact that an electrolyte obeys the same law for dissociation with increasing dilution as a gas under diminishing pressure, first pointed out theoretically by Ostwald and Planck,[20] and then experimentally established by Ostwald, Wildermann,[21] Loomis,[22] and others; and in general by the fact that the properties of a dilute solution of an electrolyte are dependent on the sum of the properties of the ions present rather than on the properties of the chemical compound which those ions may combine to produce. It would take me too far to illustrate this last statement as shown to be true of the density, color and other properties of solution.

The theory has thrown light upon many chemical riddles and has placed the chemist in a position to predict phenomena which could formerly be known only as the result of experiment. It suggests at once the distinction between reactions of ions and reactions of bodies which do not undergo ionic dissociation. The former take place in solutions at ordinary temperatures and so instantaneously that the time factor cannot be measured ; the latter frequently require an elevated temperature and are sometimes very slow. The distinction is, perhaps, a practical, rather than a strictly logical one, for theoretical considerations lead us inevitably to the conclusion that only additive reactions, and in many cases not even those, can take place without a previous dissociation of some sort. In this view the distinction between ionic reactions and others is that in solutions of electrolytes a considerable portion of the compounds have undergone dissociation; and as any ion is removed by precipitation, or otherwise, the remainder of the compound of which it is a part undergoes rapid dissociation, owing to the resulting dilution of the solution. In such cases the dissociation appears to take place almost exclusively at one point in the compound, and the reactions are clean and practically quantitative. In what may be called non-ionic reactions, on the other hand, the initial dissociation appears to be trifling and, notably with organic compounds, may take place at several points; the reactions between the resulting parts must be slow and may give rise to a variety of compounds.

In accordance with the theory, only those elements or groups which exist as independent ions in a solution enter readily into combination with other ions. Hence an atom which forms a part of a complex ion as the iron of ferro- or ferri-cyanides and the chlorine of chloro-platinic acid and of potassium chlorate cannot be detected by the ordinary reagents for these elements. This principle is of fundamental importance for analytical chemistry and has, of course, in its empirical form, been long recognized.

In the case of analytical chemistry, especially the new theories of physical chemistry seem destined to transform what has been, hitherto, an almost exclusively empirical science and raise it to a higher plane. Two illustrations of practical applications of the theory in this field may be of interest.

The first is with regard to the indicators used in acidimetry. It has long been known that the same indicator is not equally satisfactory in all cases, but the reason has never been clearly stated till recently. The principles on which the discussion depends are these : an acid solution is characterized by the presence of free hydrogen ions, a basic solution by the presence of free hydroxyl and free metallic ions ; in the case of a strong acid or base the number of hydrogen or hydroxyl ions is large in proportion to the quantity of the acid or base present, while in the case of a weak acid or base the number of ions is small ; in other words the difference between strong and weak acids and bases is that the dissociation factor of the former is very much the larger. The indicators in use are relatively weak acids or bases for which the free ions possess a different color from that of the pure acid or base. Thus phenol phthaleïn is colorless, while its ion is red; litmus is red, while its ion is blue. In the presence of hydrogen ions the dissociation of each of these substances is diminished in accordance with the well known law of dissociation that the presence of one of the products of dissociation decreases the dissociation of the compound. Hence in acid solutions these bodies are so little dissociated that the color of the compound, and not that of the ion, appears. In alkaline solutions, however, the color of the ions is developed, since the potassium and sodium salts, even of very weak acids, are largely dissociated in dilute solutions.

There is, however, a very considerable difference in the dissociation factors for the different indicators. The dissociation factor is much higher for methyl orange and for cochineal than for litmus and phenol phthaleïn, and while the dissociation factor of hydrochloric and similar acids is so high that a very small excess will cause the change in color, even of methyl orange, the dissociation factor for many acids, and especially for most organic acids, is so low that a quite appreciable excess is required, and the change in color will be slow and uncertain. Hence methyl orange and cochineal are entirely unsuited for the titration of weak acids, and litmus or phenol phthaleïn must be used. For weak bases, and notably for ammonia, the conditions are reversed. The salts of such bases with phenol phthaleïn, or with litmus, undergo hydrolysis in dilute solutions, and a considerable excess of the base will be required before the ions characteristic of the indicator will appear. The salts of the same bases with methyl orange or cochineal are not so readily hydrolyzed, and these indicators are more suitable.

A practical complication arises from the presence of carbonic acid in most of the solutions which we titrate. I will not take the time here to discuss the details of the theory which points out very clearly that, for accurate results, carbonic acid must be excluded from solutions in which litmus or phenol phthaleïn are employed, while, if concentrated, methyl orange or cochineal may be used satisfactorily for strong acids.

The other illustration of the application of the principles of physical chemistry to an analytical problem is one recently given by Stefan Bugarsky.[23] A great many methods for the separation of bromine and chlorine have been developed, but nearly or quite all of them rest on a purely empirical basis. Bugarsky has studied the subject from an entirely different point of view. Sometime since Bancroft[24] determined the electromotive forces developed between oxidizing and oxidizable solutions connected by an indifferent electrolyte, and with a platinum electrode immersed in each. The results may be considered as giving a quantitative expression for the relative oxidizing and reducing power of the various substances studied. Among other things it was found that, no matter what substance was oxidized, iodic acid with sulphuric acid develops a greater electromotive force than bromine with potassium bromide and less than chlorine with potassium chloride. It appears, therefore, that iodic and sulphuric acids together should liberate bromine, but not chlorine, from a solution containing bromides and chlorides. The practical application of this theoretical conclusion appears to have been entirely successful.

It is not alone in chemistry that the theories of osmotic pressure and of electrolytic dissociation have proved of practical value. Nernst has developed from these theories a theory for the cause of the electromotive force in batteries, which, while it may not, as yet, have received general acceptance, is a more useful expression for our present knowledge than any previously proposed. The most important conception at the basis of this theory is that of what may be called a solution pressure for metals, corresponding in some sense to the vapor pressure of liquids. When zinc, for instance, is in contact with water, or an aqueous solution, this solution pressure is a force impelling the atoms of zinc to pass into solution. In order that they may do so, however, each atom must pass over into the state of an ion; that is, it must receive a charge of positive electricity which is carried with it into the solution. But only a very few atoms can pass into solution before the negative charge left in the mass of the zinc in proportion as the positive ions separate from it will cause such an accumulation of zinc ions in proximity with the zinc as to balance the solution pressure. If, however, an opportunity is given for the escape of the negative charge from the zinc, and at the same time positive ions are allowed to escape from the solution at some other point, the zinc will continue to dissolve and currents of electricity will be set up. Thus, in the Daniell, or gravity cell, zinc ions pass into solution and a corresponding number of copper ions are deposited. The force which causes the movement of the ions, and with them the transference of electrical energy within the cell, is mainly the very high solution pressure of the zinc as compared with that of copper. Other factors, such as the osmotic pressure of zinc ions already in solution, which tends to conteract the solution pressure of the zinc, the osmotic pressure of copper ions which aids in the separation of the copper, and the different velocity of translation for various ions which may cause differences of potential when the fluids of the cell are not homogeneous, are most of them comparatively small in their effect.

No means has been found for the direct determination of the solution pressure of metals, but it may be calculated from the difference in potential between a metal and a solution of one of its salts. Methods for the determination of the latter have been devised by Ostwald,[25] and improved by Paschen.[26] By the use of these and other constants which the researches of physical chemistry have placed in his hands, the physicist can now calculate the electromotive force which can be obtained by various combinations of metals and solutions. On this side the theory has rendered essentially the same service for the galvanic cell which the atomic theory rendered for chemical compounds when it furnished the means for calculating their percentage composition. As in the early days of the atomic theory, many of the constants in question are imperfectly known, but since the theory has shown clearly their interdependence, new means for their determination and for the control of their accuracy are constantly being discovered.

Every one who is familiar with the extremely wasteful character of all processes now at our disposal for the transformation of chemical into mechanical energy must have had the thought that there is surely some means of saving a part of the enormous loss. At present the attention of the scientific world is turned toward the transformation of the chemical energy of coal into electrical energy as the probable solution of this problem. It seems to be almost certain that physical chemistry has already made clear the principles by means of which such a transformation may be accomplished. Indeed, Dr. W. Borchers,[27] by the use of a solution of cuprous chloride with producer gas, or carbon monoxide on one side and air on the other, has already obtained an electrical current which corresponds to a transformation of thirty per cent. of the chemical energy into electrical. This is an efficiency three times that of the best steam engines. There is no probability that this method can ever be practically useful, but that a practical method will soon be discovered is, at least, possible.

I have thus far spoken of the achievements of physical chemistry mainly in the direction of the development of the theories of osmotic pressure and of electrolytic dissociation. It is in this field that the most valuable practical results have been secured, because it is here that a new, far-reaching, and extremely useful theory has been developed. But work in physical chemistry has been extremely active in many other directions as well.

The most brilliant chemical discovery of the last decade was a result of the careful study of a single physical property of nitrogen. And, owing to the peculiar character of argon and helium, their further study has been almost exclusively on the physical side.

Ramsey and Shields,[23] by their work on the surface energy of homogeneous liquids, have developed a method for the determination of the molecular weights of this class of bodies.

Traube's exhaustive study of the specific gravity of solutions, promises, if all that he claims be true, and much of it seems to be, to bring order out of an almost interminable chaos of empirical data. Among other things his work has given a new and very rapid method for the determination of molecular weights.

I will not take the time to refer in detail to the work of Brühl and others on the refraction and dispersion of light as dependent on the composition and structure of bodies; to the work of Thomsen, of Stohman and of Berthelot upon thermo-chemistry; to the work of Guye, Walden and others on specific and molecular rotation, and of Perkin on electro-magnetic rotation of polarized light; and to the work of Rowland on spectrum analysis.

In all of these fields and in many others a vast accumulation of empirical data has been secured. This wealth of experimental material has been accompanied and supplemented by theoretical discussions, and many interesting relations have been discovered. Physical chemistry has proved one of the most enticing and profitable fields for work in recent years and claims many enthusiastic investigators in our own country as well as abroad. In the development of the subject perhaps no one has contributed more than Ostwald by his Lehrbuch and by his ably edited Zeitschrift für physikalische Chemie. We may congratulate ourselves that our workers in America are now to have a journal of their own, and we may confidently hope that the new *Journal of Physical Chemistry* will contribute much toward 'the chemistry of the future.'

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SECTION C.—CHEMISTRY.

Section C. of the American Association for the Advancement of Science was called together for organization on Monday, August

31st, at 11:30 a. m. Vice-President W. A. Noyes of Terre Haute, Ind., was in the chair, and F. P. Venable, of Chapel Hill, N. C., was Secretary.

Dr. E. A. de Schweinitz, of Washington, was chosen member of the Council, and Dr. Charles H. Herty, of Athens, Ga., Press Secretary. Dr. A. L. Springer was elected member of the Nominating Committee. Drs. McMurtrie, Norton and Baskerville were added to the committee to nominate officers of the Section, and Prof. F. C. Phillips, Prof. S. A. Lattimore and Prof. F. W. Clarke were added to the Sectional Committee.

The Section then adjourned until 4:30 p. m. At that hour the Section assembled to hear the Vice-Presidential address of Prof. W. A. Noyes. He was introduced in a few appropriate words by the Vice-President for 1895, Dr. Wm. McMurtrie, and made an address on 'The Achievements of Physical Chemistry,' which is printed in full above.

On Tuesday the Section assembled at 11 a. m. and the regular program of papers was taken up.

Prof. F. W. Clarke reported for the committee on indexing chemical literature. In addition he reported work now in progress by Dr. Bolton on the preparation of an index of inaugural dissertations. This is the first effort to index this matter.

Dr. Edward Hart reported on the loan made by the Association to him for prosecuting work on the method of preparation and purification of glucinum. The work is not yet complete, but he hopes to prepare glucinum on a commercial scale by reduction of the oxide with magnesium in a glucina crucible. The Section expressed approval of the work.

The following papers were presented before the Section.

PHYSICAL CHEMISTRY.

A. A. Noyes and G. C. Abbott, Massachusetts Institute of Technology: on 'Determination of Osmotic Pressure from Vapor Pressure Measurements.' The authors derive, from thermo-dynamical considerations, a formula by means of which the osmotic pressure can be calculated directly from the vapor pressure, and deduce from it the law that osmotic pressure and work are directly proportional to one another, no specific volume correction being required as assumed by many previous investigators. The authors further describe an experimental method for determining vapor pressure and communicate measurements on ether solutions of napthaline and azo-benzene. The results show that vant' Hoff's law of the identity of osmotic and gas pressure under similar conditions is fully confirmed, and that the osmotic pressure varies almost directly as the concentrations.

W. D. Bancroft, Cornell University: 'Distillation with Vapor.' From experimental data the author is led to conclude that solids present in vapors obey certain chemical laws, and are not simply mechanically suspended in the vapor. The author is now engaged in a revision of the experimental data.

H. C. Jones, Johns Hopkins University: 'A Physico-chemical Study of Water Solutions of some of the Alums.' By electrical conductivity measurements the author shows that in rather concentrated solutions there is present some of the undissociated double salt. In very dilute solutions, complete dissociation takes place.

J. H. Kastle, State College of Kentucky: 'The Hydrolysis of the Sulphonic Ethers.' The hydrolysis of the sulphonic ethers is brought about by water and also by the alcohols. It was found that in solution in acetone, water is about 3.5 times stronger in its hydrolyzing power than methyl and ethyl alcohol, which were found to be about equal in this capacity. It was found also that acids do not act by catalysis on the sulphonic ethers, but actually enter into double decomposition with them. It was found further that not only acids, but all electrolytes, react in the same way on the sulphonic ethers, and as might be expected all electrolytes were found to react upon the sulphonic ethers much more rapidly than water.

C. E. Linebarger, Chicago: 'On the Nature of Isomorphous Mixtures.' The author gives an historical review of the two views held as to the nature of isomorphous mixtures, namely, that of mechanical mixtures, or solid solutions. From experiments upon the rate of desiccation of isomorphous mixtures of sulphates the author concludes that this is a case of solid solution and not a mechanical mixture.

R. B. Warder, Washington, D. C.: 'A Discussion of Lichty's Experiments on the Speed of Esterification.' The 'coefficient of speed' in each case, as deduced by means of the formulas for reversible reactions, is shown to vary in the progress of the reaction; first diminishing, then nearly constant or slightly increasing, and finally diminishing very rapidly. Suggestions are thus gained regarding the nature of secondary influences involved.

H. M. Goodwin, Massachusetts Institute of Technology: 'The Hydrolysis of Ferric Chloride.' The author calculates the degree of hydrolysis of ferric chloride from conductivity and freezing point determinations, finding it to be inappreciable in fairly concentrated solutions (*e. g.*, decinormal), but nearly complete in more dilute ones (*e. g.*, millinormal). He also describes and discusses the remarkable increase in conductivity with the time which such solutions manifest.

A. A. Noyes and H. M. Goodwin: 'The Viscosity of Mercury Vapor.' By determinations of the viscosity coefficients of gases it is possible to calculate the relative cross-sections of the molecules of the gases. From measurements of the viscosity of mercury and carbon dioxide it is found that the spaces between the atoms of molecules are probably not large. The authors conclude that atoms and molecules are of the same order of magnitude.

INORGANIC CHEMISTRY.

F. W. Clarke, Washington, D. C.: 'Some Points in Nomenclature with regard to Analysis of Mineral Water.' It was pointed out that in the light of modern theories of solution the present method of reporting water analyses are totally erroneous. Suggestions were asked as to nomenclature in case of reporting SO_4, CO_3, etc.

C. H. Herty and H. V. Black, University of Georgia: 'The Alkali Tri-Halides.' The authors show that the successive crops of crystals obtained in the preparation of rubidium dibromiodide are identical, confirming thus the previously held view that these substances are true chemical compounds.

E. Goldsmith, Philadelphia: 'The metamorphosis of Fossil Bone into a mineral.' The author showed the substitution of carbonic acid for phosphoric acid, calcium carbonate crystallizing as aragonite.

J. L. Howe, Washington and Lee University: 'A Bibliography of the Metals of the Platinum Group.' This work will be ready for print soon.

J. L. Howe: 'Examination of Water and Deposits from a Lake in Yucatan.' The deposits (mud) proved to be almost pure gypsum. A sample from the middle of the lake contains a large quantity of hydrogen sulphide, while another sample taken from the border contained none.

T. W. Richards and H. G. Parker, Harvard University: 'A Revision of the Atomic Weight of Magnesium.' From determinations of chlorine in magnesium chloride the authors find the atomic weight of magnesium to be 24.36.

ORGANIC CHEMISTRY.

William McPherson, Ohio State University: 'Hydrazones of Quinones.' This is an extension to the naphthoquinone of the previously published work on the action of phenyl hydrazine on quinones. Zincke's idea is confirmed, that in the action of phenyl hydrazine on a naphtha quinone there is a migration of a hydrogen atom of phenyl hydrazine to the C=O group.

A. A. Noyes: 'Synthesis of Diethyl Hexamethylene Ether and other Ethers from Trimethylene Glycol.' By replacing the hydrogen of one of the hydroxl groups by sodium, then replacing this sodium by the ethyl group, then replacing the remaining hydroxyl group by chlorine, a substance is obtained from which may be prepared the diethyl hexamethylene ether.

A. A. Noyes: 'Formation of Diacetylenyl (Butaiidine) from Copper Acetylene.' The following transformations were effected: $Cu-C=C-Cu+2CuCl_2=Cu-C\equiv C-C\equiv C-Cu$. This was transformed into $H-C\equiv C-C\equiv C-H$ (Butaiidine).

This hydrocarbon takes up directly six atoms of bromine.

W. A. Noyes, Rose Polytechnic Institute: 'Camphoric Acid.' The author shows that one of the carboxyl groups of camphoric acid is primary, the other is tertiary. He further shows that camphoric acid is a derivative of succinic and not of glutaric acid. From a study of the constitution of campholitic acid he hopes to obtain accurate evidence upon the constitution of camphoric acid.

P. Fireman, Washington, D. C.: 'Introduction of Alkyl Iodides into Phosphines by means of Ethers.' This was accomplished by heating phosphonium iodide with ethers in sealed tubes. Reaction takes place more readily than with alcohol.

S. H. Bear and A. B. Prescott, University of Michigan: 'Dipyridine Methylene Iodide and the Non-formation of Corresponding Donopyridine Products.' This is a continuation of work previously published on the periodides of the nitrogen basis.

C. Loring Jackson and W. R. Lamar, Harvard University: 'On the Behavior of Trichlordinotrobenzol with Various Reagents,' 'On the action of Nitric Acid on Potassic Cobalticyanide,' 'On the action of Sodic Ethylate on Dinitranissic Acid.' In the absence of the authors, Dr. Howe persented a brief abstract of these three papers.

DIDACTIC CHEMISTRY.

F. P. Venable, University of North Carolina: 'The use of the Periodic Law in Teaching General Chemistry.' The author advocated adherence, as far as possible, to the periodic law in teaching general chemistry.

W. P. Mason, Rensselaer Polytechnic Institute: 'Chemistry at the Rensselaer Polytechnic Institute.'

A. A. Noyes: 'Laboratory Instruction in Organic Chemistry.' The author called attention to the need of greater ability on the part of students to identify the more common organic compounds, or, at least, the classes of compounds. He furnishes students with group reactions of common organic compounds, then with methods of separation.

A. A. Noyes: 'The Teaching of Physical Chemistry.' The author asked that courses in theoretical chemistry include more of the recently developed views and that such a course be accompanied by a laboratory course.

Ellen H. Richards, Massachusetts Institute of Technology: 'Instruction in Sanitary Chemistry at the Massachusetts Institute of Technology.'

T. H. Norton, University of Cincinnati: 'Points in Teaching Technical Chemistry.' The author pointed out the necessity of visiting several commercial plants with the class. He then called attention to the preliminary preparation which should be had and showed how the details of the plant could be better understood by the aid of a printed syllabus, the various parts of the apparatus being labelled in accord with the syllabus. Application of points of interest should be made in laboratory work. Well written accounts of the visit should be made, and finally, analyses should be made of samples obtained on the trip, especially as showing the quantitative proportion of material used and produced. In the discussion which followed all were unanimous that there was great necessity for higher chemical training and training in mechanical engineering for technical chemists.

G. C. Caldwell, Cornell University: 'The Aim of Qualitative Analysis.' It is much more than mere identification of particular substances; it furnishes fine training in careful manipulation and accurate observation; the student learns the importance of small things, his judgment is trained. It requires a thorough study of wider fields of chemistry and teaches classification.

A. L. Green, Purdue University: 'The Teaching of Qualitative Analysis.' This was an account of the specific method of teaching quantitative analysis at Purdue.

Ellen H. Richards: 'Some points in the use of Depth of Color as a measure of Chemical Contents.' This is a continuation of the line of work reported on at the Springfield meeting.

ANALYTICAL CHEMISTRY.

J. L. Howe and P. S. Mertins, Washington and Lee University: 'Notes on Reinsch's test for Arsenic and Antimony.' The work shows that an experienced observer will never fail to distinguish arsenic and antimony by this test.

Erwin E. Ewell, Washington, D. C.: 'A new form of Laboratory Condenser.'

Erwin E. Ewell: 'A Method of Manipulation for the Colorimetric Determination of Ammoniacal Nitrous and Nitric Nitrogen in Bacterial Culture.'

H. W. Wiley, Washington, D. C.: 'A Modified form of the Ebullioscope.'

TECHNICAL CHEMISTRY.

A. R. Leeds, Stevens Institute: 'Recent developments in the Purification and Filtration of Water.' This paper was largely historical. The author takes the position that it is better to purify water at hand than go long distances for it.

F. C. Phillips, Allegheny, Pa.: 'Some Properties and uses of Natural Gas.' From comparison of the composition of natural gas with that of coal gas, the author concludes that their methods of formation are not the same.

F. C. Phillips: 'A new Method for the Determination of Sulphur in White Iron.'

C. L. Reese, Charleston, S. C.: 'On Recent Improvements in the Manufacture of Sulphuric Acid.'

H. A. Weber, Ohio State University: 'Use of Coal for Colors in Food.' From experiments on four coal-tar colors—methyl, orange, coraline yellow, saffroline and magenta—the author finds that no one of these affects both peptic and pancreatic digestion, but that each affects seriously one form or the other. In the discussion which followed it was held that too much importance is attached to such experiments, owing to the extremely small quantities used in food stuffs.

Erwin E. Ewell: 'The Alkaloids of Anhelonium Lewinii (Mescal Buttons).'

SANITARY CHEMISTRY.

W. P. Mason: 'Well Water.' The author considers that impurities from the surface may come through soaking, in addition to surface entrance. He considers well-selected water sources much better than domestic wells. It is noticeable that in rural districts farmers are especially careless with the disposition of refuse matter.

E. A. de Schweinitz, Washington, D. C.: 'Value and Use of Formaldehyde as a Disinfectant.' Anthrax, Tetanus, etc., are destroyed by formaldehyde. It possesses many good points as a disinfectant. It is a good deodorizer, only a small quantity being required, 1 cc. in ten liters of water. This is applied by spraying. It is a good preventative of decomposition. The amount of the gas in a confined space is determined by absorption in strong caustic soda or alkaline permanganate. One objection to its use has been the length of time necessary to remove the sharp odor of the formaldehyde. This can be largely hastened by spraying with ammonia.

E. G. Smith, Beloit College, Wis.: 'Observations on the Sanitary Nature of the Mississippi River Water at Different Seasons.'

AGRICULTURAL CHEMISTRY.

L. L. Van Hyde, Geneva, N. Y.: 'The work of the Agricultural Chemists of America.' The author gave a general review of the various lines of investigation pursued by the agricultural chemists. He pointed out what valuable service had been rendered in preventing fraudulent practices. An account was also given of the Association of Official Agricultural Chemists.

S. M. Babcock and H. L. Russell, University of Wisconsin: 'Conditions affecting the Normal Viscosity of Milk,' 'On the Restoration of the Viscosity of Pasteurized Milk.'

BIOLOGICAL CHEMISTRY.

V. K. Chestnut, U. S. Department of Agriculture: 'Andromedotoxin, the Poisonous constituent of the Ericaceae and its Relation to some Food Products.' It has been shown that honey from bees feeding on the plant contains the poison; further that meat of animals feeding on the leaves contains the poison and is a source of contamination.

On Thursday the Council of the A. A. A. S. authorized the fusion of Section C with the summer meeting of the American Chemical Society, the first two days of the meeting to be conducted officially by those of the American Chemical Society. The members of the American Chemical Society are to have the privilege of reading papers in Section C, and *vice versa*.

This matter is subject to the action of the Council of the American Chemical Society.

Section C nominated Professor Wolcott Gibbs, of Newport, R. I., to be an honorary member of the A. A. A. S. The Secretary was ordered to cast the ballot.

Dr. William P. Mason was nominated for Vice-President of the Section and Prof. P. C. Freer, for Secretary for the year 1897.

F. P. VENABLE, *Secretary*,
and CHAS. H. HERTY,
Press Secretary Section C.

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*THE EMBLEMATIC USE OF THE TREE IN THE DAKOTAN GROUP.**

THE tribes of the Dakotan or Siouan linguistic stock aggregate in number about 45,000 Indians. Grouped according to a close relationship of language, we find in the United States: 32,000 in the Dakota; 4,000 in the Omaha, Ponka, Quapa, Kanza and Osage; 800 in the Iowa, Otoe and Missouri; 2,200 in the Winnebago, and 3,000 in the Hidatsa, Mandan and Crow tribes. The remaining 3,000 are widely scattered, with the greater part living in the provinces of Canada.

At the beginning of the seventeenth century a number of tribes belonging to this stock dwelt on a strip of the Atlantic coast, now within the limits of North and South

*Address by the Vice-President, before Section H—Anthropology.

Carolina, extending as far west as the Alleghanies and north to the Maryland line, and controlling the headwaters of the streams flowing westward. They were in constant warfare with their Algonquian and Iroquoian neighbors, and were exterminated as tribes within the historic period. The majority of the Siouan Indians were already beyond the Mississippi, where they were met by early explorers, and where they now dwell. We find the purport of their traditions to be that they were slowly driven from their eastern home by implacable enemies, and that once beyond the Mississippi, they spread to the northern tributaries of the Missouri, westward to the Rocky Mountains, and south to the Gulf of Mexico, where recent investigations have brought to light a remnant of the Biloxi.

Contact with Algonquian, Iroquoian, Muskhogean, Caddoan and Kioan stocks, during the period of progress over this vast tract of country, has left its traces in the Siouan rites and customs; but the uncertainty that still clouds the past history of this people makes it difficult to determine when certain rites were adopted, or to gauge with accuracy the modifying influences of other stocks upon native usages and beliefs. From the scant records left by early travellers, with the fragmentary nature of the information still obtainable from the few scattered survivors of the eastern and southern tribes, a full reconstruction of their social and religious customs is impossible; but enough can be discerned to indicate that the eastern, southern and western tribes were all under the influence of cults which seem to have been fundamentally the same.

In this paper is offered a slight contribution to the early history of social and religious development, inasmuch as in tracing the emblematic use of the tree in the Siouan linguistic group we follow a people from a comparatively primitive condition, living in isolated bands, independently of each other, to their organization within the tribal structure, compacted by the force of common religious beliefs.

That ideas are the ruling force and 'the constructive center' of human society is readily conceded as applicable to our own race. It is equally true of the Indian; but in according this power to ideas the modifying influence of environment is not to be overlooked. One cannot conceive of man apart from environment; his contact with it is the very condition of being. As Herbert Spencer has phrased it, life is 'the continuous adjustment of inner relations to outer relations.'

This 'adjustment' of man to his environment is the work solely of ideas, and the process, as evinced in this group of Indians, goes to show that those ideas which have formed 'the constructive center' of the tribe are religious ideas.

Indian religions seem to have been subject to the same laws that have governed the development and growth of religions on the eastern continent. There, we know the several systems to have been begun with the simple utterances of a seer, which, as they were passed from mouth to mouth, became more and more clouded with interpretations, gradually expanded in detail, and finally formulated into ceremonials with attendant explanatory and dramatic rites. As time rolled into centuries, these ceremonies, with their accessory priests, came to be regarded as of supernatural origin, endowed with superhuman power, and authorized to exercise control over the affairs of the tribe or nation; but the one living germ within the ponderous incrustation of doctrine and ceremony, that had accumulated throughout ages, was still the surviving, vitalizing thought of the seer.

Turning to America, to the group of Indians of our especial study, we find traces of a similar history; for, penetrating beneath the varied forms of their religious rites, we come upon a few fundamental conceptions or thoughts, the most dominant of which, perhaps, is the idea of the all-permeating presence of what we call life, and that this life is the same in kind, animating all natural forms and objects alike with man himself. Coordinate with this idea, which has received the name of animism, is that of the continuity of life, that whatever has once been endowed with it must continue to be a recipient of it ; in other words, whatever has once lived must continue to live.

There is no reason to think that, at any time in the past, it was possible for the idea of animism, or for any other idea, to have fallen into the mind of every savage simultaneously, as a cloud-burst drenches the plain. Ideas have ever made their way as they do now, slowly, and by being communicated and talked over. The idea of animism is a very remarkable one. It has been so built into the mind of the race that it is difficult to imagine a time when it was not ; and yet there was such a time, a time when man stood dumbly wondering at the birds and beasts, assailed like himself by hunger and finding food from the same supply ; at the alternation of day and night ; and at the destructive and vivifying effects of the storm. But these wondering observations were like so many disconnected fragments until some thoughtful mind caught the clue that led to the bold and clarifying thought that all things were animated by a common life, and that man was not alone upon the earth with strange and alien creatures, but was surrounded by forms replete with life like his own, and therefore of his kindred.

This mysterious power or permeating life was called in the language of the Omaha and Ponka tribes, Wa-ka*n*-da. This word is now used to designate the Deity. The original meaning, while conveying the idea of the mysterious, something hidden or unseen, also implied the power to bring to pass. Wa-ka*n*-da-gi, an adverbial form of the word, is applied to the first putting forth of a new faculty, as when a child first walks or talks, but the word wa-ka*n*-da-gi would not be used to express the resumption of faculties lost by sickness or accident.

Fourteen years ago, while sitting with me in his tent, a thoughtful old Dakota Indian, who had never come under missionary influence, spoke of his native religion, in which he was a firm believer. He explained the teaching of his fathers, and tried to make me understand that the mysterious power which animates all things is always moving and filling the earth and sky. He said, " Every thing as it moves, now and then, here and there, makes stops. The bird, as it flies, stops at one place to rest in its flight, and at another to build its nest. A man when he goes forth stops when he wills ; so the mysterious power has stopped. The sun, the moon, the four directions, the trees, the animals, all mark where it has stopped. The Indian thinks of all these places, * * * and sends his prayers to reach the mysterious power where it has stopped."

This Indian had evidently been taught that the power pervading all things was one in kind, and possessed of a quality similar to the will power of man. He said, " A man when he goes forth, stops when he wills ; so the mysterious power has stopped."

The Indian conceives of Wa-ka*n*-da as dowed with like, though greater powers than those possessed by man. The prayer chanted by every Omaha when he goes out to fast, seeking a vision :

"Wa-ka*n*-da dhe-dhu wa-pa-dhi*n* a-ta*n*-he."

Wa-ka*n*-da here needy I stand, is an appeal to something that is believed to be capable of understanding the needs of a man, and implies a conception of Wa-ka*n*-da that is anthropomorphic. But the

Indian does not apparently think of Wa-kan-da as apart from or outside of nature, but rather as permeating it, and thus it is that to him all things become anthropomorphized.

In a Ponka ritual the following address is made to the tree, as represented in the framework of the lodge in which the ceremony takes place:

"Oh! Thou Pole of the Tent, Ethka;

"Along the banks of the streams, Ethka;

"With head drooping over, there Thou sittest, Ethka;

"Thy topmost branches, Ethka;

"Dipping again and again, in very truth, the water, Ethka;

"Thou Pole of the Tent, Ethka; (The Tree now speaks.)

"One of these little ones, Ethka; (That is, the suppliant.)

"I shall set upon one (of my branches), Ethka;

"The impurities, Ethka,

"All I shall wash away, Ethka."

The tree is supposed to take the man on its branches, as in one's arms, and dip him in the stream, where 'all within the body' is 'cleansed.'

Long life is desired, and the Rock is invoked;

"Oh! Aged One! Ethka;

"Thou sittest as though longing for something, Ethka;

"Thou sittest like one with wrinkled loins, Ethka;

"Thou sittest like one with furrowed brow, Ethka;

"Thou sittest like one with flabby arms, Ethka." (The Rock now speaks.)

"The little ones (the people) shall be as I am, whosoever shall pray to me properly" (*i. e.*, ceremonially).

Many other illustrations could be given to show the Siouan Indian's anthropomorphic conception of nature.

With the acceptance of the idea that all things were quickened with the same life, came the belief that a mysterious relationship existed between man and his surroundings, and it naturally followed that, in his struggle for food and safety, he should seek to supplement his own strength by appealing to his kindred throughout nature; should 'send his prayers to reach the mysterious power where it has stopped.' Said a venerable Indian to me one day, "the tree is like a human being, for it has life and grows, so we pray to it and put our offerings on it, that the mysterious power may help us."

Coordinated with these ideas concerning nature was that of the continuity of life, which could not but lead to a belief in dual worlds with interchanging relations; thus we find that these Indians were firmly convinced that the dead camp in the unseen world, as they did while upon earth, each gens having the same relative place in the tribal circle, and each person at death going to his own gens.

Among the Ponkas the Ta-ha-u-ton-a-zhi division of the Ni-ka-pa-shna gens, whose totem is the deer, put deer-skin moccasins upon their dead, that they may be recognized by their kindred, and not lose their way in the other world. Among the Otoes, when an Indian dies his face is painted in a manner peculiar to his gens, by one having the hereditary right to perform this act, who says to the dead: "In life you were with those you have now left behind. Go forward! Do not look back? You have met death. Those you have left will come to you."

The ancient chiefs, who 'first took upon themselves the authority to govern the people,' are still active, and through the rituals chanted at the installation of tribal officials, as through a medium, they continue to exercise their functions and to confer authority on their successors. The rituals call upon the animals which had supernaturally appeared to the first rulers, 'The Crow, with frayed neck feathers; The Wolf, with tail blown to one side;' and they appeal to both chiefs and animals to remember their promise, and to continue to guide the people into safety and plenty through their successors now being ordained.

The Legend of the Sacred Pole of the Omahas, handed down from generations, gives a rapid history of the people from the time when 'they opened their eyes and beheld the day,' to the completed organization of the tribe and the institution of the rites of the Sacred Pole. From it we learn that changes in the daily and material progress of the people did not come about through miraculous intervention, but through the mind of their wise men; and that every step in the path of progress was the result of 'thought.' 'And the people thought,' is the constant prelude to every betterment or invention. By 'thought' they learned how to make fire, to build lodges, to weave, and finally to institute religious rites and ceremonies.

To quote from this Legend: "The people felt themselves weak and poor. Then the old men gathered together and said: Let us make our children cry to Wa-ka*n*-da. * * * So all the parents took their children, covered their faces with soft clay, and sent them forth to lonely places. * * * The old man said You shall go forth to cry to Wa-ka*n*-da. * * * When on the hills you shall not ask for any particular thing, * * * whatever is good that may Wa-ka*n*-da give. * * * Four days and nights upon the hills the youth shall pray, crying, and when he stops, shall wipe his tears with the palms of his hands, lift his wet hands to heaven, then lay them on the earth. * * * This was the people's first appeal to Wa-ka*n*-da. Since that time, twice in the year, * * * in the spring * * * and when the grass is yellow, * * * this prayer is said."

A study of this practice, as still found among the tribes, shows that the youth, who uttered his prayer during days and nights of fasting, was not only asking help from Wa-ka*n*-da, but was seeking a manifestation, in a vision, of the mysterious power. The form of this manifestation, which should come to him, he believed to be that to which he must appeal when in need of help. The symbol of this form, which the youth ever after carried with him, did not in itself possess the ability to help, but served as a credential by which the youth reminded the manifestation, be it of bird or beast, of the promise believed to have been received from it in the vision.

The dream and the vision were not the same; the dream of sleep came unsought in a natural way, while the manner in which the vision was striven for indicates an attempt to set aside and override natural conditions. The natural dream has exercised an influence in many ways, but it has not had the constructive force of the vision.

The cry to Wa-ka*n*-da was the outcome of 'thought' during the long barren period of primitive life. Whither this 'thought' had tended we have seen in its culmination in the ideas that all things were animated by the same continuous life and were related to each other. These generalizing ideas were not strictly in accord with the evidence of man's senses. The Indian could not help seeing the unmistakable difference between himself and all other objects. Nor could he help knowing that it was impossible for him to hold communication, as between man and man, with the animals, the Thunder, etc. The ancient thinkers and leaders met this difficulty by the rite of the vision, with its peculiar preparation. The youth was directed to strip off all decoration, to wear the scantiest of clothing, to deny his social instincts, and to go alone upon the hills, or into the depths of the forests; he was to weep as he chanted his prayer, and await the failing of his bodily strength and the coming of the vision. In this vision he saw familar things under such new conditions that communication with them was possible; and his belief in the reality of his vision could not but reconcile the animistic idea with the normal evidence of the senses.

The psychological conditions favorable to a belief in the visions, and the ethical influence of the rite of fasting, in its results upon the individual and upon society, cannot be considered here, but the constructive power exercised by the religious societies, which had their rise in the vision, claims a moment's attention, as pertinent to our subject.

From the legend already quoted, as well as from customs still existing in these tribes, we learn that men who had had similar visions became affiliated into groups or societies, and acknowledged a sort of kinship on the basis of like visions. For instance, those who had seen the Bear or the Elk, formed the Bear or the Elk society, and those to whom had appeared the Water Creatures or the Thunder Beings, were gathered into similarly defined groups. Within these societies grew up an orderly arrangement or classification of the membership, the institution of initiatory rites, a prescribed ritual and the appointment of officers.

An important stage in the secular organization of the people was reached when the acceptance of Leaders—'men who took upon themselves the authority to govern and to preserve order'—came to pass. It would seem, from the evidence of traditions and rituals, that the establishment of these Leaders, which implied the segregation of the people into groups of followers, was of slow growth and attended with rivalries and warfare. During this formative period, the early Leaders appear to have used the popular belief in the supernatural to strengthen their authority, so that they came to be regarded as specially endowed, and the efficacy of their vision was thought to extend over all their followers. In this way the symbol of the Leader's vision grew to be recognized as sacred to his kindred, and was finally adopted as the sign or totem of a common kinship or clan. This being accomplished, the taboo was instituted as a simple and effectual reminder of the totem of the Leader, and of the mutual obligations and relations of the members of the clan, which were further emphasized by the adoption of a set of names for each clan, all of which referred to its totem. Among the Omahas and Ponkas these names are called ni-ki-a, that is, spoken by a chief. In the ni-ki-a name and the ceremonies attending its bestowal there is a twofold recognition, that of a natural ancestor and that of the supernatural manifestation of this ancestor's vision. We have already seen a similar acknowledgment of a dual source of authority, where, in the rituals, the chiefs and the animals of their visions are both invoked.

In the clan organization the totem came to be representative preeminently of kinship; and its sign, as we have noted, was placed upon the dead, that they might be recognized by their kindred in the other world, and led directly to their clan. The function of the totem was social, rather than individual; the Indian depended for his personal supernatural help upon his own special vision, and his clan totem in no way interfered with his entrance into any religious society.

The resemblance which exists between the rites and rituals of the religious societies, and those which hedge about the office of Chief and Soldier, and Herald, marks the influence the societies have exercised upon the development of the tribal structure.

The control of the Thunder people runs

like a thread through all the tribes of the Siouan group. The character of their vision was such as easily to win popular recognition as preeminently authoritative, and they seem to have been singularly dominant from the earliest time.*

The Thunder gentes had charge of, or took an important part in, all ceremonies which pertained to the preservation of tribal autonomy. To them belonged the rituals and the ceremonies which inducted the child into its rights within the gens and the tribe; the adoption of captives and strangers; and the ceremonial preparation of the tribal pipes, without which there could be no tribal ceremony or enforcement of order. They had charge also of the rites for the preservation of crops from the devastation of insects and marauders. These were some of the exclusive functions of the Thunder gentes; but the rites of the worship of Thunder itself, and the ceremonies pertaining to war, of which Thunder was the god, so to speak, were in charge of other than the Thunder gentes.

In the Omaha tribe the Sacred Tent of War was set apart for the rites and ceremonies connected with Thunder. It was pitched in front of the segment of the tribal circle occupied by the We-jinshte gens, its Keeper. It stood apart as a special lodge and was regarded with awe by the people. In it were kept the Sacred Shell (a large *Unio alatus*); the Wa-i*n* (a bird-shaped bundle of raw hide, containing the skins of certain birds believed to be associated with Thunder); the Pipes used in the ceremonies of war, and a Pole of cedar.

* The members of the Thunder society claim that at death they join the Thunder Beings, although they do not thereby lose their kinship rights in their clan in the other world, but an Indian born into a Thunder gens could not at his death join the Thunder Beings, unless they had appeared to him in his vision. The people believed that the voices of noted Thunder men who were dead could be heard in the mutterings of the approaching storm.

In the myths the cedar tree is spoken of as the particular abode of the Thunder Birds. The Thunder Beings had their village amid a forest of cedars, and the club of these mythical beings was of the same tree. Cedar leaves were put upon the War Pipe after it was filled, so that when it was lighted it was the aromatic smoke of the cedar that was offered to the Four Directions, the Zenith and the Nadir. The cedar Pole, representative of Thunder, was called Wa-ghdhe-ghe, which means the power to confer honors. This name refers to the custom which prescribed that all war parties should start from this Sacred Tent and on their return report to it; and that all honors, namely, the right to wear certain regalia indicative of a man's prowess in battle, should be ceremonially conferred in this Tent.*

The vital point, in the ceremony of conferring honors, was when the warrior, standing before the Wa-i*n*, and reciting his deeds of battle, at a sign from the Keeper, dropped a small stick upon the bundle. If the stick rested thereon it was believed to be held by the Birds, who thus attested to the truth of the warrior's claims. If it rolled off upon the ground it was the Birds who discarded it, because the man had spoken falsely. These Birds, representatives of Thunder, were the judges of a man's truthfulness, and rewarded him by honors, or punished him by disaster, even to the tearing out of his tongue by a lightning stroke.

Naturally, in course of time, those warrior chiefs, who by favor of Thunder had been successful in war, whose truthfulness had been attested by the Thunder Birds,

* All these regalia, which are graded in rank, refer to Thunder. In several of the tribes these are feathers of certain birds, worn in a particular manner; the peculiar painting of a man's face, body or weapons; and, as among the Osages, the tattooing of the body and arms with lines so drawn that, when the highest rank is attained, the tattooed figure will represent the Thunder bird in outline.

and who had received their regalia, began to assume for themselves some of the authority conceded by all to Thunder itself. A song belonging to a Dakota chief says, "When I speak, it is Thunder." Gradually the exercise of the punishing power was extended to social offences; as, for instance, a man whose persistent evil conduct threatened the internal peace of the gens or tribe, might suffer loss of property or even of life, his fate being determined by the warrior chiefs assembled at the Sacred Tent around the cedar Pole, the representative of the Thunder; the function of the chiefs thus becoming augmented by affiliation with the supernatural.

When the first Thunder was heard in the spring the ceremonial of the worship of Thunder took place at the Sacred Tent. The Wa-i*n* was opened and the bird skins exposed; the Pipes were smoked, the ritual sung, and the cedar Pole anointed. No one participated in these rites, except members of those gentes whose totems were believed to be related to Thunder. Some of these totems were of creatures predatory in their habits, and therefore allied to the destructive lightning; others, like the eagle and the hawk, could soar to the very clouds, while the flying swallows heralded the approaching storm. This fancied kinship of their totems was the basis of recognition of a sort of relationship between the gentes themselves, which became the ground upon which these people united in the performance of ceremonies directed toward a common object of worship.

Although important steps had been gained in social development, none of the rites and ceremonies of the Sacred Tent of War tended to bind all the gentes together, but the Omaha ceremony of the He-di-wa-chi seems to have been adapted to meet this requirement. It is impossible to state as a fact that the He-di-wa-chi grew out of the experience of the people during the centuries when they were being slowly driven by wars, farther and farther from their eastern home; but, according to traditions preserved in the different tribes, it was during this period that group after group parted company, and the enfeebled bands became a tempting prey to active enemies. Nor was the danger always from without; disintegration sometimes resulted from the rivalry of ambitious Leaders, and, to quote from the tradition, "the wise men thought how they might devise some plan, by which all might live and move together and there be no danger of quarrels."

Many points in its ceremonial indicate that at the time of the institution of the He-di-wa-chi the people had entered upon agricultural pursuits, and were not wholly dominated by those ideas which had been the controlling power when hunting and war were the principal avocations. The He-di-wa-chi took place in the summer solstice, or, according to Indian designation, at 'the time when all the creatures were awake and out.' The choice of the tree from which the Pole, the central object in this ceremony, was to be cut, is significant. It was either the cottonwood or the willow, both remarkably tenacious of life, sending forth shoots even when cut down and hacked into posts. In the Indian's words describing the time when this ceremony was to take place, we catch a glimpse of a shadowy idea of peace, for when danger stalked abroad the animals which were 'awake' would not be 'out' but in hiding; and in the choice of the tree with its abounding life we note the beginning of an apprehension of the idea of the conservation of life. This helps us to open out and understand the terse and poetic expression of the Indian tradition concerning the ceremony, that 'it grew up with the corn.' The ideas embodied in this festival found their birth and growth in the cultivation of the maize, which held the people to their fields, preventing their constant wandering after the wild animals, and so inaugurating village life and developing an appreciation of tribal unity.

The first act in the preparation of this ceremony was the cutting, by the Leader having it in charge, of seven cottonwood or willow sticks which were stripped of leaves, with the exception of a small spray at the end, thus making a miniature pole. These were sent to the chiefs of the seven original gentes, who, in their turn, sent out the men of their gentes to cut similar sticks, which were to be painted red and carried in the great tribal dance about the Pole.

While this was being done, the Leader selected runners to represent warriors, who were to go out, as a scouting party would go in search of an enemy, and when they found the tree which was to be cut for the Pole they were to charge upon it and strike it as they would strike a foe. In this ceremony of selection, where war is so simulated, the recognition of the power and authority of Thunder is manifest, for no man could become a warrior except through his consecration to Thunder, the god of war. Moreover, it was believed that no man could fall in battle through human agency alone; he fell because Thunder had designated him to fall. So the tree, which had been struck as a foe, fell because Thunder had selected it. The tree thus chosen was now approached by the Leader, who said, "I have come for you that you may see the people, who are beautiful to behold." Then with elaborate ceremonies, in which the Four Directions were recognized, the tree was cut down; the bark and branches, all but a tuft at the top, were removed and buried at the foot of the stump, and the Pole, with much ceremony, was carried to the camp, where it was painted by the Leader in alternate bands of red and black, symbolic of Life and of Thunder. When this was done the Leader said, "It is finished; raise him up that your Grandfather (*i. e.*, Thunder) may see him."* The Pole then, being placed in position in a hole prepared for it, stood before the people as approved by the ancient Thunder Beings. Then the Herald went forth to call the people to make ready to welcome the Pole with dancing and gifts.

Now the camp is astir with preparation; every one dons his gala dress and hastens to take his place with his gens in the tribal order, forming an immense circle around the Pole. The singers, seated at the foot of the Pole, strike up the first of the ritual songs; at its close the war cry is given by all the people, who then advance a short distance and halt. Four times the song is sung, four times the cry is given, four times the people advance and halt, and at the last pause they are near the Pole. At this point the men of the In-ke-tha-ba gens, led by two pipe bearers, face about to the west, their right side to the Pole, and the women face to the east, with their left to the Pole. Each of the other gentes falls into like order behind the In-ke-tha-ba men and women, and when the second ritual song is begun the entire double circle begins to dance around the Pole. During the dance four halts are made, and at these halts if any dancer has passed beyond the line of his gens he must return to it. The songs become more and more rapid in measure and the dance fuller of mirth and gaiety. At the close of the ceremony the men, women and children throw their sticks at the foot of the Pole, to which they are tied and left for the sun and wind to dispose of.

The manner in which the Pole was approached by the whole people in the order of the tribal circle, with war cry and charge, was a recognition of the victories gained through the war god, Thunder. The entire ceremony was a dramatic teaching, to old and young, of the necessity of union

* These words, in the original, are of the nature of an invocation and consecration.

not only for defence, but for the preservation of internal peace and order, in the security of which industry might thrive and prosperity be within the reach of all.

The He-di-wa-chi, all the details of which cannot here be described, is a festivity of joy; the words of the opening song are, 'Come and rejoice!' The whole scene vibrates with color and motion; there is no hint of sacrifice; the Thunder selected tree is a symbol of Life, held in the fruitful grasp of the earth, and touched by the beneficent rays of the sun.

The so-called Sun Dance of the Dakotas and Ponkas seems to have sprung from the same parent stem that bore the He-di-wa-chi; but it shows marks of the influence of tribal environment during the past few centuries, as well as traces of contact with other stocks. For a considerable period prior to our first knowledge of the Dakotas, these tribes had dwelt in the most northern range of the Siouan linguistic stock, and had almost lost their knowledge of the cultivation of corn. Omaha traditions say that their own tribe turned back from the region where the Dakotas were when first discovered by us, because corn would not grow well there, and they sought sites for their villages farther south, where they could raise the maize in large and unfailing crops.

The Sun Dance and the He-di-wa-chi have fundamental features in common. They take place at the same time of the year; both Poles are cut from the cottonwood or the willow tree; the ceremonies attending the cutting and planting and decorating the Poles are practically the same, differing only in the elaboration of detail. Both are consecrated by and to Thunder, and about both the tribe must gather in the order of the gentes. The special rites of the Sun Dance are performed within a communal tabernacle erected about the Pole. It is made of one or more poles gathered from the tent of each family in the tribe, and covered with green branches. It represents the living branches of the tree, as well as the great congregation of the people, whose tents enclose it in a circle, often more than a mile in circumference.

The elaborate character of this ceremony precludes the mention of any of its parts, except those which pertain to the subject of this paper.

The symbol placed upon the buffalo skull, and drawn upon the U-ma-ni—a space of ground from which the sod had been removed, and the earth made fine—is a circle with four projecting points equidistant from each other. This symbol, to quote from Dakota Indians who had been instructed in this ceremony, "represents the tribe and the Four Directions. It means that wherever the tribe may travel it will be kept whole. Its circle of tents will not be broken, the members of the tribe shall live long and increase. The symbol also stands for the earth and the unseen winds that come from the Four Directions and cross over the earth and bring health and strength." The people were told that "as long as they observed the ceremony they would increase and grow strong, but if they should neglect the rite they would decrease in numbers, lose their strength and be overpowered by their enemies."

The dramatic character of the adjuncts of self sacrifice and torture has diverted the attention of observers from the true purpose of the Sun Dance, which has been clouded in the minds of the people themselves, but has not been lost sight of by the Indian priests, who still insist that the ceremony is necessary to the preservation of the people as a tribe.

The torture practised at the Pole seems to be a transference, to this ceremony, of the ancient rite known as Hanm-de-pi, where the man suspends himself while seeking a vision through fasting; or when, fixing his mind upon a particular desire, he expects through torture to render its accomplishment certain. Even in the Hanm-de-pi there are indications of foreign influence which tended not only to keep alive, but to intensify the more primitive forms connected with Thunder worship—forms which had almost died out in the more southern tribes, surviving only in certain modified rites observed in mourning for the dead and the leading of a war party.

In the absence of agricultural avocations and their attendant corn ceremonies, the belief that the Pole was selected and consecrated by Thunder came to be more and more pronounced, as is indicated by the fact that the Thunder men only could take charge of the Sun Dance, whereas, in the He-di-wa-chi it was the red corn people who were the Keepers of the ritual and Leaders of the ceremony. It is easy to see how, through the influence of Thunder, originally represented in the consecration of the Pole and augmented by the dominance of the Thunder men, the torture rites came to be grafted upon the ceremony, which, owing to environment, had lost something of its early significance.

When witnessing the Sun Dance its composite character was impressed upon me, and the lack of unity between the parts was evident. Further study has shown how different rites have been united, and what are some of the influences which have brought about this grouping.

The Dah-pi-ke or Nah-pi-ke of the Hidatsas resembles the Sun Dance. It takes place at the same season of the year. The Cottonwood Pole is selected and cut with similar ceremonies; about it the communal tabernacle of willow boughs is erected, and all the people must gather to the rites. Like the Sun Dance, it bears evidence of the same influences, which have overlaid a tribal ceremony 'that grew up with the corn,' with those other rites wherein self torture was practiced.

As in the He-di-wa-chi, the tree or Pole of the Sun Dance, and of the Dah-pi-ke, is left at the close of the ceremony to the destruction of the elements, or powers, to which, in the mind of the people, it belonged.

In the Sacred Pole of the Omaha tribe we have another off-shoot from the same parent stem. In its rites, however, the fundamental ideas embodied in the ceremonies already considered have been still further developed and specialized. The selection of the Pole, its cutting, decoration, etc., the season when its ceremonies took place, and the compulsory attendance of the people, were all practically the same as in the He-di-wa-chi, the Sun Dance and the Dah-pi-ke.

In a paper read before this Section last year the Sacred Pole was described. Your attention at this time will be called only to a peculiar function in reference to the tribal autonomy.

A tradition in the tribe says: "At one time the seven original bands wandered about independent of each other; each band had a pipe and a leader. The Hun-gagens thought that if this continued there would be fueds between the bands.* * * So the Sacred Pole was made, around which the different bands might gather. The seven chiefs were called together, and they all united and have been so ever since." The Legend corroborates the tradition, for it says: "The ceremonies of the Sacred Pole was devised to hold the people together."

The institution of the Sacred Pole marked a political change in the tribe, from the government by hereditary chieftians to an oligarchy of the seven chiefs who attained their position by personal ability to perform certain deeds, called Wa-dhin-e-dhe. The name of the old cedar Pole of the Sacred Tent of War, Wa-ghdhe-ghe, which, as we have seen, meant 'the power to bestow honors,' was given to the new Sacred Pole, which became the fount of honors won in peace, for the Wa-dhin-e-dhe were not deeds of war; for their achievement, industry and accumulation of property, as well as valor, were required. So also, whereas the honors, bestowed in the Sacred Tent of War, were worn by the warrior himself, or tattooed upon his own body, as ghdhe-ghe, or mark of honor authorized by the power represented in the Sacred Pole, was placed upon the daughter of the successful aspirant, the woman being the industrial factor in the tribe. The mark of honor consisted of two symbols; upon the forehead of the girl was tattooed a small round spot representing the sun, and upon her chest and back a circle with four equidistant points; the same symbol that was made upon the earth and the buffalo skull in the Sun Dance, and bearing the same idea, of strength in unity.

The seven chiefs who formed the oligarchy must act as one man, for without unanimity in their councils nothing could be done. In their decisions all the seven men must be alike represented, and the resultant unity was believed to be derived from Wa-ka*n*-da, present in and acting through the mysterious Sacred Pole. To quote from the Legend: "The chiefs are slow to speak, * * * no word is without meaning, and every word is uttered in soberness, * * * believing the words come from Wa-ka*n*-da, so the words of a chief are few. They (the seven chiefs) have all one heart and one mouth * * * After a question is decided, the Herald proclaims it about the camp circle, * * * none of the people dare dispute it, for they say, It is the word of our Chiefs."

The two avocations upon which the life of the people depended were agriculture and hunting, and these were controlled by the ceremonies of the Sacred Pole. From the Pole was decided the time for planting the corn, and about it the ritual of the maize was sung. The great tribal hunt was under its immediate direction, the rules and regulations of which were an important part of its function. On this annual hunt the people left their village and their fields in care of a small guard and followed the herds, under the strict control of the Chiefs and of a body of men called Soldiers. During the entire time, two months or more, the rights and inclinations of the individual were held rigidly subordinate to the good of the tribe. The Sacred Pole was carried in advance of the people, as they moved from camp to camp. From its presence the runners went forth in search of the buffalo, and to it they reported upon their return. At the close of the hunt the ceremony of thanksgiving and anointing the Pole took place, when the entire tribe gathered about this central object, erecting a communal tent for some of the particular ceremonies and offering gifts. Finally, the men enacted before it the events of their career, thus presenting a sort of dramatic current history of the tribe.

At the inauguration of the Pole and its ceremonies, to quote from the Legend: "The Leader said, this (the Pole) belongs to all the people, but it shall be in the keeping of one family." For over two centuries this Sacred Pole was preserved, and its tent was pitched a short distance in front of the segment of the tribal circle occupied by a subdivisionn of the Hu*n*-gagens, its Keepers. It was regarded with fear and reverence, as the supernatural protector of the people, as the power that insured to them an abundant supply of food, and commanded the coordination of the gentes and the unification of the authority of the Chiefs.

In all these rapidly considered ceremonies, marking periods in social development of this group of tribes—development more or less modified by shifting environments—

we note the constructive force of the religious ideas of the people; ideas which, represented by the word Wa-ka*n*-da and its kindred terms, imply the existence of an ever active, mysterious power, permeating all nature, including mankind, with the same life, thus making all things related and anthropomorphic. We have seen how these generalizing ideas become concrete, through the medium of the vision, and capable of exercising a practical, formative influence. We have traced this practical, formative influence in the unifying power of the totem, which welds together an extended though partial kinship within the clan or gens. We have seen it also operative in the religious societies, where an indestructible bond holds the members together upon a basis other than that of blood relationship. The same influence has been found at work in the association of certain clans for a common worship, the tie of their association being a supposed relationship of their separate totems to Thunder, the object of their worship. We note also that the authority of Thunder was still further extended so as to embrace the entire tribe, inasmuch as every man was brought under its control through the rites and ceremonies connected with war. Furthermore, we discern that out of the ancient ceremonies connected with Thunder, wherein primarily the cedar tree was the mythical abode of the mystical Thunder Beings, and later, the cedar Pole stood as emblematic of their power and authority, were evolved the ceremonies that made use of the old symbols, but clothed them with ideas born of newer conditions.

In the He-di-wa-chi has been found preserved the outline of one of the simplest and probably oldest ceremonies instituted to draw the people together and unite them into an organized body. And it is apparent that the Sun Dance, the Dah-pi-ke, and the Omaha Sacred Pole, from the same root, kept the same fundamental aim in view, performing their ceremonies about the same central object, the tree or Pole, selected and consecrated by the all-powerful Thunder, recognized as the judge and rewarder of all the people. We have seen the Chiefs summoned to the He-di-wa-chi by a tree stick, sent from the Keeper of the ceremony, each Chief in turn sending forth the men of his gens to gather each man sticks for himself and family, and all the people assembled and dancing about the Pole by gentes, each one carrying his stick, which at the end of the ceremony was given back to the Pole. A simple object lesson: to teach that the tribe was, like the tree, animated by the supernatural mysterious power; and that the Chiefs were its strong limbs, upon which the smaller branches grew.

In the Sacred Pole ceremonies, the constructive idea was still further developed, until not only unity of gentes was required, but unity of authority among the Chiefs was enforced. This unity, whether as demanded in the enunciations of the Chiefs, or, as necessary to the formation of the tribe, to the instituting of the religious societies, or to the development of the clan, depended upon the conception of Wa-ka*n*-da, as manifested in concrete form through the medium of the Vision. The ancient thinkers among the Siouan people, in the long centuries of an unknown past, came gradually to realize the helpfulness and power that lay in social unity. Out of this realization these ceremonies were slowly evolved, wherein the Pole, bearing the topmost branches of the living tree, stood in the midst of the assembled people, as an emblem of the presence and authority of Thunder, the universally accepted manifestation of Wa-ka*n*-da, and also, in its life and growth, as typical of tribal unity and strength.

Alice C. Fletcher.

Washington, D. C.

CURRENT NOTES ON ANTHROPOLOGY.

AMERICAN LINGUISTICS.

Students of the ethnography of the Northwest Coast will welcome the 'Haida Grammar,' written by the Rev. C. Harrison and edited by Dr. A. F. Chamberlain. It is published in the Transactions of the Royal Society of Canada (Second Series, Vol. I.), and covers 108 octavo pages. It is based on the scheme of grammars of Aryan tongues, the same grammatical categories being applied to the Haida. While this offers no special difficulty to one versed in the morphology of American idioms, it certainly presents such tongues under false analogies, which have often misled tyros in their study. It would have been better if the highly competent editor had taken the material and recast it in the form now required by linguistic science.

Dr. Paul Ehrenreich has added another to his valuable studies of Brazilian languages by publishing in the *Bastian Festschrift* several old vocabularies and a list of phrases of the tongue of the Botocudos. The analysis of them and the grammatical remarks which he adds give largely increased value to these fragments. His paper is entitled 'Ein Beitrag zur Charakteristik der Botocudischen Sprache.'

PRIMITIVE PSYCHOLOGY.

To the primitive man, as we know him, the sense of individual power, that which metaphysicians call 'free will,' was very present. The strong, the mighty, was what excited his admiration above all else. His ideal was the man who could do what he wished or willed to do. The savage acknowledges no theoretic limit to the will any more than does the religious enthusiast. It can move mountains and consume rivers. It can act at indefinite distances and its force is measureless. In the religion of ancient Egypt the highest gods could be made to serve the will of a man, did he but use the proper formula of command.

An interesting study of these aspects of savage psychology was read by Miss Alice C. Fletcher before the American Association. It is entitled 'Notes of certain beliefs concerning will power among the Siouan Tribes.' The author sets forth the strong sense of personality characteristic of the tribe and its language, though by no means confined to them, analyzes a series of terms employed to express the exercise of the power of volition, and explains a number of curious rites and customs which have sprung from the beliefs held by the Siouan gentes on this subject.

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CURRENT NOTES ON METEOROLOGY.

A TORNADO IN ARGENTINA.

A large quarto of 556 pages is Vol. X (for 1891) of the *Anales de la Oficina Meteorologica Argentina* (Buenos Aires, 1896). It contains annual summaries for the principal stations and a general account of the year's work by the director, W. G. Davis. The most notable meteorological phenomenon of the year was a tornado, which occurred on November 13th, at Arroyo-Seco, situated on the railroad from Buenos Aires to Rosario, 19 miles from Rosario. Ten persons were killed, and more than 80 wounded, and of 50 or 60 houses in the town only 5 were left intact. The atmospheric conditions preceding the tornado, its progression and its destructive force, all resembled the similar features familiar here in the United States in connection with our own tornadoes. The day had been very hot, and just before the occurrence of the tornado the air was suffocating. The movement was from southwest to northeast. One freight car, weighing over 30,000 pounds, was carried a distance of 98 feet from the railroad track. Calculations as to the force of the wind, based on all available data, give a maximum pressure of 125 pounds per square foot. The direction of the whirl is stated to have been from *right* to *left*. As this tornado occurred in the southern hemisphere we should have expected a movement from *left* to *right*. Perhaps this whirl is described as if it were looked at from the outside, and not, as we are accustomed to describe our whirls, as if we stood at the center and looked out at the circulating winds. If the former is the case, then the *right* to *left* in the published account would mean *left* to *right* from our point of view, and the Arroyo-Seco tornado would follow the general rule. Or, it may be that this tornado was one of the very rare exceptions and really whirled in the northern hemisphere fashion, instead of following the fashion of its own hemisphere.

A view of the damage done by this tornado was published in Vol. X. of the *American Meteorological Journal* (opp. p. 350), and is interesting from the fact that the original view is probably the only photograph of a southern hemisphere tornado ever taken.

ATMOSPHERIC DUST OBSERVATIONS.

ONE of the many interesting branches of the new meteorology is the study of the number of dust particles in the atmosphere, and of their effect in causing the condensation of water vapor in clouds, fog, rain or snow. Aitken's papers in this connection, published in the Proceedings of the Royal Society of Edinburgh, have made this subject more or less familiar to all scientific men, but comparatively little use has as yet been made of his Dust Counter by others than the inventor, although much important work can undoubtedly be done along the lines suggested and followed by him. In a recent paper on *Atmospheric Dust Observations from Various Parts of the World* (Quart. Journ. Roy. Met. Soc., July, 1896), Fridlander gives many interesting results obtained by him with an Aitken Pocket Dust Counter during a voyage around the world. Space permits mention of only a few of the most striking facts. The average number of dust particles per cu. cm. of air over the Pacific Ocean during eight days was 540, while, when the vessel was about 350 miles from Auckland, the number rose to 1229, and when about 15 miles from the Great Barrier Island it was 1972. The average dustiness of the Pacific was 613, and that of the North Island of New Zealand, together with the polluted area outside of it, 1336.

The clearing effects produced by fog are plainly seen in the following summary, based on many tests made on the Atlantic, the Pacific and the Mediterranean:

No. of particles per cu. cm.	Condition of air.
2000	Foggy at intervals.
3000	Thick fog.
420	Half hour after clearing of fog.
3120	Thick fog.
280	Clear region just beyond fog.
1550	Region farther out of fog.

The lowest figures obtained by the author, 210, were found on the Indian Ocean after much rain, and on another occasion the number of dust particles at 10.30 a. m. was 331, while at 11 a. m., after a shower, it was 280. The purifying effects of rain are thus clearly seen.

It is a cause for regret that there is not a large number of investigators in the United States working on this interesting subject of atmospheric dust. So far as we know, there are but two of Aitken's dust counters in this country.

RECENT KITE-FLYING AT BLUE HILL OBSERVATORY.

THE exploration of the free air by means of self-recording instruments elevated by kites has been greatly advanced during the present summer through the work done at Blue Hill Observatory, 640 feet above sea level, near Boston. The kites used are the

Eddy, or tailless, and the Hargrave, or box kites, and the instrument sent up with them is the aluminum baro-hygro-thermograph, constructed for Mr. Rotch, proprietor of the observatory, by Richard *freres*, of Paris. The altitudes reached are determined in three distinct ways: by theodolites, by the angle and length of the kite-line, and by the pressure as recorded by the barograph. During the summer of 1895 the maximum altitude reached by the instrument in the kite-flying at Blue Hill was 2,500 ft. above sea level, but this has been far exceeded during the present year, the height of one mile having been passed on six occasions. On July 20th a height of 6,596 feet above sea level was reached. At a short distance above the earth a cloud was encountered, in which the relative humidity rose to 100%, while after a further ascent of about 2,500 feet, which must have been the thickness of the cloud, the air was found to be much drier.

All kite-flying records were broken on August 1st, when the recording instrument was raised to a height of 7,333 feet above sea level, or considerably over a mile above the general level of the country. Five Eddy kites were used. The temperature at the maximum altitude was 20° less than at the observatory, and the records of the relative humidity aloft showed variations of from 30% to 80%.

Scientific kite-flying, although one of the very newest developments of meteorology, has now passed the experimental stage, and the results obtained from these investigations at Blue Hill are attracting attention the world over.

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SCIENTIFIC NOTES AND NEWS.

A BRITISH NATIONAL PHYSICAL LABORATORY.

At the recent meeting of the British Association Sir Douglas Galton read the report of the committee on the establishment of a national physical laboratory. This report enumerated the present facilities afforded by the government, by educational establishments and by private societies, for aiding research in Great Britain. These sources are chiefly the £4,000 per annum given by the government for research purposes and administered by the Royal Society; the Royal Society donation fund, derived from its surplus income; the contributions made to research by the British Association; the investigations carried on at the Royal Institution, which afford magnificent examples of private munificence in aiding science; the City and Guilds of London Institute; the Royal Commission of the 1851 Exhibition, which devotes £6,000 a year to research scholarships; research committees of various scientific societies; the Clarendon Laboratory at Oxford and the Cavendish Laboratory at Cambridge; the laboratories at Edinburgh, Glasgow and Aberdeen; the Victoria University and the larger colleges not yet incorporated into universities. There were, however, investigations of particular types which lay outside the range of effort possible either to an individual or to a great teaching institution. These were (1) observations of natural phenomena, the study of which must be prolonged through periods of time longer than the average duration of life; (2) testing and verification of physical instruments and preservation of standards; (3) the systematic and accurate determination of physical constants and numerical data which may be useful either for scientific or industrial purposes. A laboratory for such purposes would aid and not compete with laboratories for more general physical research, and if England was to keep pace with other countries it was essential that it should be started and maintained by government. After detailing the functions and management of the proposed new institution on lines similar to those of the very successful German Reichsanstalt, the report recommended that government should be asked to vote a sum of £20,000 to £25,000 for building and an annual grant of £3,000 for maintaining such a national laboratory. An appendix gave the cost and annual expenses of the German institution, which amounted to £200,000 and £15,000 respectively.

RECENT GEOGRAPHICAL EXPLORATIONS.

In an introduction to his address as President to the Geographical Section of the British Association, Major Darwin summarized recent geographic work, referring first to the feat accomplished by Nansen. It is not merely that he has gone considerably nearer the North Pole than any other explorer; it is not only that he has made one of the most courageous expeditions ever recorded, but he has established the truth of his theory of Polar currents, and has brought back a mass of valuable scientific information. Besides the news of this most remarkable achievement, the results of a considerable amount of useful exploratory work have been published since the British Association met last at Ipswich. With regard to other Arctic Expeditions, we have had the account of Lieutenant Peary's third season in Northern Greenland, from which place he came back in September last, and to which he has again returned, though without the intention of passing another winter there. In October the Windward brought home more ample information as to the progress of the Jackson-Harmsworth Expedition than that communicated by telegram to the Association at Ipswich, and on her return from her remarkably rapid voyage this summer she brought back the record of another year. As to geographical work in Asia, Mr. and Mrs. Littledale returned safely from their explorations of the little known parts of Thibet; the Pamir Boundery Commission under Colonel Holdich has collected a great deal of accurate topographical information in the course of its labors; Dr. Sven Hedin continues his important researches in Turkestan; and the Royal Geographical Society was glad to welcome Prince Henry of Orleans when he came to tell about his journey near the sources of the Irrawaddy. As to Africa, the most important additions to our knowledge of that continent are due to the French surveyors, who have accurately mapped the recently discovered series of lakes in the neighborhood of Timbuktu, Lake Faguibine, the largest, being found to be 68 miles in length; Dr. Donaldson Smith has filled up some large blanks in the map of Somaliland; and Mr. and Mrs. Theodore Bent have investigated some interesting remains of ancient gold workings inland of the Red Sea. In other parts of the world less has been done, because there is less to do. Mr. Fitzgerald has proved for the first time the practicable character of a pass across the Southern Alps, thus supplementing the excellent work of Mr. Harper and other pioneers of the New Zealand Alpine Club; and Sir W. M. Conway has commenced a systematic exploration of the interior of Spitzbergen, a region to which the attention of several other geographers is also directed.

THE UNIVERSITY SCIENTIFIC MAGAZINE.

The universities and technical colleges have, of late years, been publishing scientific magazines under the auspices of and sometimes directly by, their scientific and technical college departments. In most cases they are conducted and managed by students as private ventures, but usually securing a considerable proportion of their contributions from members of the college faculty and from the alumni; in some instances they are controlled wholly by members of the faculty or the alumni.

There has just come to hand a copy of the *University Scientific Magazine*, published by the Engineering Society of the University of Tennessee, at Knoxville. This is a good example of the class. It contains, within the compass of about forty pages, a number of valuable articles, interesting both as original contributions to science, and as exhibiting the progress of scientific work at that institution and in this field.

Dr. Perkins discusses the experimental work of Hertz on the electro-magnetic theory of light. Prof. Wait takes up the distribution of titanium, which he finds in vegetable ash, and, in another article, the oxidation of silver by lead-oxide. An excellent biographical sketch of Dr. Perkins, with a good portrait, add variety and interest to the issue. A note by Giddersleeve on the zinc deposits of Tennessee gives an excellent idea of the extent and importance of the mineral deposits of the State and indicate that it may become an important zinc-producer. The report on a test of an isolated gas engine electric lighting plant shows the character of the work in engineering. It shows further that, for above 30 lamps, the gas may be profitably burned in the gas-engine. Mr. Reynders gives an account of experiments with a differential Watt-meter indicating the probably frequent existence of errors in such work. Mr. Ferris makes a valuable contribution to the draughtsman's department in a collection of alphabets, for use in marking drawings with the pen, which have special value as illustrating the practice of a number of distinguished and successful manufacturing and other firms, whose draughtsmen have reduced the production of such alphabets to a most efficient state.

There are few phases of modern scientific and technical college work which have better exhibited the progress made on that side of education, in the last decade or two, than the appearance and progress of these scientific journals. Each measures, in greater or less degree, the standing of its source of publication; although, as a matter of course, care must be taken to distinguish between the periodicals published by students and those issued more formally and under the more practiced hands of professors and alumni. R. H. T.

INORGANIC CHEMISTRY.

Prof. Olszewski has published in the Bull. Acad. Sci. de Cracovie for June an account of his unsuccessful attempts to liquefy helium, and a translation of the paper is given in *Nature* of August 20th. In the first experiment the helium was cooled by liquid oxygen boiling at 10 mm. pressure; in the second by liquid air under the same conditions. At the temperature of — 210° and 140 atmospheres pressure no sign of condensation occurred, and on allowing the gas to expand until the pressure was reduced to twenty atmospheres and in some cases to one atmosphere, the gas remained perfectly clear, and not the slightest trace of liquid could be detected. Prof. Olszewski calculates the temperature reached by this expansion to be — 263.9° and that therefore the boiling point of helium is at least 20° lower than that of hydrogen. He also points out that helium is an ideal gas for a gas thermometer for very low temperatures.

In the *Chemical News* Profs. Ramsay and Collie describe their attempts to separate argon and helium into two parts by fractional diffusion through porous pipe clay. In the case of argon the heaviest fraction gave a density of 20.01 and the lightest 19.93, showing the apparent homogeneity of the gas. In the case of helium the density of the gas first passing was 1.874 and of the gas remaining in the apparatus was 2.133. Repeated fractionations did not change these figures. From this it would appear that helium contains two constituents with densities respectively 2.366 and 1.874 or of 2.133 and 1.580, according as the lighter or the heavier fraction is the mixture. The spectrum of both gases was the same, and the revolutionary question is raised as to whether all the molecules of an elemental gas necessarily have the same weight.

Dr. A. Angeli has described in a recent number of the *Gazetta Chimica Italiana* salts of a new oxyacid of nitrogen of the formula $H_2N_2O_3$, formed by the action of ethyl nitrate on an alchoholic solution of free hydroxylamin. The sodium and the barium salts are fairly stable when dry, but in solution decompose readily on boiling with evolution of nitrogen monoxid. The same gas is given off when solutions of the salts are treated with acids. The acid appears to be a nitro-hydroxylamin (NH. OH. NO_2), but is bibasic, the sodium salt having the formula $Na_2N_2O_3$. This compound possesses considerable interest from a theoretical standpoint, in view of the great extension in recent years of the chemistry of nitrogen in its combinations with hydrogen and oxygen. J. L. H.

GENERAL.

The British Association has approved the recommendation of the Council that on the occasion of the meeting of the Association at Toronto the President, Vice-Presidents and officers of the American Asssciation be invited to attend as honorary members for the year, and, further, that all fellows and members of the American Association be admitted members of the British Association on the same terms as old annual members—namely, on payment of £1, without the payment of an admission fee.

The ninth annual meeting of the Geological Society of America will be held in Washington, December 29–31, 1896. It is announced that details of the meeting will be communicated to the fellows of the Society in a circular to be issued about November 1st.

DR. J. WALTER FEWKES, of the Bureau of American Ethnology, has just returned from a remarkably successful collecting season in New Mexico and Arizona. Three ancient villages (Homolobi, Chevlon and Chaves) were explored and extensive excavations were made, more than fifty boxes of pottery and other relics being brought to light and shipped to the National Museum. The collection is remarkably rich, not only in the number of pieces, but in the high grade of the ware and the elaborate symbolic decoration painted on most of the vessels. Dr. Fewkes' collection of last year, in the same region, was the finest ever made in America up to that date; yet this year's collection is twice as large and no less instructive in its symbolism and associations.

THE Public Works Department of the Government of Bengal has just issued a most valuable 'List of Ancient Monuments in Bengal, revised and corrected up to August 31st, 1895' (Calcutta). The particulars given are the name of the monument, the district and locality in which it is placed, the history or tradition regarding it, its custody or present use, its state of preservation, and suggestions for its conservation and references to particulars describing the monument.

MR. A. TREVOR BATTYE has arrived in England after his explorations of Spitzbergen. He believes that the crossing of Spitzbergen by Sir Conway Martin will lead to great saving of life, because a route has now been laid down by which a crossing may be effected in a few days to the west, where the water always opens early in the summer. This point is Advent Bay, where a wooden house has lately been erected, in which it is hoped supplies of food may be kept against future emergencies.

Nature states that it was announced, at a banquet given to Dr. Nansen, September 10th, that a Nansen fund had been formed for the advancement of science. Subscriptions to the amount of 210,000 kroners had already been received.

CAPT. PEARY has telegraphed to the New York *Sun* a detailed account of his expedition on the steamship 'Hope,' which arrived at North Sydney, Cape Breton, on September 26th. The trip was without special event. It was not found possible to secure the large meteorite, as the apparatus was broken in the attempt to dislodge it from the frozen ground. Of the scientific parties, that under Prof. R. S. Tarr was landed at Melville Bay, that of Prof. George H. Barton near Disco Island, and that of Prof. Alfred Burton at Omanak, and accomplished the scientific work that they had planned. The contents of over a hundred cases will, through the interest of its President, Mr. Morris K. Jesup, enrich the collections of the American Museum of Natural History with much valuable material. The past winter in Greenland has been one of unusual severity, and the summer has been marked by much wind and an unusual amount of exceptionally heavy ice, particularly along the west side.

IT is reported in the daily papers that Dr. Lewis Swift, of Echo Mountain, Cal., discovered on September 20th a small, bright comet near the sun, one degree east of it. On September 21st the object was north of the sun and fainter.

THE French Congress of Medicine will be held at Montpellier in 1898, during the Easter holidays, under the Presidency of Prof. Bernheim, of Nancy. The annual Congress of French Alienists and Neurologists will be held at Toulouse in 1897.

SIR JOHN ERIC ERICKSEN died at Folkestone on September 23d at the age of seventy-eight years. Ericksen was an eminent English surgeon and the author of many works on surgery and physiology. He was at the time of his death emeritus professor of surgery and consulting surgeon to University Hospital, a fellow of the Royal Society and many other scientific and medical associations and had been President of the Royal College of Surgeons.

A DESPATCH from Jiminez, Mex., says that Emile Renbaugh, a German naturalist, who had been spending the summer in the Sierra Madre Mountains, has been killed by accidentally falling from a cliff.

GEORGE F. H. MARKOE, a chemist and professor in the Massachusetts College of Pharmacy, has died at Boston.

The late Enoch Pratt has made the Shepherd Asylum for the Insane at Baltimore his residuary legatee provided that it should change its name to the Enoch Pratt Hospital. The bequest is valued at $3,000,000.

The will of the Rev. Lucius R. Page of Cambridge, Mass., leaves $2,000 to Tufts' College for the foundation of a scholarship and $10,000 to the town of Harwich for the establishment of a public library, to which his library and collection will be given on the death of his widow.

The *Journal of Physical Chemistry*, whose establishment under the auspices of Cornell University we recently announced, will be supported by a gift from Mr. E. G. Wyckoff of $1,000 a year for five years.

After an interval of four years the American Institute Fair will be held in the Madison Square Garden, New York, on September 28th. A large amount of machinery and a number of technical processes will be exhibited in operation.

Prof. Fuertes, Director of the College of Civil Engineering at Cornell University, is in correspondence with the Spanish authorities in Cuba, having been asked to take into consideration plans for improving the sanitary condition of Havana.

The Paris Academy of Moral and Political Sciences has awarded the Bordin prize of 2,000 fr., the subject for which was this year Kant's Ethics, to M. Cresson, professor at Besançon.

Ginn & Co. announce for publication this fall a 'Star Atlas,' by Winslow Upton, professor of astronomy and Director of the Ladd Observatory, Brown University.

Two parts of the extensive *Handbuch der Anatomie des Menschen*, edited by Prof. Karl von Bardeleben, have now been issued by Gustav Fischer. The first part of the first volume, chiefly concerned with the spinal column and containing 92 pages and 69 illustrations, is by Prof. J. Disse. The work will be completed in eight large volumes.

The Report of the Commissioner of Education for 1893–4 gives interesting statistics concerning the number of books and manuscripts in the university libraries of Europe. Germany stands first, its twenty libraries containing as many as 5,850,000 volumes, over 3,000,000 more than the libraries of Italy, which takes the second place. Great Britain, Austria and Russia have each more than 1,800,000 volumes, Sweden and Norway and Spain have 790,000 and 726,000 respectively. It is worthy of note that, of the eight countries where statistics have been collected, France, which in the number (sixteen) of its libraries surpasses every other country, Germany and Italy excepted, should have the smallest total number of books (692,200 volumes), the largest library (142,300 volumes) being at Paris ; and that in Great Britain, which has only nine university libraries, containing 1,849,600 books, more than 1,000,000 of these are about equally divided between Oxford and Cambridge. It should, however, be remembered that the large public libraries, such as, for example, the British Museum in England and the Bibliothèque Nationale in France make up in part for deficiencies in the universities. The four largest libraries are Strasburg (704,076 volumes, with an annual appropriation in 1894 of $16,363); Leipzig (504,683 volumes, appropriation $9,520); Oxford (530,000 volumes, appropriation $41,531) and Cambridge (506,500 volumes, appropriation $9,520), while the libraries at Göttingen, Heidelberg, Munich, Vienna and St. Petersberg each contain more than 400,000 volumes.

According to the report in *The Lancet* M. A. Lachenal's inaugural address before the International Congress of Criminal Anthropology at Geneva was a brilliant review of the three previous Congresses—that at Rome having startled the lay and especially the legal world with the thesis that there are born criminals and that there exists a criminal type anatomically determined; while its successor at Paris strengthened this position by insisting not only on the anatomical, but still more on the physical 'conditions precedent' of crime, which conditions, so interpreted, yield 'a biological and moral portrait' set in the social background in which the criminal lives. At Brussels the juristic view of the question intervened, and while admitting a 'natural history of crime' sought to furnish an eclectic theory of the phenomenon in which biology and law were equally represented. To-day in Geneva the discussion is resumed and, whatever modifications these provisional solutions of the problem may yet undergo, their effect must be to impress both parliaments and people with the necessity of 'raising a penal system which, without confounding the prison with the hospital, will recognize a moral clinique as well as a repressive code,' and so tend to 'eliminate the elements which are unfit for social life and dangerous to humanity.'

PROF. L. H. BAILEY'S *Nursery Book*, first published in 1891 by The Rural Publishing Company, has now been thoroughly revised and re-cast and published by The Macmillan Co. as the third volume of the Garden Craft Series. The book contains a strictly scientific treatment of 'seedage,' 'separation and division' 'layerage,' 'cuttage,' and 'graftage,' together with an extended nursery list, filling 191 pages. The author has incorporated in this edition a paper read before the Peninsular Horticultural Society in 1892, in which it is argued that while grafting is not suitable to all plants it is not a devitalizing process for those on which it can be adopted. The wide sale of Prof. Bailey's book shows that practical gardeners are able to appreciate a scientific treatise on their art.

DR. D. WALTER has published in the *Naturwissenschaftliche Rundschau* experiments on the diffuse reflection of the Röntgen rays, made in the State Laboratory of Physics at Hamburg. More than twenty elements were used, the reflecting surfaces being separated from the photographic film by a thin sheet of black paper, while the rays passed through the glass. The amount of diffuse reflection was in relation to the position of the elements in the periodic system, being the greatest for the silver group, and decreasing on both sides. The decrease in passing from the silver to the platinum group was considerably larger than the increase from the copper to the silver group. No reflection could be detected in the case of the diamond. The angle of incidence of the rays made no difference, nor did it matter whether or not the surface was polished, but the order of the substances was different when the surface was not parallel to the film.

WE learn from *Kantstudien* that a new life of Kant by Dr. M. Kronenberg is about to be published by Beck, of Munich, and that Prof. Fr. Paulsen has in preparation a volume on Kant for *Frommanns Klassikern der Philosophie.* Volumes in this series on Fechner by Prof. K. Lasswitz, on Hobbes by Prof. F. Tönnies, and on Kierkegaard by Prof. H. Höffding, have already been published.

THE *Revue Scientifique* states that M. Vallot has this year entertained at his meteorological observatory four Frenchmen, three Swiss, one German, one Italian and one American. M. Vallot generously entertains all meteorologists who wish to make observations at this station, which is the highest in Europe, being 4,385 m. above the sea and only 427 m. from the summit of Mt. Blanc.

THE Committee of the British Association on Zoological Bibliography and Publication make the following recommendations: (1) that each part of serial publication should have the date of actual publication, as near as may be, printed on the wrapper, and, when possible, on the last sheet sent to press. (2) The authors' separate copies should be issued with the original pagination and plate-numbers clearly indicated on each page and plate, and with a reference to the original place of publication. (3) That authors' separate copies should not be distributed privately before the paper has been published in the regular manner. The Committee further asks for cooperation in the following rules of conduct upon which the best workers are agreed, but which it is impossible to enforce, and to which it is difficult to convert the mass of writers. These are: (4) That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible. (5) That new species should be properly diagnosed and figured when possible. (6) That new names should not be proposed in irrelevant foot-notes or anonymous paragraphs. (7) That reference to previous publications should be made fully and correctly, if possible in accordance with one of the recognized sets of rules for quotation, such as that recently adopted by the French Zoological Society.

ACCORDING to *Natural Science* the Geological

Society of South Africa, which was founded last year for the purpose of preserving the records of the earlier geologists who have written on South Africa, as well as of promoting discussion and investigations on the more recently discovered portions of the colony, has lately come into possession of a most valuable collection of manuscripts and papers, written principally by the late Mr. Andrew Geddes Bain and Mr. G. W. Stow. Among these are the original drawings on a large scale, colored, of all the sections taken across the country by the late Mr. Stow, and also the numerous papers, including lectures, read before various scientific societies by the father of South African geology, Mr. Andrew Geddes Bain. The Society is at present discussing the advisability of erecting a permanent building, to be used as a museum and meeting room; upon its walls the drawings of Mr. Stow would be exhibited. Mr. David Draper, the secretary of the Society, is at present on a short visit to England.

We have already noticed among the numerous international congresses meeting this year, the Congress of Hydrology, Climatology and Geology, held at Clermont-Ferrand, Puy de Dôme, from September 28th to October 4th. Among the subjects proposed for discussion in the Section of Hydrology are: The therapeutic action of various mineral waters; what is thermal treatment? carbonic acid and alkaline bicarbonates in mineral waters, and their therapeutic action; legislation relative to mineral waters, and sanitary police of thermal stations; collection, sterilization and bottling of mineral waters. In the Climatological Section the subjects for discussion include such questions as the influence of altitude, of light, of dust in the atmosphere, etc. The list of excursions includes visits to Royat, Châtet Guyon, Vichy, Néris, Bourboule, Mont Dore and Saint Nectaire, and ascent of the Puy de Dôme, and other expeditions.

UNIVERSITY AND EDUCATIONAL NEWS.

The first volume of the Report of the Commissioner of Education for 1893-94, presented on June 20, 1895, has but just been issued by the government printing office. The volume contains, in addition to the usual statistics of American schools and universities, extended reports of the condition of education abroad, and a number of papers on special subjects. It appears that there are now 476 colleges and universities in the United States in addition to 156 colleges for women only and 63 colleges of agriculture and the mechanic arts. In the 476 colleges and universities there were 10,897 professors and instructors, 60,415 collegiate students, 3,026 resident graduates and 21,265 professional students. A much larger percentage of the population attend college in the New England States than in New York, New Jersey and Pennsylvania, and some of the Western States have a large representation. Thus while for each 100,000 of the population there are in New York 117 students in college and in Pennsylvania 94, there are in Oregon 184 and in Nevada 197.

The main building of Mt. Holyoke College, at South Hadley, Mass., was destroyed by fire on September 27th. The loss will probably amount to $200,000, but there was that amount of insurance on the buildings. The building of the Northern Illinois College, at Fulton, was destroyed by fire on September 26th. The loss is estimated at $100,000.

The State Veterinary College, located at Cornell University, for which the State has provided $250,000 for buildings and $30,000 annually, will open with more than two hundred students.

The Polytechnic school, the establishment of which, at Peoria, Ill., by Mrs Julia Bradley, we announced sometime ago, will be affiliated with the University of Chicago, two of the seven trustees being members of the University. Mrs. Bradley will support the school during her life and at her death the entire estate, estimated at over $2,000,000, will be bequeathed to it.

Several universities report a large increase in the freshman class this autumn. 350 freshmen have been admitted to the University of Pennsylvania, which is an increase of 134 over the class of last year. The Sheffield Scientific School has this year a class of 180, as compared with 150 last year.

At the Teachers' College, New York, Dr. James Newcombe has been appointed lecturer on physiology, and Mrs. F. C. Torrance to be assistant in mathematics. Mr. Richard E. Dodge has been promoted to an associate professorship of natural science, and Miss E. B. Sebring to an associate professorship of the history of education.

MR. JAMES R. BAILEY, M. A., a graduate of the University of Texas, after a three years' course at the University of Munich, has just been appointed instructor in chemistry in his *alma mater*. He will be associated with Prof. Henry Winston Harper.

A POST-GRADUATE course of bacteriology has been established at the University of Sydney, N. S. W.

DR. H. MINKOWSKI, professor of mathematics in the University of Könisberg, has been called to the Zurich Polytechnic Institute. Dr. Graeff, of the University of Freiburg, i. Br., has been made assistant professor of mineralogy and petrography. Prof. Erismann has resigned the chair of hygiene at the University of Moscow.

DISCUSSION AND CORRESPONDENCE.

GEOLOGY IN THE COLLEGES AND UNIVERSITIES OF THE UNITED STATES.

UNDER this title* Prof. T. C. Hopkins has collated some very interesting data concerning the teaching of geology in the United States, which, if properly analyzed, cannot fail to impress upon the reader the fact that in some branches, at least, our university instruction is not only defective, but largely in the hands of amateurs.

As is well known, geologic study and research are not only growing in favor, but are now recognized as essential in any institution offering instruction in pure science. Moreover, the practical application of geologic truth earns for geology a place in many of the technical schools. That so important a study should be so neglected by American universities and colleges is, indeed, surprising. In Mr. Hopkins' paper 382 institutions are reported as teaching geology. By an examination of the tables furnished, corrected in a few instances by reference to the text, I find but 54 of that number offer instruction exceeding one year in length. Of the 54 thus selected four are not recognized in the body of the report as possessing any professional merit. Of the 50 now remaining 40 have established separate chairs, while 10 have geology combined with some other subject.

Another fact is interesting in this connection: The Geological Society of America, an association embracing, it is thought, not less than 90 per cent. of the trained geologists of this country, is represented in but 58 of the 382 institutions.* In the 50 institutions of reputation, giving instructions exceeding one year, the Geological Society is represented in 39; in the 40 with separate departments it is represented in 34.

The conclusion to be drawn is now apparent, viz.: That the instruction offered in the majority of American universities and colleges is given by amateur geologists, who claim no recognition in the science they teach; offer no contributions; conduct no investigations; who are content to read with a class or hear a class recite. The true teacher must be able not only to read a text, but to interpret a text as well, and, what is of still greater importance, read nature and interpret her actions. A teacher inspires a student in precisely the degree in which he himself is inspired. If he be a 'text-book geologist,' it is reasonable to expect that his students will take their geology from books rather than from nature; if he be a 'working geologist' that his students will seek the field, will frequent the laboratory.

The point I wish to make is this: Without a doubt the majority of institutions are teaching geology in an utterly inadequate manner, without proper facilities and by means of teachers unknown and unrecognized in the science. Some of these may be doing fairly good work; but the presumption is that the work will not, cannot, be of a high order.

But the mischief does not end here. Students from these institutions go forth with the

* 'Geology in the Colleges and Universities of the United States,' by T. C. Hopkins, being Chapter III. of the forthcoming Report of the Commissioner of Education, United States Bureau of Education, Washington, 1896.

* See list of Fellows, April 1896, *Bulletin of the Geological Society of America*, Vol. VII., p. 530, *et seq.*

idea that they have mastered geology; have they not recited so many weeks from a text-book? They have been misled. Education is more than a mere matter of the memory—a storing away of facts, as valuable as they may be; it is the cultivation of those powers by which the facts may be obtained at first hand. In this lies the training.

I am well aware of the excuse offered. Says the college president: "We do not pretend, nor do we care to make trained geologists; we wish to give our students an insight only into the science, that's all." Let me ask: How much chemistry worth the having can be obtained by reading or committing to memory the ordinary text-book? How much physics? How much biology? In a collegiate institution courses are offered in these branches for their *training* effect, without reference necessarily to the career of a student. Chemistry, physics and biology cannot, in these days, be taught without an equipment and teachers well versed in its management. Why should geology receive different treatment? Its demands are not less pressing and its educational value is fully as great. When the services of professionals can be obtained, why longer impose amateur instruction upon our students?

The root of the evil seems to lie not only in the want of a proper discrimination on the part of the patrons of educational institutions, but largely in the lack of a proper appreciation on the part of the authorities in charge. That more and louder protests have not been heard is strange. But the pace has been set. Those institutions which persist in offering cheap instruction, solely because it is cheap, must fall to the rear. That the best instruction will be given by the best trained teacher is axiomatic. Better by far that geology be not attempted than that it should be poorly presented; better that a curriculum be curtailed than that a study should be a source of weakness.

FREDERIC W. SIMONDS.
SCHOOL OF GEOLOGY,
UNIVERSITY OF TEXAS, August, 1896.

ON A SUPPOSED IMMEDIATE EFFECT OF POLLEN.

TO THE EDITOR OF SCIENCE: I have been greatly interested in the account of a curious freak in an apple tree given by Mr. T. H. Lennox in your issue of September 4, 1896, p. 317. After describing the freak, Mr. Lennox concludes that "there can be no reasonable doubt that the phenomenon arose from cross fertilization between pollen of tho Talman Sweet and the ovule of the Greening." As some of the features of the case, as described by Mr. Lennox, seem to me opposed to such a conclusion, I venture the following suggestions:—

The apples on the northeast side of the tree, we are told, "were Rhode Island Greenings, such as the tree had always borne, while those on the southwest half of the tree were of a mixed character, *each apple being partly Greening and partly Talman Sweet.*" If the phenomenon is to be attributed to the direct action of the Talman Sweet pollen, it is difficult to understand why every apple on one half of the tree should be affected and none on the other half of the tree. As the pollen is normally carried by insects we should possibly expect a greater number of the fruits to be affected on the side toward the Talman Sweet tree than on the opposite side, but we should reasonably expect a portion of them to remain unaffected. We should also reasonably expect a few fruits on the opposite side of the tree to be similarly affected, as some of them would as surely be crossed with the Talman Sweet pollen as those on the side nearest the Talman Sweet tree. In other words, if this freak were due to cross pollination by insects with pollen of Talman Sweet, we should expect the fruits affected to be scattered irregularly over the tree, the majority being on the side adjoining the Talman Sweet tree. That the fruits on certain limbs or a certain part of the tree only should be affected and all of these similarly affected, is indeed difficult to explain as a result of cross pollination. One must necessarily presuppose a peculiar condition of this portion of the tree rendering possible the effect of the pollen described, as the other portion of the tree remains entirely unaffected. This is evidently Prof. Bailey's conclusion, as in his note following the article by Mr. Lennox he says: "Like heredity of mutilations it (the immediate effect of pollen) is rare and therefore apparently exceptional." Even when we assume some peculiar condition of the limbs exhibiting the phenomenon the difficulty is not altogether passed, as we must still explain how it happens that all the flowers, which open quite irregularly, were pollinated with pollen from the same variety. Mr. Lennox himself calls attention to the difficulty in understanding why such results, if rightly due to the effect of pollen, as supposed, are not more common considering that cross pollination unquestionably occurs commonly in all orchards.

I am not familiar with the history of the varieties concerned and cannot suggest whether or not it is possible to consider this a reversion such as sometimes occurs late in the life of an individual. Partial reversion by segments in the same fruit, on certain limbs or the entire tree, is not of uncommon occurrence.* Such stripes, further more, are evidently not necessarily due to reversion to characters derived from a cross, but frequently to characters lost by variation. It would seem to me not at all improbable, from the facts given, that this might be such a case of reversion in certain branches. It should be remembered in this connection that Darwin has given several cases of stripes on apples similar to the case in question, which cannot be explained as effects of cross pollination.† It is a common occurrence for oranges to produce segments of rind resembling lemon or citron, and these are commonly considered to be due to the immediate effect of pollination. These modified segments, however, are not infrequently found at considerable distances from lemon or citron trees, and they do not occur more frequently, so far as I have been able to observe, when branches of the orange and lemon are near together or interlocked. It is very probable that they are in most cases to be attributed to reversion. Occasionally navel fruits occur on almost all orange and lemon varieties and are commonly believed to be positive evidence of the immediate influence of navel pollen. Yet I have proven by numerous dissections that the navel is invariably formed early in the development of the pistil, weeks before it reaches the stage for pollination. It is well known that certain varieties not navels more commonly produce navels than certain other varieties. On these varieties, again, the navel development may be found in some of the pistils long before pollination. The development of the navel is a profound morphological change originating early in the development of the pistil, and I think its production lies entirely outside the possibilities of pollen modification. Again: the absence of mature pollen in every navel anther examined by Prof. Van Deman and his assistants and myself makes it highly improbable that navel marks in oranges can ever be interpreted as due to the immediate effect of navel pollen. There is, unquestionably, a marked tendency among the various varieties of citrous fruits to sport in this way, and the isolated cases of navels on other varieties are merely illustrations of this tendency.

* See Darwin, Animals and Plants under Domestication, II., p. 10. et. seq.

† l. c., I., p. 425.

It is not impossible that a combination of the characters of two varieties on a portion of one tree, where two trees of the varieties concerned are growing quite near together as in the case described by Mr. Lennox, might be caused by graft hybridization produced by the fusion of roots from the different trees. I am not aware that any such case has ever been recorded or even suggested, but it is surely within the limits of possibility, as roots from different trees, which become closely associated or crowded together, sometimes fuse. I have observed in one case a fusion of two orange roots from different trees and have not infrequently observed the fusion of roots from the same tree. It is probable, however, that the case described by Mr. Lennox could not thus be explained, as I suppose the trees concerned were grafted on other roots. I presume Mr. Lennox is sure that the stock, on which the Greening is grafted, is in no way related to the Talman Sweet or any similar variety, and has never been 'double-worked,' that is, grafted twice with possibly a section of Talman Sweet remaining in the trunk. These are suggested as details which one must know positively before excluding their possible action.

The immediate effect of pollen is a much disputed question in horticulture, and one which demands the most careful experimental evidence to satisfactorily confirm. That there is some doubt as to whether the case described by Mr. Lennox can be considered an immediate effect of cross pollination, I think everyone critically examining it will admit. If due to reversion, graft hybridization or cross pollination, the same characters will probably appear on the tree again next year, so that further studies may be made. It is to be hoped that Mr. Lennox will be able to test the validity of his conclusions experimentally.

Horticultural literature has become so filled with descriptions of supposed cases of the immediate action of pollen where insufficient evidence is given to enable one to judge the merits of the case, that it behooves observers to be exceptionally careful in regard to all conditions if any final conclusions are to be reached.

Herbert J. Webber.

U. S. Department of Agriculture.

THE DEFINITION OF CIVIL ENGINEERING.

There is an error in my paper on the Artistic Element in Engineering which I should like to correct. Following the lead of other writers, I have ascribed the classic definition of civil engineering to Telford instead of to Tredgold, whom I have recently learned was its author. See *R. R. Gazette* of December 28, 1894, page 883, or of August 28, 1896, page 602.

I am indebted to Mr. H. G. Prout, of the *Gazette*, for calling my attention to the matter.

F. O. Marvin.

University of Kansas.

SCIENTIFIC LITERATURE.

Studies of Childhood. James Sully. New York, D. Appleton & Co. 1896.

This book is a series of topical or classified studies of certain phases of the psychology of child life, covering, upon the whole, the period of life from two to six years of age, with quite a marked preference for those phenomena which dawn or are at their height in the second and third years. The topics covered are: The imagination of childhood; its reasonings, including a study both of the process and the more marked and characteristic processes; the beginnings of language; the emotion of fear; some phenomena of morality, including a study of children's egoism, altruism, lies, and an account of their reactions to the moral injunctions of their elders; and a study of the child's æsthetic nature as manifested in his instinctive expressions and in his primitive drawings. The book concludes with a detailed individual study (covering about 100 pages) of one of his own children; and a very interesting study of the childhood of George Sand, drawn from the latter's autobiography. In this connection it may be remarked that a distinct feature of the book is not only the author's own style, which is literary rather than 'scientific,' but his wide acquaintance with autobiographical allusions to childhood and his apt use of such reminiscences. Ruskin, Dickens, Quinet, Tolstoi, Stevenson and many others figure in these pages.

This topical character of the treatment practically makes any synopsis of the book, beyond such a bare scheduling of headings, out of the question. An immense number of relevant observations of childhood, gathered from practically all available sources, supplemented by Mr. Sully's own observations, and enlivened by judicious remarks upon the salient qualities of childhood, make the book what it is. The hypercritical will probably conceive that the running commentary is sometimes discursive, occasionally dangerously near the padding point, and frequently of no great importance. But I confess myself sufficiently grateful in finding a book to review which is interesting to read as well as technically instructive.

The impossibility of summarizing the material content of the book makes it advisable to direct attention to the method, both what Mr. Sully himself says about method and that which he actually employs. As to the former, Mr. Sully devotes considerable space in his introduction to the objects and difficulties of child study, and to an account of the equipment necessary for observation and interpretation. The interest in child-study he finds to be partly due to the general development of natural science and partly to specifically psychological needs. The infant is, so to speak, more obviously a natural phenomenon than the adult; and the evolutionist in particular finds in him obvious signs of close kinship with the animal world, both in the foetal and early post-foetal stages. The ethnologist also finds in the child a summary of the prehistoric development of the race. To the psychologist the opportunities of escape from the interwoven complexities of the adult consciousness make this a promised land of science. Yet the difficulty even with the reference to the outward phenomenon is very great; witness the difficulties in identifying the first smile of the child, his first sign of recognition, his first conscious attempt in any direction. And, of course, the difficulty is still greater when we come to interpret these movements into their psychical equivalents. These difficulties are so great that the author 'confesses that in spite of some recently published highly hopeful forecasts of what child-psychology is going to do for us, I think we are a long way off from a perfectly scientific account of it;' a remark to which no one will take exception if there is much emphasis upon the 'perfectly.'

There are two qualities necessary for good work. The first is the 'divining power,' sympathetic insight, tact or fineness of spiritual insight. This is required both for such rapport with children as to establish the conditions for natural, unconstrained exhibition of genuine phenomena, and for interpretation. (Mr. Sully's own work, I remark in passing, shows a very unusual amount of such native divining tact and personal sympathy). There is danger, however, that the very liveliness of this touch with child-life will take off the edge from close, objective, systematic study of the bare, cold facts. Hence the second requirement, good psychological training. Fathers, Mr. Sully thinks, are more apt to come short as regards the first of these qualifications; mothers as regards the second.

As concerns method in general most is to be expected from the prolonged observation of individual children such as is represented by the work of Preyer and Miss Shinn. Mr. Sully's remarks here are so much to the point as to justify quotation in full. 'No fact is really quite simple, and the reason why some facts look so simple is that the observer does not include in his view all the connections of the occurrence which he is inspecting. * * * * It is only when the whole fact is before us, in well-defined contour, that we can begin to deal with its meaning.' And of course, this wholeness of the fact presupposes knowledge of the individual child, his environment, history, temperament, etc. When we come to older children this specific individual study may be supplemented by more general and statistical collections.

All this seems to me well and judiciously put. Mr. Sully's own work in the pages which follow bears evidence throughout that he realizes practically, as well as theoretically, the limitations, the problems and the needs of which he has been talking. Nevertheless, there are reasons for holding that this book will be to the psychologist, at least, rather 'raw materials to serve' than a contribution to psychology as such.

It is possible to go at the study of the child with the purpose of arranging the observed phenomena under the customary rubrics of psychology, laying emphasis upon extreme exhibitions of principles which are discernible only feebly or subtly in the adult, or upon the phenomenon which mark departures from the forms which are familiar in the adult consciousness. Here, however, unconsciously, *the adult consciousness as already analyzed is taken as the standard.* Another method treats the child consciousness as, if I may use the expression, perfectly good consciousness on its own account, just as good consciousness as the adult. The interest is wholly in the light which such consciousness may throw upon psychical principles in general. The aim is not to classify the phenomena under principles already accepted, but to reconstruct those principles from the study of facts hitherto neglected. Mr. Sully's actual procedure seems to me to adopt the first named course. He rarely uses the new facts to criticize and modify the customary classifications and explanations, but rather takes these latter for granted and crowds the observations under them—with some projecting edges.

As an example, we may take his theoretical treatment of imagination in childhood. After making a good beginning by remarking that "imagination in an active, constructive form takes part in the very making of what we call sense-experience," he goes on to give cases of the personification of inanimate objects in perception, and takes up the argument as follows: "Now, it may be asked whether all this analogical extension of imagery to what seem to us such incongruous objects involves a vivid and illusory apprehension of these as transformed. * * * A conjectural answer can be given. In this imaginative contemplation of things the child but half observes what is present to his eyes, one or two points only of supreme interest in the visible thing, whether those of form, as in assimilating the piano-hammer to the owl, or of action as the *falling* of the leaf, being selectively alluded to, while assimilative imagination overlaying the visual impression with the image of a similar object does the rest. In this way the actual field of objects is apt to get veiled, transformed by the wizard touch of a lively fancy."

Now, from the standpoint of a certain psychology, the customary one, this is very well said. But it merely assumes, without questioning, two things which the facts discussed are well adapted to make us question: the 'actual field of objects,' 'what is present to the eyes' on one side and the imagination or fancy, as some sort of distinct power on the other. But is not this somewhat naive? Is this reference to the 'actual field of objects' anything more than making the special constructions of the adult consciousness, made from the standpoint of its supreme interests, the fixed standard? Is the problem how and why the child overlays the things present to his eyes with fanciful unrealities one of his own inner being? Or is it why and how the growing consciousness gradually shears down the original experience, inhibiting the larger part of the interests which determined it, and gradually confines itself to one or two definite ends and habits in selecting the qualities which shall constitute the world of things? In a word, is the child object the adult ('or real') object with an overplus of fanciful fringe, or is the adult-object the child-object pared down and rearranged to meet the dominant needs of mature life—one being just as 'real' as the other in an abstract or metaphysical sense?

I do not mean to affirm that Mr. Sully is wrong in choosing the former alternative. But the fact that he has adopted it without considering there is an alternative, indicates to my mind that, for the most part, he is just classifying the new scientific material under the old headings, instead of remaking the point of view.

From the standpoint of the scientific psychologist this is an important qualification regarding Mr. Sully's work. Quite probably, however, it fits the book all the better for the task of mediating between the psychologist and the public of parents and teachers into whose hands the book will fall; and, as there are many signs that this is the end the book has in view, it is a pleasure to add that it fulfills this particular purpose better than anything as yet published upon child psychology. A good index adds materially to the usability of the book.

JOHN DEWEY.

UNIVERSITY OF CHICAGO.

The Whence and Whither of Man: A brief history of his origin and development through conformity to environment, being the Morse lectures (at Union Theological Seminary) for 1895. By JOHN M. TYLER, Professor of Biology, Amherst College. Charles Scribner's Sons, New York. $1.75.

The Morse lectureship was founded by Prof. S. F. B. Morse in 1865 at Union Theological Seminary, the lectures to deal with 'the relation of the Bible to any of the sciences.' These lectures for 1895, which are just published, deal with some of the most fundamental of all the relations between scientific and religious belief, and that in such a candid and fearless spirit as to at once win the attention and respect of all persons who love the truth and believe that a free expression of opinion is the best way of advancing it. The lectures include such topics as the fundamental properties of living things; a brief consideration of Classification, Ontogeny and Phylogeny; the probable course of evolution from amœba to man; the history of mental development and its sequence of functions from reflex-action to reason and altruism; natural selection and environment, making at first for digestion and reproduction preeminently, then for muscular strength and activity, then for shrewdness, finally for unselfishness and righteousness; conformity to environment; man from the biological, social and religious standpoint; finally a chapter on the teachings of the Bible relative to the subject in hand and another on the present aspects of the theory of evolution in which are considered a number of modern theories as to causes of evolution, inheritance and variation.

These lectures present the evolution idea not from the theological, but from the scientific point of view. They are largely biological in content and spirit though addressed to theologists. The author does not attempt to prove everything, but takes many elementary principles for granted, among them the truth of the entire doctrine of evolution. One is consequently spared the weariness of listening to a labored argument to prove the truth of fundamental ideas, which everybody, except a few immutables, believes. On the other hand it presents in a clear and suggestive way many of the more recent developments of the evolution idea. It does not purport to be an original contribution to knowledge, but it is a valuable and extremely well written book of the 'educational' type.

E. G. Conklin.

University of Pennsylvania.

SCIENTIFIC JOURNALS.

THE ASTROPHYSICAL JOURNAL, AUGUST.

The New Elements of Clèveite Gas: By J. R. Rydberg. In referring to the work of Runge Paschen and regarding the reduction of the spectrum of clèveite gas, the writer recalls the following simple law, announced some time ago by himself: *The difference between the common limit of the nebulus and the sharp series, and the limit of the corresponding principal series, gives the wave number of the common first term of the sharp and principal series.* This law holds good to a considerable degree of approximation for the alkali metals Li, Na, K and Rb, which have corresponding triple series, and is proposed as a criterion of the proper *mating* of the subordinate with the principal series. If we denote the principal series by P_1 and P_2 and the subordinate sets by S_1 and S_2, and assume that P_1 belongs with S_1 and P_2 with S_2, the law will hold; otherwise, in general, it will not.

In the correspondence chosen by Kayser and Runge the criterion is satisfied within the limits of observational error. The values of the first terms (in wave numbers, per cm.) of the principal series are as follows:

	Computed.	Observed.	C — O = $\triangle$
Pa	4857.79	4900.65	— 42.86
He	9230.22	8950.14	+280.08

Although the $\triangle$'s are well within the limits of error for the observation of this first line, which is in the infra-red and must be measured with the bolometer, there is evidence, in the case of He, of a probable disturbance due to the proximity of Na λ 11392.5, the sodium lines being strong in the visible spectrum. The author, therefore, concludes that the computed values of the lines are the most accurate. More accurate determinations of the lines in question will be of extreme value in testing this most interesting law.

Attention is also called to another law due to the writer, which seems to show Parhelium to be of uneven and Helium to be of even valency.

Outlines of a Theory of Spiral and Planetary Nebulæ: By E. J. Wilczynski. 1. A theory to explain the peculiar formation of spiral nebulæ. The writer supposes a mass of nebulous matter to be moving in a circle under the action of a central force. In case the mutual attractions of different parts of the mass upon one another are insufficient to resist distortion, it is shown that the different parts of the mass must be moving in concentric circles, the common center, of course, being the attracting body. Under these conditions it is evident, from Kepler's third law, that those portions of the nebulous mass nearest the center of the circles must rotate faster than those furthest away. In this manner a former radial line in the nebula will be distorted into a spiral.

The writer suggests that this gives us a means of approximating to the age of the nebula (as a spiral).

2. If a nebula has the shape of a flat disc, then the following differential equation exists between ρ, the density at any point, r, the distance of the point from the center, and ω, the angular velocity of the point, where ω and ρ are both supposed to depend only upon r.

$$\frac{d^2\rho}{dr^2}+\frac{1}{r}\frac{d\rho}{dr}-\frac{1}{\rho}\left(\frac{d\rho}{dr}\right)^2+4\frac{\pi}{c}\rho^2 = \frac{\rho}{c}\left(2\,\omega^2+r\frac{d\omega^2}{dt}\right)$$

If we know $\rho = f(r)$ we can now solve for ω. Assuming ρ proportional to the brighness, it is suggested that we find by observation

$$\rho = f(r)$$

and the angular velocity of the nebula at any point may be found, except with regard to the constant of integration.

Hydro-dynamical Investigation of the Solar Rotation: By E. J. Wilczynski. An application of Lagrange's differential equations for the motion of a fluid, to the case of the sun. Assuming the sun to be gaseous, it is found that the angular velocity of any point within it or upon its surface depends only upon its distance from the axis of rotation, and the distribution of density and pressure within the sun as a whole, *i. e.*, all points on a cylinder with the sun's axis as center revolve with the same angular velocity, but the differential slipping of these cylinders upon one another depends upon the internal conditions of temperature and pressure. If another relation between these three quantities ω, ρ and t could be found, the above conditions could be found as functions of the observed law of rotation.

Researches on the Arc Spectra of the Metals. II. The Spectrum of Titanium: By B. Hasselberg. The article is devoted to a consideration of the spectrum of titanium, from λ 3450 to *D*. Our present knowledge of the spectrum rests upon Thalen's work of thirty years ago, and consequently is not accurate as measured by modern standards. Many new lines have been discovered by the author and some of the old ones resolved. Extreme care was taken to eliminate impurity lines. All lines occurring within 0.1 meter of lines catalogued as belonging to other metals were compared with them on the same photographic plate and classified as follows:

A. As belonging to titanium.

(*a.*) All lines distinctly separated from those of comparison metal.

(*b.*) Those lines coinciding with comparison lines but having greater intensity.

(*c.*) Lines exactly coinciding and strong in both spectra (probably belonging to both).

B. As *doubtful.* Lines coinciding, but so feeble in both spectra as to make them possible results of a common impurity.

C. As *impurity* lines, those weak in titanium spectrum and strong in comparison spectrum.

Comparisons with the spectra of Fe, Co, Ni, Cr, Mn, Mg, Zn, Hg, Al, Pb, Sb, Na, K, Cs and Th, served to eliminate many impurity lines. These metals have been investigated by Kayser and Runge, and the comparisons cast doubt upon the legitimacy of some of the lines catalogued as belonging to these elements.

Minor contributions and Notes, including 'On a New Method of Preparing Plates Sensitive to the Ultra-violet Rays,' one of the series of articles by V. Schumann.

Reviews of recent papers on astro-physical subjects.

THE MONIST—OCTOBER.

C. Lloyd Morgan, in *Animal Automatism and Consciousness*, examines Huxley's and Descartes's views, rejects the theory that consciousness is a collateral product of brain action, and claims for consciousness a rôle of guidance both in the acquisition and utilization of habits, all of which is effected by association and suggestion.

In *The Regenerated Logic*, C. S. Peirce submits to critical examination Ernst Schroeder's great work, discusses the way in which professional opinion is formed, treats of the nature and scope of logic generally, and of 'assertion,' of hypothetical and categorical propositions, and of the quantification of the predicate in particular.

The third article is by E. Douglas Fawcett and is entitled *From Berkeley to Hegel*, being a chapter of the history of philosophy 'embodying a critique of the panlogist phase of idealism.' The treatment is thoroughly speculative in character (the author attempting to resuscitate the Leibnitzian monadology), and hence is the occasion of a reply from the editor, Paul Carus, who, under the caption of *Panlogism*, expounds anew his theories of mind, the soul and immortality.

The concluding article is by George Bruce Halsted, *Subconscious Pangeometry*, and treats of certain mooted points in the history of the theory of parallel lines and of the Non-Euclidean geometry. The usual correspondence follows, with quite a long list of reviews of important publications in philosophy and science.

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AN INTERNATIONAL ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The American Association for the Advancement of Science will meet next year at Detroit, on the Canadian frontier, and will adjourn to Toronto to welcome the British Association to American territory. The British Association has acknowledged this courtesy by inviting the officers of our Association to attend the Toronto meeting as honorary members and by admitting all members and fellows of our Association as members for the meeting. The *Association française pour l'avancement des sciences* has proposed that it should meet at Boulogne in 1898 or 1899, and suggested to the British Association that it should meet at some town on the opposite coast, such as would allow an interchange of visits between the two Associations. This proposal was cordially welcomed, and the British Association will meet at Dover in 1899.

Within the past few years International Congresses for a number of the leading sciences have been organized. In nearly every case each new congress has been more successful and stimulating than the preceding, and the future growth of these congresses is assured. They are accomplishing a work, the importance of which cannot be over estimated, not only by unifying scientific methods and contributing to the symmetrical progress of science, but also by bringing men of science from all parts of the world into personal contact. A further stage in scientific cooperation has been reached by the decision of the International Zoological and Physiological Congresses to meet together at Cambridge in 1898.

The time has now come when an International Congress for the Advancement of Science is possible. The cooperation between the British, French and American Associations; the successful international congresses in the separate sciences and for scientific bibliography; the establishment of journals, international in circulation, in contributions and even in editorship, are steps in a forward movement leading directly to a world's congress of men of science.

All the arguments that can be urged for national associations for the advancement of science, and for international congresses in the separate sciences, tell in favor of an international scientific congress. Cooperation furnishes both the means and the motive for scientific progress. As science becomes more complex the interrelation of all its parts becomes more evident. It would, indeed, be difficult to mention a scientific question that concerns one of the sciences only. Much good might come from the discussion of purely scientific problems by men approaching them from the most diverse points of view.

There are further many questions which may be regarded as external conditions of the progress of science which can only be settled by international cooperation. These questions usually concern more than one science and often all the sciences. Such are bibliography, nomenclature, the definition of units, libraries and museums, explorations, the teaching of science and many more. Progress results from chance variations and the survival of the fittest, but in a manner wasteful of time and life in comparison with what may be accomplished by intelligent direction.

One of the great advantages of gatherings of men of science is the personal contact and acquaintance which they further. This is an important function of local and national societies and could be attained by an international association to a degree otherwise impossible. Such a meeting would be amply justified if only by bringing together the leaders in the different sciences from the different nations.

Now at the end of the nineteenth century science is the dominant factor in the world. It should be acknowledged as such if only for the more efficient performance of its work. An international congress would impress the collective weight of science on the outside world. If the money and men used in preparations for war could but for a few years be used for the advancement of science preparations for war would no longer be necessary.

The advantages of an international association for the advancement of science seem evident, and the difficulties seem slight. The first year of the twentieth century is opportune for the first meeting. Many men of science will be in Paris, and if London or Berlin should seem more eligible they could easily gather in one of these cities. The preliminary arrangements could readily be made by the American and British Associations in 1797, and the final arrangements by the British and French Associations in 1899.

ADDRESS BEFORE SECTION B OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE BY THE VICE-PRESIDENT.

The selection of a subject for presentation in an address such as I am called upon to deliver to-day, seems difficult. A large proportion of those who may listen to me to-day are workers in the same field which interests me and are familiar with the progress in the science of physics. It is, therefore, unlikely that I shall be able to present to you anything which may be new or startling; this I regret, for it seems that it requires something of this character to stimulate interest and research.

The aim of science in its most general sense, is the discovery of truths. Its progress may be expressed by a curve approaching truth asymptotically, probably never in human experience approaching to its *complete* knowledge. So long as investigators find that they are working upon the steep part of the curve where it approaches truth rapidly, there is no lack of interest; this, however, seems to die out quickly when much labor and great patience are required to extend experimentally the curve now more slowly approaching complete knowledge, or straighten out some of its irregularities. As soon as a startlingly new or curious line of investigation is suggested every one pounces upon it and older problems are left far from completion. That we in America are especially inclined to this weakness in physical investigations I believe to be the case. Though investigations have been carried out by a number of American physicists, well-nigh to completion, involving years of painstaking labor, of which we may well be proud, yet I believe the tendency exists. It is this thought which has led me to select for a brief review a line of study patiently carried on in Europe for a number of years, yet hardly touched upon by physicists in this country. In the last few years the studies in electrolysis and solution have been so fruitful that we can no longer afford to neglect them. It is also remarkable that these studies in electrolysis and molecular physics have been made almost exclusively by chemists, though of equal, if not greater, interest to the physicists; the problem should be attacked by them. To direct your attention then to some of the important work that should be undertaken by physicists is my object in reviewing, in the briefest possible manner, the progress of studies in electrolysis from their beginning to the present time.

Scarce one hundred years have passed since the first note of chemical action having been produced by electricity is to be found. About the middle of the 18th century Pater Beccari obtained metals from oxides between which electric sparks had passed. These results led to no further inquiry at the time, and were passed by almost unnoticed. Priestley, in 1778, critically studied the effect of the passage of the spark through air, noting the production of an acid gas. Cavendish continued these researches, explaining the action in the sense of the Phlogistic Theory of the day. Van Marum, extending Cavendish's investigations, decomposed ammonia, and through a careful study of the chemical changes brought about by the electric spark became converted from Stahl's Phlogiston Theory, stoutly maintained at the time, to Lavoisier's Oxygen Theory. Van Troest and Dieman, in 1739, gave the first unmistakable evidence of electrolytic action in decomposing water by means of the spark. The tendency towards an Electrical Theory of chemical action, fully developed later, becomes evident from the study of the literature of the day. These investigations were almost exclusively carried on by chemists; but little attention was given to the study of electricity, its nature and physical action; only the chemical results were of interest. The quantity of electricity at the command of the experimentalists at that time, was so small that very definite results in electrolytic action could not be expected.

So far some progress had been made in the production and study of chemical effects resulting from electrical action; *the question of the possibility of the reversal of these effects, the production of electricity from the chemical action*, had not been thought of. Volta was the first one to investigate *that* question. Galvani's discovery given to the world in 1791 in a brochure of 58 pages gave a new stimulus to investigation, now taken in hand by physicists. The perusal of the little work is of great interest in the historical study of electricity. Galvani, as anatomist, looked for the source of electricity to the phenomena of life, believing it to be stored in the living cell. Volta, the trained physicist, sought for it in the material world and gave us the Contact Theory of electricity as distinguished from the Chemical Theory. These two theories have each been as stoutly maintained as controverted by the best experimentalists and thinkers of the century. Volta's great gift to the world was the Voltaic Battery, the study of which, together with the reversibility of the action, has thrown a flood of light upon problems in molecular physics as well as upon chemical action, though the 'contact theory' of electricity of Volta, accepted with modifications by many of the greatest physicists of this century, has undoubtedly been one of the strongest barriers to the progress of later and more satisfactory theories as to the seat of the electromotive force in the battery.

Passing over many important contributions from co-workers of Volta, laying a foundation for an understanding of the chemical effects of electricity, the most valuable work having perhaps been done by Ritter, we come to Nicholson and Carlisle, who, on the 2d of May, 1800, opened the field for the study of electrolysis by the decomposition of water by means of the current from the Voltaic pile.

Volta seems to have avoided almost purposely the recognition of chemical action associated with the production and action of the current. It is remarkable, at any rate, that such action should have impressed itself most strongly upon all other experimentalists of that day and scarcely be noticed by him.

From this time on we recognize for a considerable period two lines along which electrical problems have been studied. A long list of illustrious physicists from Ermann to Ohm studied the laws and physical effects of current electrical phenomena without questioning the somewhat unsatisfactory theory of Volta as to its source; another list, mostly chemists from Nicholson and Carlisle to Davy and Faraday, sought to determine the source of the current. To trace the development of modern theories historically would demand following both of these lines of research; time forbidding this we will consider but a few of the more important discoveries in each field as required.

Sir Humphrey Davy succeeded in decomposing the fixed alkalies in a fused condition; the separation of the elements from their compounds was by him demonstrated in many experiments.

Before proceeding, however, it may be well to define a few terms used in discussing electrolysis and recall a few of its phenomena.

By electrolysis we mean the chemical changes which result from passing an electric current through a compound, usually in solution or in a state of fusion. The substance decomposed is called electrolyte. The battery terminals, or source of current, connected by the electrolyte, are called Electrodes—the one bringing the current to the electrolyte the Anode, the one carrying it away the Kathode. As a result of the difference of potential of the electrodes, the materially different constituent parts of the electrolyte are impelled to move towards the electrodes; these wandering particles are called ions; those gathering about or moving towards the anode, anions; those about the kathode, kathions. The chemical changes are observable only at the electrodes. Taking as a simple case, ordinary hydrochloric acid—a compound of hydrogen and chlorine dissolved in water—the passage of the current causes chlorine to appear at the anode and hydrogen at the kathode. The hydrogen and chlorine, while in the solution finding their way to the electrodes, are ions; the chlorine-anion, the hydrogen-kathion. In many cases the action is not so simple. The electrolytic decomposition may be accompanied by chemical action occurring subsequent to or simultaneously with the appearance of the ions at the electrodes; the substance formed differing from the ions actually carried to the electrode. Changes of this character considerably complicate the problem and make the correct interpretation of observed phenomena difficult. This general law may, however, be enunciated: An electrolyte under action of the current is split into two and only two parts, atoms or groups of atoms, no matter how complex its structure may be. These atoms or atomic groups thus separated, are similar to the ones which exchange places in the ordinary chemical reactions. This early observed law led to the theory advocated by Berzelius, that all salts consisted of two atomic groups, one acid the other basic—erroneous, in that the chemical changes subsequent to the electrolytic action were not properly understood.

The wondering attention of early investigators had been directed to the curious phenomenon that the substances resulting from electrolysis appeared only at the electrodes and were not recognizable in the solution between the electrodes. The various theories propounded to explain this vied with one another in improbability. The difficulty of explaining this behavior satisfactorily seems to have led to the abandonment of the problem until, in 1805, Chas. J. D. Freiherr Von Grothuss propounded a theory which gave a sufficiently reasonable explanation to be adhered to for fifty years, even quoted to-day in many text-books. Grothuss conceived that each molecule of a chemical compound acted like a conductor consisting of two parts capable of being separated; these molecules acted upon inductively by the charged electrodes, one group would become positively charged, the other negatively, the nature of the charge being determined by the character of the group, being acted upon by attractions and repulsions, varying inversely as the square of the distance from the electrodes, the electrified *end* particles would be attracted to the electrodes; the remaining groups by separation and recombination would at once form a new series of molecules as before the action, ready for a repetition of the process; no freely charged groups thus remaining in the mass of the solution between the electrodes. This theory demands that the electrical forces between the plates vary inversely as the square of the distance; that, when the force reaches a certain definite magnitude the groups will be separated; a further consequence is that when this critical force is attained all or a very great number of groups will be separated, instantly, for if this attraction be equal to the force holding the groups together, the whole mass will be in unstable equilibrium, and any increase will cause complete separation of all groups.

Important experimental contributions followed one another rapidly, batteries were perfected, many physical actions of the electrical current were studied, the action of the current upon magnets was discovered, measuring instruments for quantitative work were invented, Ohm's law was enunciated, etc., so that when Michael Faraday, Sir Humphrey Davy's man of all work and his successor at the Royal Institute, with matchless experimental genius and wonderful breadth of view, attacked the problem of electro-chemical action, he had at his command the means for quantitative work in this field which enabled him to discover and formulate one of the most important laws of electrolysis. Faraday's charming directness and clearness in the exposition of his work and results contrast refreshingly with the prolix, flowery and mystifying style of his immediate predecessors; it at once stamped him a master of the subject treated. Faraday's original notes are well worth studying; they may be taken as models to-day by many who essay to record experimental results and conclusions. Confusion in terms and errors in inferences occurring in his work are well excusable; from our more extended and accurate knowledge, we are inclined to be unfairly critical. A review of Faraday's work in electrolysis alone would be interesting, for in it we may see foreshadowed many important points in the theories of to-day, though Faraday himself scarcely appreciated them.

The most important law Faraday contributed to the behavior of electrolytes acted upon by a current is stated thus:

The amount of chemical decomposition in electrolysis is proportional to the current and time of its action.

The mass of an ion liberated by a definite quantity of electricity, is directly proportional to its chemical equivalent weight.

The quantity of electricity which is required to decompose a certain amount of a certain electrolyte is equal to the quantity which would be produced by recombining the separated ions in a battery.

The latter law, clearly showing the reversibility of the process, at once makes the problem one capable of theoretical treatment from the standpoint of conservation of energy and has brought most abundant fruit in later years. Faraday, in the main, accepted Grothuss' hypothesis, differing from him in the conception of the character and manner of action of the forces. Faraday showed experimentally, by measuring the change of potential between the electrodes, that Grothuss' conception of attracting and repelling forces, varying inversely as the square of the distance, was untenable; he (Faraday) assumed that through the action of the electrodes the chemical affinities of the combined ions were so changed or weakened that they acquired a greater attraction for the plates and their neighboring opposite ions; that decomposition and recombination occurred along the entire line. With Grothuss, he assumes that each liberated ion has a definite quantity of electricity belonging to it. This theory then demands that the action of the constituent parts of the electrolyte extend to considerable distance, and that the effect of the electrode is to modify or weaken the chemical affinity between the groups so that decomposition results. Faraday leans to the opinion that chemical and electrical forces are identical, and in considering the reversibility of the process becomes an advocate of the chemical theory of the Voltaic cell.

Faraday, though somewhat confused in his nomenclature, brings out very clearly the relations between quantity of electricity and quantity of material separated, and electrical potential and chemical affinity, though at that time the concept of energy and work done, as a function of both potential and quantity of electricity, was not clearly established.

To review the work of Faraday in electrochemistry alone, and the influence it had in the development of the more modern theories, would require more time than is alloted to us ; the most important contribution in this subject has alone been mentioned.

In 1851 Williamson, from purely chemical evidence in the manner of the formation of some ethers, was led to believe that in solutions there is a constant interchange of atoms or groups of atoms between molecules, equivalent to dissociation and recombination, a view differing from those previously held, where this condition was supposed to be brought about by the action of the electric current. Williamson made no application of this conception to electrolysis.

Clausius, in 1857, applying the ideas growing out of the Kinetic Theory to solutions, points out the weaknesses of previously advocated theories; he shows that Grothuss' hypothesis, as well as its modifications by Daniell and Faraday, are not in accord with experimental results from accurate measurements. He shows that the hypothesis that the decomposition or tearing apart of the groups of atoms in the molecule by the electric forces, before transfer of electricity takes place, is untenable.

Clausius assumes that the molecules in the liquid stored with energy, move with varying velocities ; that collisions will occur which may cause the separation of the molecules into atomic groups for a short time ; that during the period of separation these groups charged with opposite kinds of electricity peculiar to the groups will, under the influence of the electrode, be directed towards the electrodes in their path and thus become carriers of electricity ; he ascribes to the liquid the conditions of dissociation due to fortuitous impacts always occurring, whether the solution be under the influence of external electrical forces or not; that the function of the electric forces is but directive, the effect being, the disturbance of the internal kinetic equilibrium.

The principle of the conservation of energy, developed and applied in thermodynamic relations, influenced the manner of looking upon and interpreting electrochemical processes. The most prominent names associated with the application of this great principle are Joule, Helmholtz, Willard Gibbs, Thomson, Boscha, Favre and others. Much attention was now given to the problem : What is the cause of the electromotive force? The distribution of the energy in the electric circuit, including battery, electrolytic cell and conductors, was investigated in the light of the energy concept and attacked from the mathematical or dynamical side. Weaknesses in older theories were glaringly revealed if searched in the light of this principle. The dependence of the electromotive force upon the entropy term in the equations was shown, and its consequent variation with temperature.

The contributions of Willard Gibbs in this field are the most important, though scarcely appreciated; published in the Transactions of the Connecticut Academy, 1876–78, they were not very accessible and not generally known. This great work anticipated the many discoveries since made experimentally, in a manner all but final in its comprehensiveness and completeness, opened out and suggested experimental investigations only partially undertaken and beginning to be carried out to-day. Why it was and is not more fully appreciated is probably due to its concentration; in the compass of some 300 pages and in 700 equations the entire subject of molecular dynamics is treated. The treatise was too rich to be grasped in its day; it is only beginning to be properly estimated twenty years after its first appearance.

About 1853 Hittorf quantitatively investigated, with great care, the change of concentration in solutions of electrolytes about the electrodes when a current passes. This phenomenon had been noticed and studied to some extent by Daniell and others, without, however, having been made use of in explaining the nature of electrolytic action. Hittorf's studies and conclusion bring us into the very midst of the modern views of electrolysis. Taking a simple case, let two electrodes of copper be placed vertically over one another in a solution of copper sulphate, pass a current through the cell making the lower plate the anode; no very noticeable change occurs other than that copper is dissolved at the anode and deposited at the kathode; if after the current has passed for a short time it is interrupted and the electrode short circuited through a galvanometer, a current will for a short time flow in the cell from kathode to anode, that is, in a direction opposite to the one which has passed through in electrolyzing. The counter-electromotive force in this case can not result from polarization at the electrodes, for no change has been brought about at their surfaces, such as a gas deposit in the case of decomposition in acidulated water with platinum electrodes. If the electrolyzing current be continued for some time it will be seen that the solution about the anode has become more concentrated and more dilute about the kathode; the total quantity of copper salt in the solution having, however, remained the same, the counter-electromotive force above referred to is due to this change in concentration.

Hittorf, from 1853 to 1859, examined in a most careful manner the behavior of many electrolytes, and by a series of analyses of the solutions determined this change of concentration due to the passage of the current. His patient labor has only within the last few years received proper recognition.

All theories which so far had survived the test, conceived that the electricity was conveyed by a migration of particles, called ions by Faraday; whether these particles received their changes by contact with the electrodes or contained definite inherent quantities of electricity, the charges being the same for all ions, need not be considered at this time.

The first step toward the decisive establishment of the fact of the migration of the ions towards the plate would be an experimental measurement of the rate of migration; this was accomplished by Hittorf and led to the enunciation of these laws:

1. The change in concentration due to current, is determined by the motion which the ions have in the unchanged solution.

2. The unlike ions must have different velocities to produce such change in concentration.

3. The numbers which express ionic velocities mean the relative distance through which the ions move between the salt molecules, or express their relative velocities in reference to the solution, the change in concentration being a function of the relative ionic velocities. Hittorf's analyses enabled him to give their numerical values. A great many such have been made by him, Nernst, Loeb and others; these results show that in dilute solutions the relative velocities of the ions are independent of the difference in potential between the electrodes (if the current be steady), and that they are only slightly affected by temperature.

Hittorf points out that a knowledge of the specific resistance of electrolytes should give valuable information in reference to the nature of electrolytic action. Horsford, Wiedemann and Beez made such measurements; their methods were, however, imperfect; it remained for P. Kohlrausch to devise a method, using an alternating current, by means of which accurate results were obtained. Kohlrausch's work shows an amount of patience and experimental skill rarely found; his contributions will remain classical. In connection with Hittorf's work, Kohlrausch recognized that, according to Faraday's law, the conductivity should be represented by sums of the velocities of the ions, each carrying its electric charge. Thus, having from experimental data on conduction the sum of the velocities, and from Hittorf's migration constants, based upon changes in concentration, the ratio of the ionic velocities, the absolute velocities of the ions would be calculable. Inasmuch as the quantities he was to deal with were groups of atoms or molecules he determined at once to make the molecule his unit of quantity, and not mass alone. This expedient simplified the comparison of results and has been neglected by physicists. The comparison of results obtained by making the molecule the unit, revealed at a glance relations between the physical behavior of different substances which would have been obscure if the mass had been chosen as unit. The selection of the most convenient proper unit is of great importance in the interpretation of results and the enunciation of physical laws.

Kohlrausch expressed the concentration in *gramme molecules* per unit volume of solution, the unit solution containing a number of grammes of the electrolyte equal to the number expressing the chemical equivalent on the hydrogen scale, in one litre of water. The measurements were then made upon solutions, the relative numbers of molecules in which were known. The ratio between the conductivity and the number of gramme molecules contained in the solution will then give molecular conductivities.

The results of such measurements show, that as dilution increases there is an increase in molecular conductivity, that in very dilute solutions it approximates a limiting value. This increase of conductivity is considerable for bad conductors, less so for good conductors. The limiting value in dilute solutions of good conductors can be reached. In bad conductors, even at the extremest dilution accessible to measurement, the molecular conductivity is still far from the limiting value.

In general there is an increase of conductivity with increase of temperature, usually amounting to about 2 per cent. per degree Centigrade.

The conductivity of equivalent quantities of neutral salts is of much the same order of magnitude, usually reaching the limiting value at a dilution of $\frac{1}{2000}$ gramme equivalent.

From Kohlrausch's numerical values and Hittorf's constants, the absolute velocity of a large number of ions was calculated. It appears from this, that the velocity of the ion in very dilute solutions depends only upon its own nature and not upon the nature of the ions with which it may have been associated; thus the velocity of the Chlorine ion was found to be the same whether determined from solutions of KCl, NaCl, HCl, etc.

This important general law was also found, that the conductivities of neutral salts are additively composed of two values, one depending only upon the metal or positive ion, the other upon the acid radical or negative ion. According to this law the conductivity of a neutral salt can be calculated from a knowledge of the velocities of the ions independently, a test which has been applied in many cases with very satisfactory results when checked experimentally. For quite a number of compounds, however, the computed results were much too high an abnormality to be discussed later. This law confirms the idea of independent migration of the ions.

Kohlrausch's numbers expressing velocities were checked by some exceedingly ingenious experiments by Oliver Lodge and Wethan. By a change in the color of the solution of two layers the migration of the ions could be directly measured, these results agree surprisingly well with Kohlrausch's, considering the widely different conditions and the difficulty of measurement.

About 1887 electro-chemistry entered into a new stage of progress; the central figure among those who were mainly active in bringing about this development was Svante Arrhenius, who, together with Ostwald and others, advanced a theory of electrolytic action, explaining very satisfactorily many well-known phenomena. Arrhenius' theory involves the general idea contained in the theory of Clausius and Williamson, namely, that the solution contains the electrolyte dissociated into ions before the current is forced through it. Arrhenius adds that this dissociation is affected by solution or fusion, and that the ions contain charges of positive and negative electricity dependent upon their nature, but of equal quantity in every ion. While in this state, that is, as ions, they move in an irregular manner between the molecules of the solvent and the undissociated molecules of the electrolyte, now attaching themselves to one another and again separating, upon the whole maintaining a condition of Kinetic equilibrium. As soon as brought under the influence of the electrodes of different potential, they are impelled in definite directions, the anions towards the anode, the kathions towards the kathode.

The first work done by the current is the overcoming of the viscous resistances of the medium, not an inconsiderable amount; thus a portion of the energy of the current is fritted into heat.

At the electrodes another kind of work has to be done; either the charges have to be removed from the ions, changing them into the molecular condition, or new ions must be produced from the material of the electrode and the solvent, for kathions arriving the formation of anions or for anions kathions.

Undissociated molecules of the electrolyte take no part directly in electrolysis, except in so far as they may alter the viscous resistance of the solution.

The fact that molecular conductivity increases with dilution means, that as infinite dilution is approached complete dissociation or ionization of the electrolyte is effected.

The ratio between molecular conductivity at greater concentration and infinite dilution, expresses the degree of dissociation or ionization. The conductivity can always be expressed by the sum of the velocities of the ions into a coefficient expressive of the degree of dissociation: $C=A(u+v)$. In the limiting case $A=1$ and the conductivity is measured by the sum of the ionic velocities, this in accord with Kohlrausch's law.

One of the important points in this theory is that solution effects dissociation. Chemically pure substances, such as HCl in the liquid state, should not be electrolyzed; such is found to be the case. The curious fact that pure HCl and pure water alone are non-conductors, but become electrolytic conductors when mixed, is not rationally explained, other than that dissociation results. Why it takes place we do not know; that some change in the associated energy always takes place we do know. In general, unless some chemical change occurs, solution is accompanied by refrigeration, except in the case of gases. It is probable, then, that some of the heat energy taken from the mixture is concerned in this dissociation.

In the case of fused substances heat may be a considerable factor in dissociation.

The question whence come the electric charges upon the ions is not solved. Whether they are inherent in the molecule and become free by ionization or whether they result from the work done upon the molecules in dissociation is not known. Some progress has been made towards the solution of the question by Ostwald, who succeeded in measuring the heat energy of ionization in a few cases. This problem is one that should be carefully studied.

An objection to the theory of the existence of free ions in a solution has been urged from the chemical side, namely, that the ions possess different properties from the atoms, or atomic groups. It seemed remarkable that a potassium ion should be capable of existing in water without combining with the oxygen, as would be the case in the ordinary atomic or molecular condition. If we consider, however, that the amount of associated energy in the two conditions is different, it is not difficult to imagine different properties. We know, for instance, that negatively charged zinc will not act on hydrochloric acid; that several elements exist in well-known allotropic conditions, showing quite different properties. We explain this by different amounts of associated energy, which, in some cases, is quite measurable.

The difficulty of applying Ohm's law in the case of Grotthus' and Faraday's theories disappears in case of the dissociation theory; it rather becomes a necessary consequence of it.

Considering now a few phenomena not directly involved in electrolysis, evidence in favor of the dissociation theory may be found.

Substances form solutions when a homogeneous mixture results, the constituents of which can not be separated by mechanical means, the proportion between the parts being continuously variable between certain limits, with a corresponding continuous variation in properties.

According to the state of aggregation of the dissolved substance before solution, energy changes usually become apparent, either in temperature changes, contraction of the volume, or the like, when solution is affected. As a rule, such energy changes occur in the same sense when solutions of different concentrations are mixed, until a point is reached, with very dilute solutions, when they no longer are observable. The substance in the solution is then very small in amount as compared with the solvent.

It is a well-known fact that when solutions of different concentration are carefully superposed, the molecules of the dissolved substance pass from the more concentrated to the more dilute solution, until finally a uniform degree of concentration is attained, when a condition of kinetic equilibrium is maintained. This diffusion phenomenon in liquids is similar to that in gases, only it progresses much slower. In the case of gases the dynamics of the process is pretty well understood and satisfactorily explained by the kinetic theory, the mixture of the gases resulting from the projectile energy of the molecules. In the case of liquids it has been variously explained; in general, however, the molecular attraction between the solvent and the dissolved substance has been assumed as the cause. Van't Hoff has recently offered an explanation along the same kinetic lines so satisfactorily applied in gases. The force tending to produce diffusion must be measurable as a pressure, if it exist; if then, the two solutions are separated by a semi-permeable membrane which will allow but one of the two constituents to pass, this pressure will become measurable upon the membrane. The production of such semi-permeable septa is a matter of very great difficulty, but has been accomplished to a very perfect degree for some substances. The general method of making such measurements is familiar to all physicists. Traube, Pfeffer, De Vries, Tammen and Pringsheim, from 1867 to 1885, have succeeded in producing semi-permeable membranes of great perfection, and with improved apparatus have made many measurements of very satisfactory character. These results show, that equimolecular solutions of non-electrolytes show equal osmotic pressures. The osmotic pressure is directly proportional to concentration (expressed in gramme equivalents). The osmotic pressure is proportional to the absolute temperature.

The similarity of these laws to those of gaseous pressure, is at once apparent. Van't Hoff further, upon the bases of absolute measurements and the applications of the ordinary equations for properties of gases, enunciates the laws: That the molecules of the dissolved substance exert pressures in osmotic action, equal to the pressure which would be exerted by the same number of molecules in the gaseous state upon the sides of a containing vessel of the volume of the solution, the temperature remaining the same.

Osmotic pressure seems then to be merely a molecular kinetic effect. On this assumption thermodynamic considerations led to the same result as experiment.

The first two laws of osmotic pressure could be satisfactorily explained under the ordinary supposition of molecular attraction; the last two, however, are difficult to reconcile with any explanation other than the one that the pressure is due to molecular impact.

The osmotic pressure of electrolytes is considerably greater than that of non-electrolytes; in dilute solutions they, however, follow the same laws of variation. In quite a number of binary compounds it is just twice as great numerically as in the non-electrolytes. The behavior is, as though the number of molecules contained in the electrolyte solution per gramme equivalent, was greater than in non-electrolytes. If we imagine that solution has dissociated the molecule into two groups, the anomaly is easily explained. There is evidence here, independent of electrolytic behavior, that electrolytes are dissociated in solution.

Blagden, as early as 1788, recognized that salts in solution lowered the freezing point of water; his experiments were made mainly on sea water. He found that in very dilute solutions, the lowering of the freezing point was very nearly proportionate to the amount of substance dissolved. Riedorf, Coppett and Raoult carefully studied the subject and found that the molecular depression of the freezing point was equal for salts of similar composition. For non-electrolytes, equimolecular solutions of different salts gave very nearly the same values, showing, that the effect was purely a molecular one independent of the nature of the substance.

The problem may be treated from the dynamical point of view upon this supposition: Knowing the osmotic pressure and imagining the change in state in the nature of a reversible cycle, the necessary energy changes are calculable. The depression of the freezing point calculated in this way for a number of substances gave values closely agreeing with experiment. The evidence that this effect is purely a molecular kinetic process is very strong.

Electrolytes cause a depression of the freezing point, experimentally determined, far greater than non-electrolytes; we have here another evidence of dissociation by solution.

The investigation of the effect of substances in solution upon vapor pressure and boiling point made by Berthelot, Beckmann, Raoult, Ciamician, Ostwald and others lead to precisely similar laws.

We may summarize these laws thus: Equimolecular solutions of different substances made with equal masses of the same solvent, show equal osmotic pressure, equal relative diminution of vapor pressure, equal elevation of boiling point and equal depression of the freezing point.

Electrolytes give greater values than non-electrolytes. The effect is as though there was present a greater number of molecules than indicated by the amount of substance dissolved. Binary compounds in dilute solutions, give nearly twice the numerical values found in solutions of non-electrolytes.

From these experimental results the theory of dissociation of electrolytes by solution and the electrolytic conduction by directing the migrating ions seems very strong.

Chemical evidence can not be reviewed here; the evidence is, however, fully as strong or even stronger than that considered.

Reversing the phenomena of electrolytic decomposition, Nernst applies these concepts to the battery problem. We will apply the theory to one or two simple cases only.

When two solutions of the same electrolyte are brought in contact electrical differences manifest themselves. The mere statement, that the cause for such difference in potential is contact, is unsatisfactory. Nernst reasons in this wise: The ions in virtue of osmotic pressure will diffuse; migrating with different velocities, as shown by Hittorf, they will diffuse at different rates; there will result, therefore, an excess of anions in the one solution and kathions in the other; the ions possessing characteristic electric charges, there will be found an excess of positive electricity in the one solution and an accumulation of negative electricity in the other solution. If an indifferent electrode be immersed in each solution, connected through a conducting circuit, there must result a current. We have here a battery giving an electrical current as a result of osmotic pressure. The necessary conditions for the production of the current are, that the ions have different velocities and exert osmotic pressure; that in solution we have the molecules dissociated or ionized; that the energy associated if current flows, is less at the close of the operation than at the beginning.

Nernst and Helmholtz calculated the electromotive force for such cells from the experimental data of osmotic pressure and ionic velocities, obtaining results agreeing very well with electrical measurements.

It would, perhaps, be expected from the above that the current would continue until the concentration had become uniform; such, however, will not be the case in the battery just described, for the kathions at the kathode and the anions at the anode will now develop electrostatic attractions which can not be overcome by the electromotive force of the battery.

Modifying the cell so that, in place of indifferent electrodes, we use electrodes of the metal, the salt solutions of which surround it, a battery results which will continue in operation until uniform concentration results. In this case the kathions will, at the kathode, by giving up their electric charges, become metallic, the electrode becoming positively charged; at the anode metallic particles will go into solution as kathions. This ionization involves energy changes. The kathions there produced, carrying positive charges with them, leave the electrode negatively charged.

In a battery, such as described, three differences of potential result; one at the surfaces of the solutions differing in concentration, and a difference of potential between the surfaces of the electrodes and the solution, the first having been explained as originating from osmotic pressure. Nernst explains the latter as resulting from a solution pressure. Just as a liquid evaporates from the surface until the vapor pressure becomes equal to the vaporization tension, so in solution will a salt dissolve until the osmotic pressure becomes equal to the solution tension of the salt. In the same way Nernst supposes that each metal has a tendency to convert atoms of the metal into ions in solution as soon as it is immersed in an electrolyte; this has been termed electrolytic solution tension. Osmotic pressure and solution tension thus become analogous concepts. Three conditions are possible in the battery cell:

1. If the solution tension be greater than the osmotic pressure the metallic plate acts like a salt mass in a dilute solution. Kathions will be thrown into the solution positively charged, leaving an equal negative charge upon the electrode; at the surface of separation between solution and electrode we shall have positive kathions upon one side and negatively charged metal upon the other, these exerting electrical forces, a condition will be reached when they are equal to the solution tension, further action will then cease until the kathions are discharged or made metallic.

2. If the osmotic and solution pressures are equal, no difference in potential will result; as when a mass of salt is introduced into a saturated solution, of itself no change takes place in equilibrium.

3. When the osmotic pressure is greater than the solution tension, kathions will be projected upon the plate and made metallic, the electrode becoming positively charged and the solution negatively, similar to the action which takes place when a solid salt is brought into contact with a supersaturated solution where salt particles will be deposited.

The determination of the relative values of solution pressures is comparatively simple, the determination of their absolute values very difficult. In the case of mercury and a saturated solution of calcium chloride, the absolute value has been determined with considerable accuracy from the effect upon tension phenomena in the mercury surface, fully discussed by Lippman, Helmholtz and Paschen. Ostwald and Planke obtained, values by two methods based upon this action agreeing very well. With this value as a basis others have been determined. Applying those values experimentally obtained, together with the ones for osmotic pressure, in calculating the electromotive force of a number of well-known cells, an excellent agreement with experimentally determined values is found.

It will be impossible in this review to apply these theories to the various forms of batteries known, and to many phenomena of electrolysis which we have no space even to mention; the theories briefly reviewed have borne rich fruit in the more satisfactory explanation of electrolytic action. Many problems still remain to be attacked, while some have been but now appreciated.

The development of the solution and dissociation theories gives no explanation of the forces and conditions which cause solution or ionization, though some attempts have been made in this direction. Thus, J. J. Thomson has shown that if the attractions between the ions in the molecule is due to electrical forces it will be weakened, if the molecules be immersed in a medium of high specific inductive capacity. Experimental evidence, in so far as it goes, shows that in liquids of high specific inductive capacity, ionization is most complete. This is one of the problems to be systematically studied.

With the solution of the older problems new ones present themselves. This is the effect of any comprehensive good theory. Many new problems in molecular physics and electrolysis are suggested through Arrhenius's, Van't Hoft's and Nernst's theories. Their development and solution will not be one of chance, however, to be stumbled upon by daring or blind groping, but by intelligent, painstaking research. A bird's-eye view of the field is given us through these theories, in filling in the detail and contours, the chance explorer must give way to the systematic investigator.

Until within the last three or four years, the systematic and careful amassing of experimental data for building up or verifying these theories, was done by a few European workers, mostly chemists ; since Willard Gibbs's theoretical work bearing upon this subject, scarcely a single addition of importance has come from American workers; in fact, it seems that much of the work done abroad is scarcely known to American physicists. It is to be regretted that in the history of the development of this branch of electrical science hardly an American name will appear.

There, however, remains much to be done, and contributions from this side will I trust be made.

Whether electrolytic action ever occurs in solids, is a question which I do not believe has been definitely settled. If such action ever does take place, the theories just considered will have to be modified. Some very curious phenomena in glass, subjected to the action of the electric currents, have been noticed; the claim has been made that glass has actually been electrolyzed, though the evidence so far is not conclusive. The very interesting changes of conductivity with variation in temperature, exhaustively studied by Thomas Gray, indicate molecular changes which may be due to dissociation. The form of the equation for change in conductivity with temperature shows a maximum with reversal, considerably below the fusing point. A similar peculiarity is noticed in alloys. The systematic study of this seems important.

Careful study of heat absorption when salts are dissolved should be made. Much work has been done in this direction. A careful examination and comparison of results, however, convinces one that the methods and manner of conducting the investigation must have been widely different, for the results vary in a most astonishing manner; at any rate, definite conclusions cannot be based upon them. If ionization requires energy, it is more than likely that some will be taken from the solution in the form of heat. In very dilute solutions dissociation of the electrolyte seems complete, while in concentrated solutions it is incomplete. A careful determination of the heat absorption per molecule, when the salt is dissolved in concentrated or dilute solutions, might give valuable results. The problem is very complicated, yet it should be attacked.

That gases can conduct electrolytically seems fairly certain. This field is scarcely entered and may well be studied.

The peculiar behavior of charged plates under the influence of violet light seems likely to involve electrolytic action and bear upon dissociation questions.

So multitudes of problems suggest themselves, the study of which may tend to crystallize the theories of dissociation and solution, so promising at this time, into more perfect form. It can scarcely be doubted that the remarkable connection, evident when the phenomena of solution, modification of freezing and boiling point, osmotic pressure, optical rotation, chemical equilibrium and stability, metathetical reaction, thermal neutrality, electrical conductivity and electrolysis are considered, taking the molecular equivalent mass as the unit, indicates a very near relationship of these processes. The power of Arrhenius's dissociation theory, Van't Hoft's solution theory, together with the conceptions of Hittorf, Clausius, Nernst and Ostwald in explaining the dynamics of molecular action, is most promising. Whether more accurate and more plentiful quantitative studies of these so closely related phenomena will lead to closer concordance or greater divergence of the numerical values obtained, and thus strengthen or reveal weaknesses in the theories, must remain to be seen.

These theories, if fastened, will have a marked influence both upon the chemical and physical conceptions of the structure of complex molecules. They seem to demand essentially a condition of kinetic equilibrium between molecules and atoms; inter-atomic distances we shall have to consider greater than was our wont; atomic and molecular influences must extend to considerable distances. Geometrical static arrangement of atoms or groups of atoms seems incompatible with their behavior. The relation of atoms in the molecule seems rather to be orbital, permitting of ready rearrangement and readjustment by relatively slight disturbing causes, capable of returning to former relations promptly, involving various quantities of energy. All our inferences in reference to molecular magnitudes will have to be interpreted as effective merely, and not actual in the sense of space occupied.

The one central pillar upon and about which all physical science is erected to-day, the conservation of energy, stands unchanged and, if possible, more clearly defined and strengthened than ever in these tests.

I repeat, may American physicists take up these problems and add their share to the development of these epoch-making theories.

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THE CORNELL EXPEDITION TO GREENLAND.

The Cornell party, which accompanied Lieut. Peary on the steamer Hope, left Sydney, July 16th, and passed the entire eastern coast of Labrador near the land, with one stop at the island of Turnavik. Entering Hudson Strait a stop of several days was made at Big Island and the neighboring coast of Baffin Land. From here an unsuccessful attempt was made to penetrate the ice which stretched across the mouth of the Cumberland Sound, after which the ship steamed across to Disco Island, on the Greenland coast. A stop was made there, another in the Vaigat Strait and a third at Umanak. After a brief stop at Upernavik, the party was landed, August 7th, on the Nugsuak peninsula, Latitude 74 °7′, about 80 miles north of Upernavik. The party remained there until September 7th, and then returned, following practically the same route and making nearly the same stops as those made on the northern passage on the Greenland coast. On the American side a stop of two or three days was made in Cumberland Sound, where the conditions closely resemble those in Hudson Strait.

The main object of the expedition was to study the geology of a small area in some detail; but collections of plants, insects, marine invertebrates and birds were also made. In connection with this work considerable dredging was done.

Briefly stated, the principal geological results are as follows: At Turnavik, on the Labrador coast, evidence of recent glaciation is abundant. The hills are all rounded; there has been little post-glacial decay, and the transported boulders, as well as the bed rock, are very fresh. Upon exposed rock faces, unprotected from the weather, glacial striæ are still very distinct. Granting equality of weathering, this region has been much more recently glaciated than regions of similar geological structure in New England. The amount of glacial carving has not been sufficient to lower the surface of the gneiss to the level of the pre-glacial decay in the trap-dike valleys.

Until the northern end of the Labrador peninsula is approached evidence of glaciation in the form of rounded contours is so distinct that it may be seen from a ship several miles from land. At Cape Mugford, Table Mountain and vicinity, in Latitude 58° 59′, the topography changes to the angular type, and this highland portion of the narrow northern prolongation of Labrador may have risen above the ice. Later experience in Greenland, however, has led me to place little confidence in evidence of this sort. Rounded contours are positive evidence of value, but the negative evidence of angular outline is of little value, particularly when combined with considerable elevation. The rate of weathering and erosion on some classes of rock in high latitudes is extraordinary ; and if, as is so often the case in Greenland, the glaciation did not suffice to greatly modify the pre-glacial topography, the combination of pre-glacial and post-glacial denudation serves to abundantly mask the evidence of glaciation when the hills are viewed from a distance.

That part of Baffin Land bordering Hudson Strait in longitude 70°–71° has all been glaciated up to an elevation of at least 600 feet. The evidence of this is found in indistinct striæ, an abundance of transported fragments of limestone, and other foreign rocks, and the roches moutonneés form of the rock outcrops. The garnetiferous gneiss and crystalline limestone of the region have been markedly disintegrated since the retreat of the ice sheet ; and yet the recency of this retreat is shown by the freshness of some of the rocks and also by the fact that some of the lakes have two outlets, while one was seen with five outlets.

Both at Big Island and on the main Baffin Land evidence of very recent elevation is found to a height of 270 feet above the sea. The evidence of this is present in the form of a series of perfect boulder beaches, one above the other, marking various halts. In a muddy gravel, at an elevation of 270 feet, an abundance of Saxicava, Mya and other shells was found. A depression to this amount would lower a very considerable area of the border of this part of Baffin Land.

The results of the study on the Nugsuak peninsula will be more fully described elsewhere. At the southeastern base of the peninsula there is a large glacier which is given the name Cornell glacier and on the northern side is the Wyckoff glacier.* The latter is nearly stagnant and enters a narrow fjord from which the winter floe ice did not escape during the summer. The Cornell glacier is active, but not nearly so much so as some of the glaciers south of it. This is shown not by actual measurements of the rate of motion, but by the quantity of the bergs which are discharged. For various reasons, mainly because of the roughness of the ice surface and the lateness of the season, no determination of the rate of movement of the Cornell glacier was attempted. On the Nugsuak peninsula there are several glaciers ranging from mere snow fields to a glacier of the valley type which just reaches the sea.

The Nugsuak peninsula extends 24 miles from the front of the Cornell glacier to the end at Wilcox Head. To seaward at a distance of 8–10 miles from Wilcox Head lie the Duck Islands, one of which rises to an elevation of 110 feet above the sea, while the other attains an elevation of 200 or 300 feet. The depth of the neighboring sea is in some places over 100 fathoms.† The highest point on the Nugsuak peninsula is 2,500 feet and in many places its elevation is over 1,000 feet. At Wilcox Head the elevation is 1,400 feet and the sea near by more than 100 fathoms in depth. The rocks are all gneiss crossed by numerous trap dikes, the gneiss being apparently a metamorphosed sedimentary series faulted and folded with great complexity.

A retreat and advance of the Cornell glacier at some recent time is proved by the presence of fragments and entire shells of

*Named after Mr. E. G. Wyckoff, who generously furnished the money needed for the expedition.

† Based upon a sounding made about half way between Wilcox Head and the Duck Islands, which gave 114 fathoms, and upon the fact that bergs from 75 to 100 feet above the water pass through the channel.

Saxicava, etc., in the moraine now being constructed as well as in the ice itself. These occur at all elevations from sea level to 600 feet, but the configuration of the region is such that this may not mean a retreat of more than one or two miles.

Notwithstanding this retreat and advance, the glacier is now engaged in a rapid withdrawal. The evidence of this is found in moraines 100 or 200 feet from the ice front, in some of which an ice core still exists, while in all cases the withdrawal has been so recent that the boulders have not become lichen-covered. The same is true of the bed rock between the moraines and the ice.

This very recent retreat is a part of a general withdrawal of a vast ice sheet, which extended outward beyond the Duck Islands, a distance of no less than 32 miles from the front of the Cornell glacier. The entire Nugsuak peninsula has been so recently glaciated that striated rocks are still present even at the outer end. Boulders of slate, quartzite and porphyritic granite-rocks, nowhere found in place on the Nugsuak, occur abundantly in the moraine of the glacier and are strewn over the peninsula. The granite was also found on the Duck Islands in a bed of till. At the Devil's Thumb, which rises 2,600 feet above the sea, transported blocks of the granite were found, and they are abundant at the top of the highland of Wilcox Head, 1,400 feet above the sea. Therefore, granting a depth of no more than 100 fathoms for the fjord south of the Nugsuak, there has recently been an ice sheet here covering all of the land and having a depth of no less than 2,000 feet, and probably much more. At the Duck Islands, 8–10 miles farther from the mainland, and 32–34 miles from the present ice front, the ice sheet had a depth of no less than 800 feet, and probably much more.

So, in this part of Greenland at least, the present glaciation is a shrunken remnant of a former greater sheet, the western limits of which cannot be drawn. At Disco Island, at an elevation of 2,000 feet, gneiss boulders rest on trap; and, while they *may* have been brought from within the island, it is equally possible that they were brought from the direction of the mainland. It will be an interesting point to decide how extensive this greater glaciation has been. It seems hardly probable that it was local.

Various detailed observations were made along the margin of the glacier and upon the direction of movement in the ice as well as of the ice over the peninsula. One of the most marked features noticed is the remarkable control which topography has upon ice movement, especially in the last stages of the ice. In one case the movement of an ice tongue of the main ice cap is moving in exactly the opposite direction from the general movement of the ice which supplies it. The general movement is one thing, the deviation from this induced by larger topographic features is quite another, and the influence of minor topographic features in the very last stages is still another; but while one gains much in the way of valuable hints from a study of the Greenland ice sheet, he must needs be very cautious in his application of these to our own recent glaciation. The conditions are very different, and in no way is this more markedly shown them in the decided poverty of drift in the control of the Greenland ice.

The thanks of all connected with the expedition are due to Lieut. Peary for the sagacity with which his plans were laid and executed. The terrors of Arctic navigation, of which we have all learned so much, do not appear in his summer trips; and, judging by this summer and the several preceding ones, an expedition to Greenland under the lead of Lieut. Peary is as safe and pleasant a summer excursion as one to Alaska. The expedition went and returned on schedule time, and this has been

his previous experience. It is one constant panorama of wonderful scenes, with land nearly always in sight, often on both sides, and with the water ordinarily as calm as the surface of a small inland lake. The fact that all who go wish to go again in the best evidence that can be offered of the great attractions offered by Greenland to the geologist and naturalist. I feel that this statement is warranted because it is so greatly at variance with the common conception of Greenland and the southern Arctic. Ralph S. Tarr.

Cornell University.

ALBERT NELSON PRENTISS.

Prof. Albert Nelson Prentiss, who for twenty-eight years has occupied the chair of botany in Cornell University, died at his home on the University Campus, Friday, August 15, 1896. He had been in failing health for several years, and the readers of Science will recollect that last February severe illness induced him to ask to be retired from active labor in the department, and the Board of Trustees elected him professor emeritus.

Prof. Prentiss was born May 22, 1836, at Cazenovia, Madison County, N. Y. He was a member of the first graduating class of the Michigan Agricultural College, at Lansing, in 1861, and the entire class of seven young men immediately enlisted in the army at the outbreak of the Civil War. He was enlisted in the Signal Service Corps at Battle Creek, Mich., and assigned to special signal service duty in the interior of Missouri. His connection with the army was of short duration, owing to a reorganization on the retirement of the commanding general. In 1862–63 he was associate principal of the Kalamazoo, Mich., high school, and in 1863–64 was instructor in botany and horticulture at his *alma mater* the Michigan Agricultural College, receiving the degree of M. S. in 1864. He was promoted to the professorship of botany and horticulture in 1865, and held this place until called to the professorship of botany, arboriculture and horticulture in Cornell University, at the opening of the University, in the autumn of 1868. He entered upon his work in this new field with enthusiasm and planted the first autumn seeds of a number of species of trees for a nursery to provide trees for beautifying the grounds. Many of these trees were transplanted in various parts of the campus, but the rapid growth of the University has called for their displacement to provide room for buildings, so that now but three pine trees remain of this original nursery, which are of the same age as the University.

Prof. Prentiss' work has been given largely to teaching and to the supervision of the large grounds of the University, and there are not many published papers of his. In 1871 he wrote an essay on the 'mode of the natural distribution of plants over the surface of the earth,' which won the first Walker prize offered by the Boston Society of Natural History, and was published in pamphlet form. Later, at the request of Prof. B. E. Fernow, Chief of the Division of Forestry, U. S. Department of Agriculture, he prepared an extended monograph of the hemlock (*Tsuga canadensis*), that has not yet been published.

In 1872 he studied for six months in the Royal Botanic Garden at Kew, London, and in the Jardin des Plantes, Paris.

Prof. Prentiss was one of the members of the 'Cornell Exploring Expedition,' as it usually is called, which was organized by Prof. C. F. Hartt, the then professor of geology in Cornell. This expedition was made possible largely by the generous gift of funds by the Hon. Edwin Barber Morgan, of Aurora, N. Y., and is known in University history as the 'Morgan Expedition.' The party sailed from New York the latter part of June, 1870, explored the valley of the Amazon for a distance of about 400 miles above Pará, as well as the rivers Chingu and Tapazos, two of the principal tributaries of the Amazon. Prof. Prentiss thus had an opportunity of studying the tropical flora, and of making collections for the department. The party returned early in January, 1871. Among the large number of students who have received instruction from him, many have become botanists or teachers of botany, and a noteworthy list of names of these persons might be presented, several of whom occupy some of the most prominent botanical positions in America. In his lectures he was deliberate, clear and concise in his statement, and an easy and fluent speaker. His dignified bearing led many at first to regard him as unsympathetic, but those who came to know him well regarded him as a most delightful companion.

His keen interest in the work of the individual student, and his well chosen words of approval and encouragment kindled enthusiasm among his pupils, and stimulated them to renewed effort. The same gentle and elevating influence, with his cultivated and refined taste, exerted upon his pupils, also was felt in his home and in his social life, and it is to be regretted that the lack of a strong constitution and reserve power, coupled with failing health for a number of years, prevented the production of work and publications which otherwise might have been expected of a man who possessed such culture and natural gifts.

Geo. F. Atkinson.
Cornell University.

CURRENT NOTES ON PHYSIOGRAPHY.

WATERWAYS OF ENGLISH LAKELAND.

Under the above title J. E. Marr discusses the origin of the river courses in the lake district of northwestern England (London Geogr. Journ, vii., 1896, 602–621). The chief streams are thought to have been superposed on the deformed paleozoic rocks of the region from an unconformable cover of the younger strata ; Marr advocating the former occurrence here of Cretaceous or even of Eocene beds. Subordinate streams are subsequent, being developed along weak strata or along faulted belts. The lake basins, large and small, are not explained by glacial erosion, but by drift barriers ; fuller evidence on this point being promised. The gradual retreat of the Pennine escarpment, and the beheading of the Tees headwaters by the steep 'gills' that descend to the Vale of Eden, are incidentally described.

In certain paragraphs there does not appear to be sufficient appreciation of the long perspective of events involved in the history of so old a region as Lakeland. The upper part of river Lune, flowing from carboniferous rocks to the higher-standing paleozoic beds of Howgill fells, is given as an example of antecedent drainage. Several branches of the Lune, that flow from the thrown to the heaved side of the great Dent fault, are likewise explained as antecedent. Here the possibility that many cycles of erosion elapsed since the ancient rocks of the region were deformed and faulted is not clearly set forth. Yet, during these cycles, it is quite possible that the land forms initiated by the ancient deformation, and the river systems antecedent to or consequent upon these land forms, may have suffered extensive alteration; the lands may have been more than once uplifted, dissected and peneplained; they may have been drowned, buried, uplifted and stripped; and the rivers may have lost their initial courses by spontaneous adjustments to internal structures, by superposition, or by displacement through warping of the land surface. The problem is not simple enough to be decided merely by the direction of a stream with respect to the heaved side of a fault.

ORIGIN OF LAKE ZURICH.

THE discussion of this problem by Aeppli has been noticed in SCIENCE. Preller now dissents from some of the conclusions of the Swiss geologists, and maintains that he has identified deposits of 'Deckenschotter' (first glacial epoch) in the trough of the lake valley, and hence that the valley must have attained its present general form by fluviatile erosion before the earliest glacial invasion (Q. J. Geol. Soc. London, lii., 1896, 556–586). He attributes the lake basin to a deformation of the valley, here following Heim and Aeppli. In curious contrast to Geikie and Wallace, who place no value upon such deformation or upon unequal subsidence, Preller allows glacial erosion no share in excavating the lake basin, and does not even present arguments for the exclusion of this important agency. The main points of this essay, the occurrence of 'Deckenschotter' in the deep valley trough, and consequently the great abbreviation of the first interglacial epoch, will doubtless be discussed by Swiss observers on the ground.

DUST AND SAND STORMS.

DUST and sand storms in the western part of the United States are described by J. A. Udden, with special reference to the geological significance of these phenomena (Pop. Sci. Monthly, Sept., 1896). He estimates that the dust in a cubic mile of lower air during a dry storm weighs at least 225 tons; while in severe sand storms the solid contents in the same volume may reach 126,000 tons. At Yuma, Ariz., any high wind, without rain, generally blows clouds of dust. At Ontario, Cal., there are from twelve to forty dust storms in a year. The brief dust squalls in the Eastern States, preceding a thunder storm, are in the arid region replaced by dust storms lasting twenty or thirty hours. One observer gives local color to his phrase: "A strong wind was made thick and yellow by flying real estate."

The physiographic value of the wind in drifting sand is illustrated in an account of the Takla-makan desert, Central Asia, by Sven Hedin (London Geogr. Journ., viii, 1896, 264–278). He finds that shallow lakes occur at the western base of the desert mountains, while the eastern base and slopes of the ranges are encumbered with sand hills, carried by the prevailing northeast or east winds. The widespread sand hills of our western plains were abundantly described by early explorers; for example, Warren, in 1855, '56 and '57, but they are less heard of to-day, when the railroads carry travelers quickly across the plains to the more varied scenery and problems of the mountains.

PHYSICAL GEOGRAPHY OF NEW YORK STATE.

THE American Geographical Society turns attention to home study in an essay by R. S. Tarr under the above title (Bull. A. G. S., xxviii., 1896, 99–129), the first of a promised and welcome series. The State is divided into eight provinces, named Long Island, Gneissic Highland, Taconic, Catskill, New York-Pennsylvania Plateau, Lake Shore Plains, Mohawk Valley and Adirondack; each of these is briefly characterized. The drainage system is then described. The geological development of the state is concisely explained in eight pages, and the essay closes with four pages on climate.

GEOGRAPHY FROM NATURE.

IN the same Bulletin, R. E. Dodge urges the importance of studying 'Geography from Nature' (p. 146–156), and mentions a number of localities near New York city where such study can be undertaken to advantage. Tarr advocates the same method, emphasizing the value of a training in field geology, in an article on the 'Teacher's Outfit in Physical Geography' (School Review, iv., 1896, 161–172, 193–201). With similar intention, the undersigned has prepared pamphlets on 'The State Map as an aid to the study of Geography in Grammar and High Schools,' published for distribution to all public school teachers by the Boards of Education of Connecticut and Rhode Island.

W. M. Davis.

Harvard University.

CURRENT NOTES ON ANTHROPOLOGY.

ORIGIN OF THE ANCIENT INDIAN ALPHABETS.

In the 'Mélanges Charles de Harlez', Prof. Friedrich Müller has an instructive article on the origin of the alphabets of ancient India. These may be traced to two early forms, one known as the Brahmi, the other as the Kharosthi writing. The latter is limited in area to a portion of northwest India, while the former extended in remote times over a much larger territory.

The paper makes it clear that the Karosthi alphabet was introduced under the Achæmenides from Ariana, and hence is comparatively modern; while the Brahmi at some very remote age was derived from the southern Semitic alphabets, and adapted to the needs of the Aryan tongue by the addition of characters for the vowels.

These views are confirmed by the presentation of a comparative table of the Indian with two north Semitic and two south Semitic alphabets. The analogies are well marked, and render it probable that the route of extension was by way of southern Arabia. The early connection of the region with India is also proved by the close relationship of the arts in photo-historic times.

EXPLORATIONS IN YUCATAN.

In number 10 of the current volume of 'Globus,' the experienced traveler Theobert Maler describes briefly the explorations he has made this year in southern Yucatan and along the upper Usumacinta river. They have been unusually productive in bringing to light ruined cities hitherto unknown. He crossed the boundary of Guatemala at Chuntuki, and reached Lake Peten at San Andres. Thence he made an expedition to Tikal, near which he discovered an important site, Motul de San José. Near Saiyanche, he came upon a series of ruins with enormous carved pillars. After visiting several less conspicuous localities he passed a few days in 'Lorillard city,' where he made some interesting finds.

In going by land from there to Tenosique he reached a massive series of pyramids and walls hidden in the forest, known to the hunters as Piedras Negras, but wholly unvisited by Europeans. This site presents an 'acropolis' of stately proportions with many surrounding lesser structures. In front of the temple were seven beautifully carved steles in good preservation. They were carefully cleaned and photographed. The inscriptions were numerous, showing close analogies to those at Palenque. On some the colors were yet distinct. There is a marked difference between the architectural details of this and the ruins on the river above, probably indicating contrast of secondary culture centers. Maler expects to spend the present autumn and winter in continuing these researches.

D. G. Brinton.

University of Pennsylvania.

ASTRONOMICAL NOTES.

The report of Dr. David Gill, Director of the Cape of Good Hope Observatory, upon the Geodetic Survey of South Africa, has been presented to the Cape Parliament. The Survey was executed by Colonel Morris, under the general direction of Dr. Gill. The volume contains about 450 pages, folio, and it will be of the greatest interest to astronomers and geodesists. Especially noteworthy is the great amount of work which has been accomplished in a comparatively short time. Such a record of speed, combined with equal precision, has probably never before been made.

Two theodolites were employed: An eighteen-inch by Troughton & Simms, and a ten-inch by Repsold. Dr. Gill reaches the following conclusions with regard to these two instruments:

1. That the employment of instruments larger and heavier than the Repsold ten-inch is attended with no advantage.

2. That observations should be made at each station equally in the morning and afternoon; if possible, also, in opposite directions of the wind.

3. That hardened steel pivots are essential.

4. That a watch telescope attached to the arms of the circle microscopes not only increases very materially the accuracy of the observations (even when the most rigid stand is employed), but it permits the use of a form of stand which is easy to erect and light and convenient for transport, without risk of diminished accuracy.

Many American geodesists will be surprised by conclusions 3 and 4.

Dr. Gill gives an interesting table of the probable error of a single angle, as obtained in various series of geodetic operations. Some of the values given are as follows:

	No. of Triangles.	Prob. Error.
South Africa, verification of Natal base,	5	±.″14
South Africa, prolongation of Port Elizabeth base,	24	.23
U. S. Coast Survey, San Francisco and Salt Lake,	31	.25
U. S. Coast Survey, flat country,	198	.79
Ordnance Survey of Great Britain,	476	1.19

It is interesting to note that the poorest work was done on the Ordnance Survey of Great Britain, according to Dr. Gill's table.

In Colonel Morris's report we find the following interesting statement concerning transport:

"The equipment of the observing part of the detachment consisted of:

1. A military ambulance wagon, drawn by 16 oxen.

2. An 18-foot buck-wagon, drawn by 16 oxen.

3. A Scotch cart, drawn by six oxen.

4. A water cart, drawn sometimes by two oxen, sometimes by four.

5. The four out-parties were each provided with a Scotch cart drawn by six oxen.

The minimum number of oxen was therefore 66. A few additional animals were, however, always kept to supply the place of those which tired or fell sick, or which died from one cause or another."

We strongly recommend anyone interested in geodesy to procure a copy of Dr. Gill's interesting and important work.

THE *Astronomische Nachrichten* of September 8th contains an article by Dr. J. Repsold, in which he describes the newest micrometer devised by his firm. It is an instrument intended to combine the new form of transit micrometer, in which an effort was made to avoid the effects of personal equation, with a new kind of registering declination micrometer. Dr. Repsold points out that it is very desirable to increase the precision with which declination bisections can be made in the field of view, so as to bring the bisection to the same order of accuracy attainable in the reading of the circle microscopes. H. J.

NOTES ON INORGANIC CHEMISTRY.

IN the current *Comptes Rendus* P. Villard describes a crystallized hydrate of argon with water. Argon is compressed to 150 atmospheres in the presence of water cooled to nearly zero. On chilling the tube at a small point crystallization begins proceeding out from the point cooled. Or crystallization may be induced by introducing a crystal of the hydrate previously formed. Crystallization does not take place, however, by merely compressing argon in the presence of cold water. The crystals are colorless and small, though easily visible with a lens. The tension of dissociation at 0° is about 105 atmospheres, at + 8° 210 atmospheres.

An account of the Jubilee of the Chemical Society of London, in 1891, has just been published by the Society in book form. It contains a record of the proceedings of the Jubilee meeting and also a full history of the Society. Abstracts are given of all the presidential annual reports, the subjects of all lectures before the Society, and the full text of the first Faraday Lecture, which was given in 1869 by Dumas, and which had never before been printed in the Society's publications. The whole volume, which includes 292 pages and gives the full history of one of the most important scientific societies of the world, will be found of value to all who are interested in chemistry.

A series of experiments has been carried out by Messrs. Dixon and Baker, having for their object the determination of the chemical activity of the Röntgen rays. Carbon monoxid and oxygen (dry and moist), hydrogen and oxygen, carbon monoxid and chlorin, hydrogen and chlorin, and dry hydrogen and sulfid and sulfur dioxid, were exposed half an hour to the rays; sparks were passed through dry carbon monoxid and oxygen, both with rays falling on the mixture and when they were not. In no case could any chemical effect of the rays be detected, hence the authors conclude that if there is any chemical activity of the rays it is too small to be measured. The action of the rays on the photographic plate they attribute to the fluorescence of the glass behind the film.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

The attendance at the Liverpool Meeting of the British Association was 3,181, distributed as follows: Old life members, 330; new life members, 31; old annual members, 383; new annual members, 139; associates, 1,384; ladies, 873; foreign members, 41. As had been already arranged, the meeting for next year will be at Toronto under the Presidency of Sir John Evans, beginning August 18th. The meeting in 1898 will be at Bristol and in 1899 at Dover. The sum of £1,355 was appropriated in grants for scientific purposes.

In addition to the lecturers in connection with the sesquicentennial celebration at Princeton, already announced, the exercises will be attended by a number of distinguished men of science as delegates from foreign universities. The names have not as yet been published, but include M. Henri Moissan, the eminent chemist from the University at Paris, and Prof. E. B. Poulton, professor of zoology at Oxford, and personally known to many Americans from his previous visit.

We learn from *Die Natur* that elaborate arrangements are being made in Portugal to celebrate the 400th anniversary of Vasco da Gama's discovery of the sea route to India. The 8th, 9th and 10th of July of next year are to be made national holidays and a number of expositions and congresses are to be held at Lisbon, including agriculture, ethnography, fisheries and hydrography. The event will also be celebrated by the Geographical Society of Vienna, before which an address will be made by Prof. Wilh. Tomaschek.

The Jubilee of the discovery of anæsthesia will be celebrated in France in connection with the meeting of the French Surgical Congress beginning October 18th. The event will also be celebrated in London and in Boston. The first surgical operation under ether was carried out by Dr. J. Collins Warren in the Massachusetts General Hospital on October 16, 1846. The anæsthetic was administered by W. T. G. Morton, who about two weeks before had extracted a tooth from a patient under the influence of ether.

It is stated that Lieut. Joseph E. Maxfield, Chief Signal Officer of the Department of the Missouri, and now stationed in Chicago, will soon make an ascent on a man-carrying kite, to be built by Octave Chanute. The ascent will be made in an arm-chair fastened to a portion of the kite's frame, and will be for the purpose of testing the efficiency of a flying kite for observation purposes, as an adjunct to the balloon service, which for some time has been an important part of the signal corps work.

ALTHOUGH the 300,000 frs. needed for the Belgian expedition to the polar regions has been collected, it was not found possible to make the necessary preparations, and the expedition has been postponed until July of next year.

THE Danish steamship *Inglof* has returned after two years spent in exploring the coast of Iceland. It is stated that scientific results of importance have been secured.

PRESIDENT JORDAN, with the British and American commissioners sent to study the condition of the seals in Behring Sea, has arrived at Seattle and is reported to have said that there is still a vast body of fur seals on the islands, more than the commissioners were first led to expect, but the number is steadily declining. The only cause of this decline is the killing of females through pelagic sealing. The females are never molested on the islands. Pelagic sealing, as an industry, has already cut its own throat, as the fleet this year will not pay expenses. The killing of surplus young males, as provided for by law, has always been a benefit to the herd. The commissioners believe that the way is open to an honorable and amicable settlement of this question in a manner highly satisfactory alike to the United States and England and to Canada. There can be no longer any difference of opinion as to any facts in question.

A DESPATCH to the daily papers from San Diego, Cal., states that the junk *Alta* has arrived from Lower California with Mr. E. A. Anthony, who went there in the interest of the Smithsonian Institution. He brings back a great quantity of shells, mosses and sea flora and natural history specimens, many of them entirely new to naturalists.

DR. DAVIS GARBER, professor of mathematics and astronomy in Muhlenburg College, Allentown, Pa., died on September 22d, aged 67 years.

DR. THEODOR MARGO, lately professor of zoology in the University of Budapest, died on September 6th, at the age of 80 years.

YEN MEN, a commissioner from the Emperor of China, is now in America collecting information regarding American manufactures and methods of transportation. He will also visit the principal countries of Europe.

A LABORATORY built for the Massachusetts General Hospital, Boston, at a cost of over $20,000, will soon be ready for use. The building is 25x97 feet, and includes well fitted laboratories of chemistry, bacteriology and histology. It is hoped that an additional sum of $100,000 will be collected for an endowment.

THE International Congress of Criminal Anthropology will next meet in 1901, at The Hague, at the invitation of the Dutch government.

THE Scientific Alliance of New York has issued its first bulletin for the year, giving the programs of the different scientific societies included in the Alliance for the month of October. Most of the societies give opportunities for report on work carried out during the summer. Prof. J. A. Allen will report to the Linnæan Society, on October 13th, on a visit to some of the natural history museums of Europe. On October 12th, before the Section of Biology of the New York Academy of Sciences, informal reports will be made by Dr. Bashford Dean and Mr. G. N. Calkins, 'On the Columbia University Zoological Laboratory upon Puget Sound;' by Prof. Henry F. Osborn, 'On the American Museum Expedition to the Puerco and Wasatch Beds;' and by Mr. William J. Hornaday, 'On a Tour of Inspection of Foreign Zoological Gardens.'

THE regular October meeting of the American Mathematical Society will be replaced by a special meeting to be held at Princeton, on Saturday, October 17th, at 3 p. m. Addresses will be made by Professors Felix Klein and J. J. Thomson.

THE following field meetings have been arranged by the Torrey Botanical Club: Oct. 3, Englewood, N. J.; leave foot W. 130th St., 1:15 p. m.; guide, Mr. Fay. Oct. 10, Forbell's L. I.; leave Montauk Ave. Station, King's County Elevated R. R., 1:30 p. m.; guide, Mr. Hulst. Oct. 17, Grant City, Staten Island;

leave foot Whitehall St., 1 : 30 p. m.; guide, Mrs. Britton. Oct. 24, Richmond Hill, L. I., L. I. R. R.; leave foot East 34th St., 12 : 50 p. m.; guide, Mr. McCallum. Oct. 31, Pelhamville, N. Y., N. H. and H. R. R., 1 : 30 p. m.; guide, Mr. Ericson.

The President and Secretary of the American Physiological Society have sent out an announcement calling attention to the fact that, at the Baltimore meeting of the Society in 1894, it was recommended that 'The Internal Secretion of Glands' be selected as a suitable subject for public discussion by the Society at the next Medical Congress to be held in Washington in the spring of 1897. At the meeting held in Philadelphia in 1895 it was voted that the President of the Physiological Society be empowered to communicate with the Association of American Physicans regarding a joint public session of the two Societies at the Medical Congress of 1897. In accordance with these instructions communication was had with the Association of American Physicians, with the result that the latter body has decided to join with our Society in a public discussion of the above subject at the Medical Congress of 1897. The details of this joint session, so far as the Physiological Society is concerned, are to be arranged by the Council of the Society; but members of the Society are reminded of the importance of carrying out research along the lines covered by the subject chosen for discussion, and it is suggested that the results might be reported on at the December meeting.

A meeting of the Texas Academy of Sciences was held on October 2d, at which the annual address by the President of the Society, Dr. J. Bruce Halsted, was given, the subject being 'Life and Science in Russia.'

The American Institute of Electrical Engineers held its first meeting for the season on September 30th. The President, Mr. Lewis Duncan, made an address on 'The Present Status of Power Transmission.'

A course of eight lectures, mainly upon science and travel, has been arranged by the Feld Columbian Museum for Saturday afternoons in October and November. The lectures are as follows: Oct. 3, 'Archæological Explorations in Peru,' Dr. G. A. Dorsey, Assistant Curator of Anthropology, Field Columbian Museum. Oct. 10, 'A Trip to Popocatapetl and Ixtaccihuatl,' Prof. O. C. Farrington, Curator of Geology, Field Columbian Museum. Oct. 17, 'San Domingo,' Mr. G. K. Cherrie, Assistant Curator of Ornithology, Field Columbian Museum. Oct. 24, 'Egypt and What We Know of Her,' Dr. J. H. Breasted, Instructor in Egyptology and Semitics, University of Chicago. Oct. 31, 'The Petroleum Industry,' Dr. D. T. Day, Chief of Division of Mineral Resources, U. S. Geological Survey. Nov. 7, 'Alaska and its Inhabitants,' Prof. George L. Collie, Beloit College, Wis. Nov. 14, 'The Economic Geology of the Sea,' Mr. H. W. Nichols, Curator of Economic Geology, Field Columbian Museum. Nov. 21, 'The Physical Geography of New England,' Dr. H. B. Kümmel, Assistant Professor of Physiography, Lewis Institute.

The daily papers state that the great engineering work of removing the obstruction in the Danube known as the Iron Gates, between Alt-Orsova, in Hungary, and Gladova, in Servia, has been finally accomplished, and on September 11th the river was opened to navigation with elaborate ceremonies by Emperor Francis Joseph, accompanied by the Kings of Rumania and Servia. The program included a procession of steamers through the Iron Gate.

The Report of the Tenth Annual Meeting of the American Association for the Advancement of Physical Education contains a number of papers on anthropometry. The Association, through its Committee on Anthropometry and Statistics, is doing a good work in systematizing and improving the anthropometric methods applied in gymnasia. The following are the titles of anthropometrical papers in the present volume: 'Anthropometry Individualized,' by David P. Lincoln, a plea for investigating the laws of growth by studying the growth of individuals, rather than by the generalizing method. 'The Growth of Boys,' by Schuyler P. Moon, a discussion of the proportions of the body during the period of growth. Bowditch's 'Law of Growth and What it Teaches,' by E. M. Hartwell, in which attention is drawn to the correlation between mortality and freeness from certain disorders and the rates of growth. 'Proposed Standard Chart of Proportions of American Females,' by Anna Richards and Bessie Belle Little. 'What Nervous Tests shall we use to Complete the Picture of the Individual?' by G. W. Fitz. 'The Use of Anthropometrical Measurements in Schools,' by Wm. T. Porter.

THE first number of the *Journal of Physical Chemistry* has now been published by the editors, Professors Wilder, D. Bancroft and Joseph E. Treevor. It contains articles by Mr. A. E. Taylor and Prof. Bancroft in continuation of work on Irreversible Cells and on Ternary Mixtures previously published in *The Physical Review* and on Chemistry and its Laws by Dr. F. Wald, starting from Prof. Wolcott Gibbs' propositions concerning the equilibrium of missible substances. 18 pages are devoted to reviews written by a special board consisting of Messrs. W. Lash Miller, E. H. Loomis, C. L. Speyers and R. B. Warder, in addition to the editors. The *Journal* will be issued monthly with the exception of July, August and September, and will contain from 48 to 64 pages.

AT the recent meeting of the British Association Prof. Ramsay read a paper on helium, in the course of which he gave an account of his experiments undertaken with a view to determining the character of helium by comparison with hydrogen, oxygen, argon, acetylene and other gases. He has obtained the remarkable result that different samples of helium have different densities, which indicate that helium may be a mixture of two gases.

Appletons' Popular Science Monthly for October opens with an article by President Mendenhall, in which he reviews seriatim the letters by Mr. Herbert Spencer first printed anonymously in the London *Times* and subsequently, under Mr. Spencer's signature, in the *Monthly.* President Mendenhall finds no difficulty in answering the rather weak arguments of Mr. Spencer, which, indeed, have under his hands the appearance of men of straw set up on purpose to be knocked down.

Nature states that letters have been received from Prof. Sollas, by the Chairman and Secretary of the Coral Reef Boring Committee of the Royal Society, which show that, so far as the main object of the expedition is concerned, the effort has been an almost complete failure. When the party had landed on Funafuti from the 'Penguin,' they selected the most promising site, as it appeared, for a bore-hole. The apparatus was landed and set up, and a bore-hole carried down to a depth of about 65 feet, when further progress became impossible, for material like a quicksand was struck, which choked the bore-hole. Very little solid coral rock was pierced. To pass over the steps then taken, it may be enough at present to say that another attempt was ultimately made nearer to the edge of the island, where there appeared some hope of finding more solid coral rock. This boring was carried down to 72 feet, and then similar difficulties prevented further progress. The material struck was a kind of quicksand containing 'boulders' of coral. As fast as the sand was got out, fresh material poured in, and the water pumped down the tube, with a view of cleaning it, actually flowed out into the surrounding bed, while the coral boulders made it impossible to drive the tubes through the quicksand. So far as the reef was pierced it appeared to be not solid coral, but more like a 'vast coarse sponge of coral with wide interstices, either empty or sand-filled.' Although the expedition has failed in its main object, it has met with great success in all the others. Large collections have been made. Messrs. Gardiner and Hedley have thoroughly investigated the fauna and flora, both land and marine, of the atoll. Dr. Collingwood has obtained information of ethical interest, and Captain Field a series of soundings, both within and without the atoll, which Prof. Sollas states are more complete than have yet been obtained, and must greatly modify our views as to the nature of coral reefs. Of all these matters it would be premature to speak, till Prof. Sollas has returned and been able to give fuller particulars, and Captain Field has reported to the Admiralty.

THE *British Medical Journal* states that a new and unexpected agency is having a most beneficial effect in contributing to the abatement of the smoke nuisance in London. The relative clearness of the London atmosphere within the last twelve months has been plainly apparent, and the smoke cloud which obscures the London atmosphere appears to be progressively lightening. Mr. Ernest Hart, Chairman of the Smoke Abatement Exhibition in London, frequently pointed out that the greatest contributors to the smoke cloud of London were the small grates of the enormous number of houses of the poor, and a great deal of ingenuity had been exhausted with relatively little success in endeavoring to abate this nuisance. The use of gas fires was urgently recommended, but had hitherto been difficult, owing to its cost and the want of suitable apparatus. The rapid and very extensive growth of the use of gas for cooking as well as lighting purposes by the working classes, due to the introduction of the 'penny in the slot' system, is working a great revolution in the London atmosphere. During the last four years the South London Gas Company alone has fixed 50,000 slot meters and nearly 38,000 small gas cooking stoves in the houses of the workingman.

UNIVERSITY AND EDUCATIONAL NEWS.

The faculty of Cornell University has resolved that, in place of the degree of Master of Arts, Master of Philosophy, Master of Letters and Doctor of Sciences, the one degree of Master of Arts be conferred; and that in place of the degree of Doctor of Philosophy and Doctor of Sciences, the one degree of Doctor of Philosophy be conferred.

Prof. Collier Cobb contributes to *Appletons' Popular Science Monthly* for October an interesting article in which he calls attention to the modern plan of instruction in the sciences offered by the University of North Carolina more than one hundred years ago. The course planned in 1792 gave great prominence to scientific studies, especially those which could be applied to the arts. The report of the committee recommended the purchase of apparatus for experimental philosophy and astronomy, in which must be included a set of globes, barometer, thermometer, miscroscope, telescope, quadrant, prismatic glass, electrical machine and an air-pump. The ancient classics were made elective, the degree of B. of A. being obtainable without the study of either Latin or Greek.

Dr. D. K. Pearsons, who had promised $10,000 to the trustees of the Mount Holyoke Association, has agreed to give them $40,000 for the building fund.

Garden and Forest states that the name of the donor of the new range of greenhouses recently completed for the department of botany of Smith College has up to the present not been announced. Last week, however, a bronze tablet placed at the entrance of the Palmhouse bears this inscription: 'The Lyman Plant House. A Memorial Tribute to Anne Jean Lyman, by her Son, Edward Hutchinson Robbins Lyman.'

It is proposed to create a chair of biology in the University of Christiania, to be filled by Mr. Nansen.

A number of promotions and new appointments have been made at the Massachusetts Institute of Technology. Four associate professors have been advanced to full professorships. Dwight Porter, in Hydraulic Engineering; Alfred E. Burton, in Topographical Engineering; C. F. Allen, in Railroad Engineering, and Peter Schwamb, in Mechanism. Linus Faunce has been appointed Associate Professor of Drawing. Four new assistant professors have been appointed: George H. Barton, in Geology; William H. Lawrence, in Architecture; George G. Robbins, in Civil Engineering, and Joseph J. Skinner, in Mathematics. Seven assistants have been raised to the rank of instructors. They are William J. Drisko, in Physics; George B. Haven, in Mechanical Engineering; Frank P. McKibben, in Civil Engineering; Alexander W. Moseley, in Mechanical Engineering; James F. Norris, in Organic Chemistry; Joseph W. Phelan, in General Chemistry, and Samuel C. Prescott, in Biology, and in addition A. W. Weysse has been made Instructor in Biology. Fourteen new assistants have been appointed, as follows: In Civil Engineering, Reuben E. Bakenhus, Minor S. Jameson, Charles M. Spofford and Harold C. Stevens; in Geology, Amadeus W. Grabau; in Industrial Chemistry, Leonard W. Goodhue and Harrison W. Hayward; in Mechanical Drawing, Albert J. Wells; in Mechanical Engineering, Edward M. Bragg and Frank B. Masters; in Oil and Gas Analysis, William L. Root; and in Physics, George K. Burgess, William D. Coolidge and Ralph R. Lawrence.

Dr. E. Lesser has been appointed associate professor of dermatology at Berlin and Dr. Chermak to the chair of comparative anatomy and embryology at Dorpat. Dr. Winkler, professor of chemistry, has been appointed director of the School of Mines at Freiberg i. S., and Dr. Godschmidt has been promoted to an assistant professorship of chemistry in the University of Heidelberg.

DISCUSSION AND CORRESPONDENCE.

THE STRAIGHT LINE AS A MINIMUM LENGTH.

To the Editor of Science: In looking over the beautiful new text-book of geometry by Profs. Phillips and Fisher one meets with the following proposition of spherical geometry:

The shortest line that can be drawn on the surface of a sphere between two points is the arc of a great circle, not greater than a semi-circumference, joining these points.

The demonstration given is one which has been given before. It appears, for example, in the treatise of Chauvenet (1869) and also in that of George Bruce Halsted (1885). In connection with this demonstration, the reader can hardly escape noticing that every step of it applies equally well to plane geometry. In fact, it is perfectly easy for any student of Euclid's Elements to construct, step by step, a precisely similar proof of the corresponding proposition of plane geometry:

The shortest line that can be drawn between any two points is the straight line which joins them.

The definition of a straight line given by Profs. Phillips and Fisher, therefore, embodies a statement capable of deduction from the geometrical axioms by a chain of logical reasoning, and as a definition, is on strictly scientific grounds, quite indefensible.

Upon examining Prof. Halsted's book, the definitions of which more closely conform to the Euclidean models, one naturally wonders why this demonstration, even more simple in plane than in spherical geometry, has been introduced only in connection with spherical geometry; and one is led to inquire at how early a point the proposition of plane geometry could properly be introduced.

In attempting to establish between any two lines a relation of equality or inequality, we find ourselves compelled to start from the following principles: *The whole is greater than any of its parts; The whole is equal to the sum of all its its parts; Lines which may be placed so as to coincide are equal.* Using these principles alone, it is evident that we cannot compare every two arbitrary lines in magnitude. In any such comparison we must be able to place one of the lines, or portions of it, in complete or partial coincidence with the other. No direct comparison can be instituted, for example, between a straight line and a line no part of which is straight. For the purposes of the proposition in question, therefore, it is necessary to make the distinct assumption, that *the magnitude of every line is comparable with the magnitude of every other line, and between these magnitudes there exists a relation either of equality or of inequality;* or else, what is better, to await the method of limits and the development, by means of it, of metrical ideas, not only for straight lines, but also for curves. Prof. Halsted, accordingly, in spite of his apparent lateness in introducing the proposition, is guilty of an error in theory. He has attempted to give a complete discussion of a proposition, and appears to believe that he has done so, when in reality assumptions additional to those previously made must be introduced before such a discussion can be undertaken.

It seems worth while to make these criticisms, because the two books above referred to are at other points remarkable for their scientific accuracy, and are of so high an order of excellence generally that the student may not readily appreciate the existence of such errors as occur.

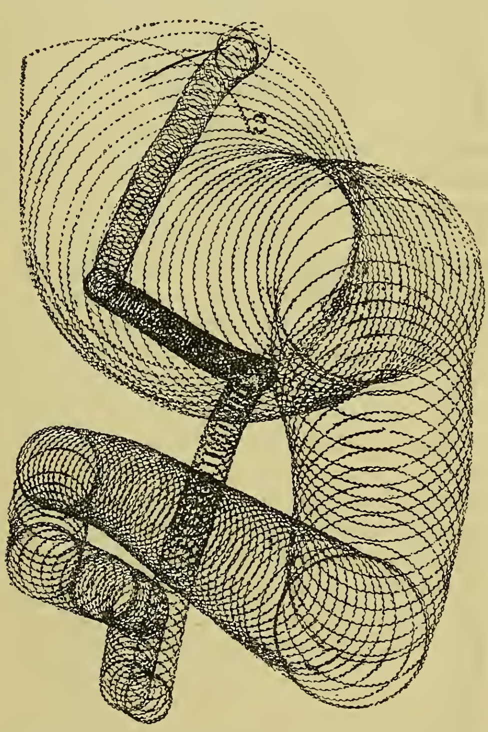
Thomas S. Fiske.

September 30, 1896.

'A CURVE-TRACING TOP,' AND A CURIOUS OPTICAL ILLUSION.

Editor of Science: If Prof. Barus will use a smoked glass for his curve-tracing top to spin on, he will get more beautiful tracings than with any lead pencil arrangement. Then let him flow it over with *thin* demar varnish, and dry; the tracings will be permanent and can be photographed or printed directly by transmitted light. Some ten years ago I had a top made from an excellent gyroscope by removing the supporting ring and fitting a socket on one arm of the axle, in one end of which (the socket) was a female screw. I also had several 'points' made of hardened polished steel, one ending in a very fine point, one in a truncated cone $\frac{1}{20}$ of an inch across the smaller base, others smaller and one in a hemisphere say $\frac{1}{4}$ of an inch in diameter.

These were made to screw into the socket, and the whole most carefully centered by the very best mechanical skill to be had. It was set in motion as humming tops usually are, with a string and wooden handle.



I send you a few of my tracings, with the sharp point.* The abrupt changes in direction are due to my tilting the glass, and are always approximately perpendicular to the inclination, but never exactly so. In the tracings which I send you they begin at the larger curve and grow smaller as they progress. In a few cases, very few out of hundreds, this is reversed. The very small undulations, which are so marked a feature in most of the spirals, are due to minute nutation and precession resulting in the larger effects, as the minute movements of the earth result in the grand precession of the equinoxes.

Sometimes the smaller movements are so very small that they leave no visible traces. All that is seen is what I may call the secondary curve. Sometimes even that so nearly disappears that the path becomes to the eye a straight line.

If the glass plate is 'level,' *i. e.*, approximately so, interesting figures are traced, oblique spirals I may call them, *i. e.*, spirals traced about a point which is not quite stationary.

At first glance they appear merely like flat spirals out of center. Looking at one of them steadily, with one eye or both, you look into a deep basket resting on its smaller end. Look a little longer, and without knowing how it happens, the basket is reversed, it rests on the larger end, and you see only the small bottom and the outside.

Look longer, and without seeing any change you are looking again into the basket.

Now look at the figure with both eyes, but as if focussed for a distant object. You will see two baskets, and probably both in the same position, *i. e.*, both with the small end, or both with the large end, toward you. Keep looking; move the paper quickly a little in any direction, both will reverse; if you have good luck, with a little practice, you will soon get it. Look a little longer. One basket will stand on the small end, and the other on the large one. Focus the eyes on them or near by, and there will be only one basket. This is all well shown in the short spiral I send you.

Double images are common enough, but the new and singular thing is that they appear to each eye so different, and that all these changes take place without effort. You do not see them change, but only that they are changed.

C. B. WARRING.

SEPTEMBER 26, 1896.

*These were made so long ago that I cannot be certain whether the sharpest point was used, or one that measured $\frac{1}{50}$ of an inch across its face.

EMBRYOS OF THE SMOOTH DOGFISH (GALEUS CANIS).

DURING the early part of September, while working on some integumentary structures of the selachians at the Marine Biological Laboratories, Woods Holl, Mass., I was fortunate enough to secure two female dogfish which had been kept during the summer in the U. S. Fish Commission aquaria. Each fish measured 1.07 m. from the end of the snout to tip of tail. On opening their body cavities I secured three embryos from one and four from the other, the smallest measuring 84 mm., the largest 89 mm. The specimens had well-developed external gills, and were attached by long spirally twisted umbilical cords to the yolk sac, which was still filled with abundant yolk material. One of the embryos has been drawn by Mr. Hayashi, the laboratory artist, and serial sections have been made of another. Fuller description and figures will be given in my paper on the Ampullæ of Lorenzini of the Selachian Fishes.

The condition of the genital organs of the females was interesting. In the first specimen the three embryos were all contained in the right uterus, the left being empty, although the walls of the latter were thickened and highly vascular. At the anterior end of the body cavity the dorsal region of the right ovary was distended with immature eggs. Five of the eggs, varying in diameter from 8 mm. to 15 mm., were supplied with yellow yolk, and were doubtless to be the eggs for next year's young. Other white spherical bodies, presumably very immature eggs, in size from $\frac{1}{4}$ mm. to 5 mm., were thickly imbedded in the stroma of the ovary. Both uteri were developed equally in the second specimen, each carrying two embryos.

These facts seem to throw some light on the breeding habits of this fish and suggest a means of securing the stages now much needed in the study of the development of the nervous system.

The smooth dogfish is very abundant at Woods Holl throughout the spring and is supplied to the laboratory in great quantities from the fishtraps. This species is viviparous, and if the adult females are dissected in May or early June they are found to carry eggs in the earlier embryonic stages. During July the dogfish begins to leave these shores, and in August it is impossible to get any material. Where the fish spends the winter is not known. The embryos secured during the latter part of July average 10–20 mm., or at most 40 mm. in length. So far as I know, sizes larger than this have not been taken before along the south shore of Massachusetts. When the fish reappear in the early spring the embryos have reached the 'pup' stage, 15–20 cm. in length, and are often born while the fish are in the traps. I have never seen the 'pups' in the uterus of the female later than May.

Hence it seems certain that the breeding habits of *Galeus* are as follows: Eggs which have received their yolk in the ovary during the previous year begin their development in the uterus in late spring. The embryos are carried in the body of the mother until the next April or May, when the young 'pups' are extruded.

It is probable, therefore, that embryos of any required length may be obtained if the large females are secured in April or May, confined in as natural surroundings as possible, and killed when the young have reached the stage of development desired.

JAMES E. PEABODY.

WOODS HOLL, September 10, 1896.

THE LAW OF RHYTHMIC MOVEMENT.

IT has long been known that in such rhythmic movements as walking, running, etc., a certain frequency in the repetition of the movement is most favorable to the accomplishment of the most work. Thus, to go the greatest distance in steady traveling day by day the horse or the bicyclist must move his limbs with a certain frequency; not too fast, otherwise fatigue cuts short the journey, and not too slow, otherwise the journey is made unnecessarily short. This frequency is a particular one for each individual and for each condition in which he is found. Any deviation from this particular frequency diminishes the final result.

Some measurements that I have already made on natural and unnatural rhythms have suggested a law governing the amount of deviation from the natural rhythm and the resulting loss.

The rhythm used is that of a movement of the forearm. A series of movements is made in a natural rhythm, then other series in unnatural rhythms. The average and the mean variation (mean error) are computed for each series. The psychological mean variation (all apparatus errors being rendered negligible) is a good measure of the subject's irregularity or of the difficulty of his mental processes. Using the mean variation thus as a measure of the disadvantage of a rhythm, we can express the relation of disadvantage to length as $m = f(r)$ where m is the mean variation and r the length of the rhythm. Now, the law that I believe myself able to assert is

$$\frac{m}{\text{abs }(r-R)} = \text{const.}$$

where m and r have the same meanings as before, R is the length of the natural rhythm and abs indicates that the sign of the quantity is disregarded. In other words, the amount of irregularity is proportional to the amount of deviation from the natural rhythm.

The full proof of the law with a determination of the constants I hope to furnish during the coming year. E. W. Scripture.

Yale University, September 20, 1896.

SCIENTIFIC LITERATURE.

The American Lobster: A Study of Its Habits and Development. By Francis Hobart Herrick.

This monograph, issued as a portion of the Bulletin of the U. S. Fish Commission for 1895, has over 250 pages of text and 64 plates, and represents the work of the author as an investigator of the U. S. Fish Commission from 1890 to 1895. Its general appearance is quite up to the improved standard of the more recent government publications. The typography is good and many of the plates are really excellent.

It is presumed that the publications of the Fish Commission will have some practical bearing upon the innumerable problems of fish-culture, and Dr. Herrick has not confined himself to mere questions of morphology and embryology, but, following the suggestion of Prof. Rathbun, has endeavored to determine the *natural history* of this most important and strangely persecuted invertebrate; and it is to be hoped that with these natural data at hand the government will adopt some rational method of experimentation which shall finally lead to successful lobster culture.

In the Introduction the author considers the immediate questions of nomenclature, the methods of lobster capture, and the rise and inexcusable decline of the lobster fishery in America.

Chapter II. deals at considerable length with the general subject of reproduction. The essential and secondary organs are described, the peculiar pairing habits of certain Crustacea are mentioned, and the methods of oviposition are discussed. In describing the spermatozoa the author writes: "The sperm cells have a characteristic shape and are absolutely immobile in the conditions under which they are ordinarily observed, but it is impossible to suppose that this is always the case." The reviewer has seen the spermatozoa in active movement, swimming across the field of the microscope with the same nervous contractions that are characteristic of the Hydromedusæ.

The facts collected in reference to the time of egg-laying and period of incubation are very complete, and indicate the time when artificial hatching should commence. We cannot, however, agree with the author that there are at present adequate data for the assumption that eggs are frequently deposited during the fall and winter. When the temperature of the water is known to be so important a factor in the rate of development, and when the range of temperature variation is from 35.5° F. in February to 71.4° F. in August, it is extremely hazardous to estimate the actual age of 'winter' embryos from the known age of those whose growth has been accelerated by the warmer water of midsummer.

The data illustrating the law of production, arranged in Table XV., have been gathered from an examination of 4,000 adult lobsters, and represent a vast amount of work. The rearrangement of this material in other tables, and the author's conclusions regarding the period of greatest fertility, are especially instructive.

In dealing with the destruction of the egg-lobster and its spawn, it is to be regretted that

Dr. Herrick has not expressed disapproval of the destructive methods of 'lobster-hatching' that have been practiced in certain hatcheries for several seasons past.

The subject of molting and the function of the gastroliths are exhaustively treated, the literature reviewed, erroneous ideas corrected, and many interesting observations recorded.

In Chapter IV., on the Regeneration of Lost Parts, we read, "the new limb appears to arise mainly by growth of the connective-tissue cells already present in the stump;" and, further on, "the fibrous tissue becomes gradually differentiated into the muscles, blood-vessels and nerves, as in an embryo." It is unfortunate that figures are not given illustrating this method of regeneration. The sections on Variation will supply valuable material for one interested in the lines of investigation outlined by Bateson.

Chapters XI.–XIII. deal with general questions of crustacean development and larval life, and are excellently illustrated by prints and colored plates.

We may add in conclusion that, from the breadth of the field covered, Dr. Herrick's paper will be frequently consulted, not only by those devoted to artificial fish-culture, but by working naturalists, whether embryologists, physiologists or students of variation.

H. C. BUMPUS.

BROWN UNIVERSITY.

ISOPENTANE AND HEXANE.

The Thermal Properties of Isopentane. By SYDNEY YOUNG, D. Sc., F. R. S., University College, Bristol. (Communicated to the Physical Society of London.)

The isopentane employed in this research was procured from Kahlbaum, of Berlin; the substance is obtained as a bye-product in the manufacture of amylene from amyl alcohol by the action of zinc chloride. The isopentane was purified by repeated agitation with concentrated sulphuric acid and with a mixture of sulphuric and nitric acids and by subsequent fractional distillation.

The vapor pressures were determined at temperatures from —30° to the critical point, 187.8°; the orthobaric volumes of a gram of liquid from 0° and of saturated vapor from 10° to the critical point; and the volumes of liquid and of unsaturated vapor between wide limits of temperature and pressure.

The experimental methods employed are described in the original paper and, in regard to pressure, the error due to the vapor pressure of mercury is fully discussed. The volumes of a gram of liquid and vapor were plotted against the pressure and from the isothermals isochors were constructed; it was found that at large volumes and just about the critical volume the isochors were straight, at any rate within the limits of experimental error, but that at volumes smaller than the critical volume the values of $\frac{dp}{dt}$ increased slightly with rise of temperature, whilst at volumes greater than the critical volume they diminished slightly with rise of temperature.

The formula $p=b\mathrm{T}—a$ at constant volume (Ramsay & Young, Phil. Mag., 1887, 435, *cf.* Amagat, Compt. Rend., 94, 847), is therefore not quite, though very nearly, true for isopentane, and the results seem to confirm the conclusion arrived at by Amagat in the case of the substances examined by him that the values of b are not absolutely constant.

Values of b and $\frac{10,000}{bv}$ and of a and $\frac{10^{10}}{av^2}$ for volumes of a gram from 1.58 to 4000 cub. cms. are given in the original paper.

The absolute temperatures (boiling points) and molecular volumes of liquid and saturated vapor were read from the curves at pressures 'corresponding' to those adopted in previous papers on the 'Generalizations of Van der Waals regarding Corresponding Temperatures, Pressures and Volumes,' (Phil. Mag., Feb., 1892, 153; Jan., 1894, 1; Trans. Chem. Soc., 63, 1191) and the ratios of the temperatures and volumes to the critical constants were calculated. The ratios prove that isopentane belongs to Group I in the classification of substances previously adopted (Phil. Mag., Jan., 1894, 1).

The ratio of the actual to the theoretical density at the critical point, 3.73, agrees well with the ratios for the other members of Group I (3.65 to 3.83), and with that for carbon dioxide (3.62) deduced from Amagat's observations.

From these results it may be concluded that the molecules of liquid isopentane are simple, like those of the gas.

Specific Volumes of Isopentane Vapor at low Pressures. By SYDNEY YOUNG, D. SC., F. R. S., and G. L. THOMAS, B. SC., University College, Bristol. (Physical Society of London.)

The specific volumes at low pressures were determined in a Hofmann's apparatus, modified in such a manner that the volume as well as the temperature could be altered at will. This apparatus was first employed by Ramsay and Young (Phil. Trans. 1887 A. 58), but various improvements have been introduced, and are fully described in this paper.

Isopentane from Amyl Iodide. By the same authors. (Physical Society of London.)

A specimen of isopentane was prepared by the action of very concentrated hydrochloric acid (added drop by drop very slowly) and zinc slightly coated with copper on an ice-cold alcoholic solution of amyl iodide. The isopentane was purified by treatment with bromine and subsequent fractional distillation.

Determinations were made of the boiling point, specific gravity at 0°, the critical temperature and pressure and of the vapor pressures and specific volumes of liquid and saturated vapor at a few temperatures.

The boiling points, specific gravities and critical constants of both specimens of isopentane are given below:

	Isopentane from Amylene.	Isopentane from Amyl Iodide.
Boiling point (mean)......	27.95°	27.95°
Specific gravity at 0°.......	0.63924	0.63935
Critical temperature........	187.8°	187.8°
Critical pressure.............	25010 mm.	25030 mm.
Critical volume of a gram..	4.266 cb. cms.	——

The Vapour Pressures, Specific Volumes and Critical Constants of Normal Hexane. By the same authors. (Communicated to the Chemical Society of London.)

The normal hexane employed in this investigation was obtained from Kahlbaumit; it had been prepared by the action of sodium on propyl iodide. It was purified by treatment with mixed sulphuric and nitric acids and by subsequent fractional distillation.

The vapor pressures and the volumes of a gram of liquid and saturated vapor were determined at a series of temperatures, and the ratio of the absolute temperatures (boiling points) and the volumes to the critical constants were calculated at a series of pressures 'corresponding' to those previously adopted.

Like isopentane, normal hexane was found to belong to group I, and the molecules of liquid in this case also are probably simple like those of the gas. The ratio of the actual to the theoretical density at the critical point is 3.83.

As regards the comparison with isopentane, it is noticed that the absolute temperature ratios at 'corresponding' pressures are higher for the paraffin of higher molecular weight, and in this respect the paraffins seem to resemble the esters (Trans. Chem. Soc. 63, 1252), for which the ratios increase without exception with rise of molecular weight.

In the case of the esters the volume ratios appear to be independent of molecular weight, but, for isomeric compounds, to depend to some extent on the constitution. It seems probable that this may also be the case for the two paraffins studied, but an investigation of other paraffins will be necessary before these points can be decided.

The relations of pressure to temperature at constant volume were investigated through a small range of volume (from 9 to 33 cub. cms. per gram; critical volume = 4.268 cub. cms.), and it was found that with hexane as with isopentane the values of $\frac{dp}{dt}$ at these volumes diminish slightly on rise of temperature.

Normal Hexane from Petroleum Ether. By the same authors. (Chemical Society of London.)

An attempt was made to obtain a pure hexane from 'petroleum ether' by fractional distillation by the method employed by the authors in the separation of ethyl acetate from a mixture of methyl, ethyl and propyl acetates (Phil. Mag. Jan. 7, 1894, 8). A dephlegmator 125 cms. in length, with twelve constrictions (Chem. News, 77, 177) was employed.

Each fraction was weighed and its temperature range noted and corrected for the thermometric error and for the difference between the barometric reading and 760 millims. The ratio of the weight of any fraction ($\triangle w$) to its temperature range ($\triangle t$) gives, as a rule, a measure of the purity of the liquid, though in the early fractionations of a complex mixture this cannot always be relied on. Thus, in the 4th fractionation, the fraction coming over between 65° and 66° had the highest value of $\frac{\triangle w}{\triangle t}$, whereas in the 16th fractionation the corresponding fraction (65° to 66.85°) had the lowest value. In the first case a mixture of normal and iso-hexane was separating rapidly from the pentanes and heptanes in the petroleum ether; in the second considerable progress had been made in the separation of normal from iso hexane (B. P[s] 69°0 and about 61° respectively).

After the 16th fractionation it was decided to proceed at first with the separation of normal hexane only, and after the 31st preliminary fractionation it was considered that the separation had proceeded far enough for the final series of fractionations to be undertaken (*loc. cit.*).

The normal hexane obtained by the final fractionation of the fractions boiling at and above 69.1°, when distilled from phosphorus pentoxide, boiled at 69.1° or 0.1° higher than the hexane from propyliodide; its specific gravity at 0° was 0.68478 or 1.15 per cent. higher.

The hexane was, therefore, shaken repeatedly with a mixture of concentrated nitric and sulphuric acid, when considerable heat was evolved and some m-dinitrobenzene was formed. The impurity, which could not be separated by fractional distillation, was, therefore, benzene with, possibly, some hexanaphthene.

The other fractions were separately treated with the mixed acids and after further fractionation a product was obtained boiling at 69.05° and with the specific gravity 0.67813 at 0° or only 0.17 per cent. higher than that of pure hexane.

The boiling points, specific gravities and critical constants of the two specimens of normal hexane are given below:

	Normal Hexane from Propyl Iodide.	Normal Hexane from Petroleum Ether.
Boiling point	69.0°	69.05°
Specific gravity at 0°	0.67696	0.67813
Critical temperature	234.8°	235.15°
Critical pressure	22510 mm.	22560 mm.
Critical volume of a gram	4.268 cb. cms.	

SOME RECENT MEXICAN PUBLICATIONS.

MEXICAN men of science are doing much active scientific work, as is shown by the extent and value of the following publications:

1. *Biblioteca Botánico-Mexicana. Catalogo Bibliografico, Biografico y Critico de Autores y Escritos Referentes a Vegetales de Mexico y sus Aplicaciones, desde la Conquesta Hasta el Presente. Escrito por el* DR. NICOLAS LEÓN, Mexico, 1895.

This work of 375 pages is comparable to Sereno Watson's Bibliography of American Botany, issued a number of years since. The number of separate entries in the main alphabetically arranged list is 805, making, with those of the appendix (82), a total number of titles quoted of 887. The work aims at being a complete list of the floras and books, as well as papers and separates, dealing with the plants of Mexico published since the Conquest. A fair number of American authors are cited, and their botanical work reviewed briefly or at some length; among such may be mentioned Audubon, Bailey, Chapman, Eaton, Eggers, Engelmann, Gray, Parry, Pursh, Riley, Rose, Rothrock, Torrey and Trelease. Short biographical sketches of the botanists who explored Mexico, as far as known, are added, as also an account of their work while in the field and the extent and importance of their collections. Botanists of the United States, Canada and Europe not familiar with this comprehensive work would do well to procure a copy from the author or from the printer in the city of Mexico; Oficina Tip. de la Secretaria de Fomento.

2. *Informe que rinde á la Secretaria de Fomento. El Director del Instituto Médico Nacional* DR. FERNANDO ALTAMIRANO. *Sobre algunas excursiones á las Montañas del Ajusco y Serranía de las Cruces.* Mexico, 1895.

This pamphlet of some 64 pages gives an account of a new amphibian *Amblystoma Altamirani*, A.Dugès, with a colored lithographic plate of the same, as well as an account of an insect *Lachnus Strobus*, Fitch. The botanical portion deals with a description of the region of Ajusco and of Las Cruces explored, with an enumeration of the plants collected, as also meteorological tables showing the climate of Guadalupe, Ajusco, City of Mexico, and Hacienda de Eslava for July, 1895. A description of the plants new to the valley of Mexico forms a portion of the pamphlet, the following plants being noted, *Halenia candida* Ramirez and *Passiflora eslavensis* Ramirez. The pamphlet closes with a discussion of hydrology of the region, in which chemical analyses are shown of the potable waters, which might be introduced into use.

3. One of the most interesting publications recently issued by the National Medical Institute, under the auspices of the Secretary of Agriculture and the direction of Fernando Altamirano, is one dealing with the gradual disappearance of Lake Texcoco, which is being hastened by the drainage operations now being carried forward to completion. The publication entitled *Estudios referentes a la Desecación del Lago de Texcoco Año de 1895*, *Primera Parte*, is one of 126 pages, dealing first with the meteorology of the region and the rate of evaporation from the lake. The second portion deals with the fauna of Lake Texcoco, by Prof. Herrera, a most interesting study to the biologist; a discussion of the influence of malaria on the hygiene of the capital follows, with a description of the geography and climatology of the lake, presented by Dr. Domingo Orvañanos. Accompanying the report are a series of graphic tables illustrative of the evaporation and meteorology of the lake.

4. *Anales del Instituto Medico Nacional. Tomo I. Num. 8*, Mexico, 1896.

This number is devoted to Materia Medica, or a pharmaceutical description of certain Mexican plants, such as: *Aristolochia fragrantissima*, Ruiz., *A. fœtida*, H. B. K., *A. odoratissima*, L., *A. anquicida*, L., *Mikania Houstonis*, Wild., *M. scandens*, Wild., *Dorstenia contrayerba*, L., *Pluchea, odorata*, Cav., *Erynguim aquaticum*, L., *Poinsettia pulcherrima*, Graham, and a chemical study of *Jatropha spatulata*.

John W. Harshberger.
University of Pennsylvania.

NEW BOOKS.

Life Histories of North American Birds. Charles Bendire. Washington, Government Printing Office. 1895. Pp. ix + 518.

A History of Elementary Mathematics. Florian Cajori. New York and London, The Macmillan Company. 1896. Pp. viii + 304. $1.50.

An Outline of Psychology. Edward Bradford Titchener. London and New York, The Macmillan Company. 1896. Pp. xiv + 352. $1.50.

The Crowd, A Study of the Popular Mind. Gustave le Bon. New York, The Macmillan Company. 1896. Pp. xxiv + 230. $1.50.

Education of the Central Nervous System. Reuben Post Halleck. New York and London, The Macmillan Company. Pp. ix + 258. $1.00.

Elements of Solid Geometry and Mensuration. Henry Dallas Thompson. New York and London, The Macmillan Company. 1896. Pp. vii + 199. $1.25.

Röntgen Rays and Phenomenon of the Anode and Cathode. Edward P. Thompson and William A. Anthony. New York, D. Van Nostrand Company. 1896. Pp. xix + 190.

Report of the Sixth Meeting of the Australasian Association for the Advancement of Science, held at Brisbane, January, 1895. Edited by John Shirley. Published by the Association, Sydney, N. S. W. Pp. xxxiv+875.

Peru: Beobachtungen und Studien über das Land und seine Bewohner. E. W. Middendorf. Berlin, Robert Oppenheim. 1893, 1894, 1895. Vol. I., xxvii+638; Vol. II., xii+424; Vol. III., xv+603. M. 48.

Handbuch der Praktischen Gewerbehygiene mit besonderer Berücksichtigung der Unfallverhütung. Herausgegeben von Dr. H. Albrecht. Mit 756 Figuren. Berlin, Robert Oppenheim. 1896. Pp. xi+1053. M. 27.

Bulletin of the U. S. National Museum, No. 47: The Fishes of North and Central America. David Starr Jordan and Barton Warren Evermann. Part I. Washington, Government Printing Office. 1896. Pp. lx+1240.

SCIENCE

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CONTENTS:

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

THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS—ADDRESS BY THE PRESIDENT—THE EVOLUTION OF ECONOMIC ENTOMOLOGY.

THE earliest accounts of injuries caused by insects, so far as I have seen, are contained in the Old Testament, but nowhere in this work is it stated that attempts of any kind were made to destroy the insects or hold them in check in any way. In many instances the visitations of insects in large numbers were looked upon as plagues sent by the Almighty. Three of the plagues of Egypt, portrayed so vividly in the book of Exodus, were caused by insects, one by lice, one by flies and one by locusts, but in each case Pharaoh looked for and sought relief only by divine interposition through the good influence of Moses, 'the great lawgiver.'

In the book of Joel sundry judgments of God are declared, among which the devastations of insects are referred to with some detail. The prophet seems to take a pessimistic view of their work, and no hint is given, or even suggested, of any method of checking their ravages.

Aristotle, in his History of Animals, published about 200 years before the Christian era, while treating of insects, gives us nothing whatever of an economic nature concerning them.

Pliny, in his great work on the History of the World, published about the year 77 of the Christian era, has given much of interest concerning the work of insects and the methods of destroying them adopted in those times. In the eleventh book of this work, p. 327, it is stated that if the spring be wet and rainy the eggs of the locust, which have remained in the ground during the winter, perish and do not hatch. Pliny further says that whole armies of locusts often came from Africa into Italy, and many a time the people of Rome, fearing a famine, had recourse to the Sibylline books for a remedy and to avert the wrath of the gods. These books were supposed to contain the fate of the Roman Empire. In the Cyrenian province of Barbary it was ordered by law that all the inhabitants should wage war against the locusts, first by hunting for their eggs and crushing them, second by killing the young, and lastly by destroying the adults. A severe punishment was inflicted on those who neglected to perform this duty. On the island of Stälimni it was determined just what quantity each man should kill, and the full measure was required to be exhibited to the magistrate. The people made much account of the assistance rendered by the jays and other birds in destroying the locusts. This account given by Pliny is the earliest concerning the enactment of laws for the destruction of insects that I have anywhere found.

This is more in accordance with our modern ideas on economic entomology than the remedy given by Cato for caterpillars on fruit trees, which was to moisten the tips of the twigs with the gall of a green lizard, or the remedy for canker worms given by Pliny, which was to hang the bones of a mare's head on the pales around the garden. He emphasizes the fact that the bones must be those of a female, as those of the male would prove of no avail. It appears that the common people needed special cautioning in these matters in the days of Pliny just as they do to-day.

In the twenty-fifth book, chapter five, Pliny says that if white hellebore be powdered and put into milk all the flies that eat of it will be destroyed. This is the earliest mention I have found of the use of white hellebore as an insecticide. I do not know who claims the honor of the discovery of hellebore as an insecticide in modern times.

The next account in order of time that I have been able to find is given by Berg in his History of the German Forests. In the year 875 hosts of grasshoppers appeared on the Rhine and destroyed all the grass and grain. The remedies employed for their destruction were by the priests, who went in procession around the infested fields, carrying holy relics and making intercessory prayers, 'but,' adds the chronicler, 'it was of no avail.' This was said to be the oldest record to be found of methods of treating insects in German lands, and was taken from the Bavarian chronicle of Aventinus.

During the Middle Ages lamentations over the destructive ravages of different species of insects are of frequent occurrence in many chronicles of those times. The means used for the destruction of insects were all, so far as we can learn, of a spiritual nature. In the fourteenth century Uhland, in his contributions to the history of poetry and legend, relates that the Bishops of Chur and Lausanne pronounced the anathema over grasshoppers and other insects. At one time a thoroughgoing procedure, according to all the rules of jurisprudence, occurred before the spiritual judge. The accused insects were summoned, and in case of non-appearance, which always occurred unless the insects were moving to new feeding grounds and the court house happened to be in their way, a proxy was appointed to represent the accused insects, who debated the whole subject with the accuser, after which judgment was rendered, invariably against the accused insects, in the form of an excommunication which was carried into effect only when the insects disappeared at the time of pupation.

Lesser, in his 'Insecto-Theology,' published in London in 1799, says: "We are at this day still almost in the dark with regard to those means by which we may deliver ourselves from the depredations of insects. In the Church of Rome recourse has been had to different exorcisms. Other people have fabricated amulets and talismans, to which great virtues have been attributed.

"Whatever credit these means have gained with the people, they are far from having the efficacy of prayer, or the worth of the remedies I am about to prescribe.

* * * * * *

"There are several ways of preventing the increase of insects, the easiest and most natural, in my opinion, are the following: By spreading on the ground ashes mixed with pigeon's or goat's dung, not only insects newly come forth, but those about to be hatched are destroyed. By destroying the old ones we rid ourselves of the generation they would have produced, and we thus perform in an instant what we would not fail to have been employed in during the whole course of a year. But should the season anticipate our intentions we must seek their nests in the furrows and clefts of trees. In truth the industry of insects in choosing places in which their brood may be in safety makes it impossible, but some of them will escape our search; but if in one province the country people would use strategems on their part it is certain that they would insure that profit of which they are often frustrated.

"We cannot defend fruit trees from the ravages of caterpillars better than by carefully pruning them. By this they acquire much more sap; and, as these insects are not fond of too abundant juice, they seek elsewhere a food more to their taste. If the approach of winter obliges them to gather together in the nests which they form at the extremities of the branches they must be taken off before the spring has made any progress.

"It is possible that these means may not be practicable at all times; but then other strategems must be fallen upon to stifle the evil in its birth. If caterpillars, ants and other insects roam over the ground, and have not yet got upon the trees they are in search of, a stratum of ashes or of chalk must be laid at the bottom, which will obstruct their passage. I believe this to be infallible; for, besides that they are enemies to all constraint, they would be so embarrassed by these substances that they would not be able to disengage themselves. Twisted straw, clay, wool and cotton are likewise successful obstacles to their ascent. Circles of them are put around the stem of the tree, and, if a little resinous substance is added to them, the tree will be out of danger. Let us change the case: suppose the insects have already gotten upon the trees, plants and bushes, the hand must be employed. But there are some times when this is done with greater success than at others, as in the morning, the evening and during rain. These times are preferable to any part of the day, because coolness and humidity cause insects to collect together, and then they form heaps which may be crushed at once. If, moreover, they have gained the top, and the height prevents their being reached with the hand, the tree must be shaken, or a pole, with rags on the end of it, employed to sweep them off. But expedients must be suggested by circumstances. Another snare, the success of which is not less happy, for securing fruit trees is to lay the trunk over with glue, etc."

This represents fairly well the status of economic entomology at the end of the last century. It is undoubtedly true that the great advances made in the systematic study of insects during the last half of the 18th century, by Linnæus, Fabricius, Denis and Schiffermiller, Esper, Herbst, Schrank, Illiger, Scopoli, Latreille, Rosel, Panzer, Olivier and a host of others, gave a great impetus to economic entomology, as shown by the remarkable work of Bechstein on 'Forest Insects,' published in 1804-5; 'Hints to the Proprietors of Orchards,' by Salisbury, published in London in 1816; Kollar's 'Insects Injurious to Farmers and Gardeners,' published in 1836; Ratzeburg's 'Forest Insects,' published in 1840, with many others in Europe; while in this country there were numerous essays on injurious insects and methods of destroying or holding them in check, published in the early part of this century. Harris published numerous papers on economic entomology in the *New England Farmer*, beginning as early as 1823, but his classic work on the 'Insects of Massachusetts Injurious to Vegetation' appeared near the end of 1841. Fitch published his first 'Report on the Insects of New York' in 1855, and this was followed by thirteen others. Townend Glover began his work in economic entomology in 1854, from the smallest beginnings, and we can scarcely realize that in forty years the division of entomology, under the leadership of such brilliant men as Riley, Comstock and Howard, with their able assistants, should now be giving to the world such masterly reports as emanate from that center.

It is not my intention, however, to speak so much of the men as of the development of methods in economic entomology. The entomologists of the present century have given us rational methods for combating insects; methods based on a more or less complete knowledge of the entire life history of the different species of which they treated, with their natural enemies and the best artificial means for their destruction that their ingenuities could devise. It was sometime in the sixth decade of this century that arsenical compounds were proposed. There was bitter opposition to the use of these insecticides for a long time, and the reports of cases of poisoning, which were said to have occurred at that time, were startling in the extreme. It was even claimed that potatoes would absorb the poison to such an extent that the tubers would carry poisonous doses, so that after each meal it would be necessary to take an antidote to the poison. There is something in the human mind that leads it to accept the dreadful more readily than the prosaic, and as many believed the fabulous stories so widely circulated at that time, and for a long time after the advent of the beetle into the extreme east of this country, it was a common thing to see large fields of potatoes with persons of all ages and both sexes, each carrying a pan and stick with which they knocked the potato beetles off into the pan. Little by little, however, one farmer after another abandoned the 'stick and pan' method and adopted the use of Paris green, till it came into very general use. This seemed to give it popularity and there developed a readiness to use any kind of substance that bore the name of insect poison, till now the market is well stocked with a great variety of substances which are claimed to kill all kinds of insects. London purple followed closely in the wake of Paris green, and kerosene emulsion has also come into great favor for the destruction of the sucking insects, or such as do not eat the entire substance of the leaf. Thus we have several excellent insecticides which are in such general use that we may call the latter half of this century the period of insecticides.

There were men in the past ages who were far ahead of their times in economic entomology as well as in other departments of human knowledge. J. C. Schaeffer, in the third part of his work on the gypsy moth, published in 1761, discusses the methods of destroying this insect in a manner equal to Harris or Fitch, while Pastor Rimrod, in his paper published in 1781, on the same insect, handles the subject with equal ability. These papers were rare exceptions in those times, and probably made little impression on the public mind because they were so much in advance of the times. On the other hand, there are men to be found in all ages who are very much behind the times, and we may even now find men who believe every invasion of insects to be an Israelitish plague sent upon us because of the sins of the people.

In 1875 Governor Harding, of Missouri, issued a proclamation appointing a day of fasting and prayer for the interposition of Divine Providence to relieve the calamities caused by the devastation of the Rocky Mountain Locust. Many of us well remember the newspaper accounts of the terrible suffering and starvation in some of the Western States caused by this insect in those times, and it need not surprise us so very much if, after having tried every plan that human ingenuity could devise, they should, in their final extremity, have appealed to Almighty God. This is about the way with us all. In the supreme hour, when everything else fails, we remember and appeal to the Overruling Providence. If I may be permitted here to express a personal opinion along these lines I would say that, while it is exceedingly helpful to the human soul to trust in the Divine Creator of heaven and earth, I cannot rid myself of the conviction that in economic entomology God helps those most who most help themselves; those who make themselves most conversant with his laws as exhibited in the life and habits of the insects they have to deal with, as well as the climatic and other conditions which affect them—in fact the whole environment—and make the best possible use of this knowledge in their attempts to destroy insects or hold them in check.

Last year the Chairman of the Board of Selectmen in a Massachusetts town refused to use any of the public money for the protection of the trees along the streets, from the canker worms, because the idea of fighting insects was 'agin natur.' This year that same man's apple trees are as bare of leaves as though a fire had run through his orchard, and therefore I am of the opinion that it will be 'agin natur' for that man to gather a crop of fruit from his trees this fall.

The establishment of agricultural experiment stations by the general government in 1888, with entomologists in a large proportion of them, gave a wonderful impetus to the study and development of economic entomology in this country. At first it was thought that, because of the lack of a sufficient number of well trained and experienced entomologists to fill these positions, very poor work would be done until a sufficient time had elapsed for young men to become educated and trained in this line, when they would crowd the more inferior material to the wall. To me it has been a matter of pleasure and pride to see the young men coming to the front so rapidly, filling these places so satisfactorily and publishing bulletins and other papers of such rare value. I am deeply impressed with the idea that, unless those of us who are older and have been in the work for a long time look well to our laurels, we may soon find ourselves crowded up against the displacement wall and younger, perhaps more competent, men standing ready to take our places. Nevertheless it is a great pleasure to me to help and encourage any promising and modest young man who is thoroughly in earnest in the study of entomology.

In this connection I cannot too highly

commend the course taken by some of our economic entomologists who, in connection with their other work, make a systematic study of some family or group of insects, or study thoroughly the anatomy or embryology of one or more species. Even a fragment of such study will sometime prove useful, since it forms a link in the great chain of human knowledge and each link forged into it tends to strengthen and make it more useful. I have no sympathy with those who work only in one restricted field till they become so narrow that they can appreciate nothing except what is to be found in their own extremely narrow groove. The entomologist who broadens the horizon of his observations becomes better able to grasp and comprehend the great problems presented to him.

With the discovery of insecticides came the necessity for various kinds of apparatus for the application of them, and here again there has been an evolution which is still going on. Many of the spraying pumps, nozzles and other apparatus first placed on sale are no longer in use, but greatly improved kinds are on the market, and investigations are still giving us improvement after improvement, some of which, unfortunately, are no improvement at all. On the whole, however, the insecticide apparatus of to-day is greatly superior to that of a decade ago.

THE FUTURE OF ECONOMIC ENTOMOLOGY.

It seems to me that in the future development of economic entomology we have need of the chemist and of the physiologist. Some work has already been done on the use of Paris green and lime, but the results do not appear to be beyond question. It is to be hoped that the investigations already made in the work on the gypsy moth, as well as those not yet completed, may prove of value in operating on other species of insects. This work has already given us arsenate of lead and arsenate of barium as insecticides, and investigations are still going on concerning the nature of the intestinal secretions of this insect and the poisons that will most readily react on these secretions and thereby destroy it. It may be that investigations by the chemist and physiologist, working together along these lines, may give us something in the future superior to anything in use at the present time. The three most important characteristics of an insecticide, which must be kept constantly in mind, when investigating a new or untried poison, are : 1st. It must kill the insects quickly, the more quickly the better. 2d. It must not injure the foliage when used in as large proportion as one may need for the destruction of the insects. 3d. It must be cheap enough to come into general use. There are other considerations of more or less importance, as the ease with which the insecticide may be applied, its liability to clog the nozzles or corrode and injure the apparatus, and, in fact, any objection that will prevent the substance from coming into general use.

After one has made valuable investigations and discoveries in economic entomology, it remains for him to publish his discoveries in such a place as will be accessible to those who most need this information, and in such a manner as to lead them to read the paper carefully and intelligently. I know very well that there are thousands of persons who receive our bulletins who do not even look them over. I was told by the editor of one of our leading agricultural papers, a few years ago, that he sent out a circular letter to his subscribers, asking what changes, if any, they would like to have him make in his paper, and a large percentage of them requested him to give them more stories ; and I have sometimes wondered if the information given in our bulletins were presented in the form of a strongly sensational novelette they would not get a much more general reading. Personally I cannot adopt the plan, as I have no skill as a novelist.

After all, it is more important to investigate and make new and valuable discoveries, even if they are not so widely read at first, for they will be taken up by others and disseminated far and wide, and in time the useful information will become filtered through the public mind.

There is often need of legislation to aid in the carrying out of the recommendations of the economic entomologists, and this is an important question at the present time. There is no law in Massachusetts to prevent a nurseryman or any one else from selling and distributing nursery stock that is infested with the San José scale, or of distributing and establishing colonies of injurious insects, except the gypsy moth, nor is there, so far as I know, any law in the land to prevent the importation of injurious insects from any other country.

I have generally felt very shy of legal enactments, because they are so often couched in language quite beyond my comprehension, and in many cases they seem to require a 'Philadelphia lawyer' to interpret them, and even then two lawyers frequently differ in their interpretation of the same legal point. I am, therefore, of the opinion that there is need of great clearness and simplicity in the wording of an act, and also that it would be wise to have more or less uniform laws in all the States concerning those injurious insects which are, or are liable to be, generally distributed throughout the country. In this matter we should also consider our nearest neighbors, Canada and Mexico, for, while politically distinct from us, entomologically there is no dividing line.

In conclusion, allow me to congratulate you on the growth, importance and success of the Association, and bid each and every member Godspeed in his chosen field of labor, assuring him that every good piece of work he may perform will not only redound to his credit, but will add to the sum-total of human knowledge and human happiness.

C. H. Fernald.

EIGHTH ANNUAL MEETING, BUFFALO, N. Y., AUGUST 21–22, 1896.

The Association was convened in the lecture hall of the Library Building, Buffalo, N. Y., and its meetings were attended by some 19 active members, including the following officers: President, C. H. Fernald; Vice-President, F. M. Webster, and Secretary, C. L. Marlatt. A number of entomologists not members of the Association were also present, with other zoologists, the number of persons present at the meetings averaging about 30.

The following new active members were elected:

W. G. Johnson, College Station, Md.
E. E. Bogue, Stillwater, Okla. Ter.
James S. Hine, Wooster, Ohio.
C. W. Mally, Wooster, Ohio.
H. L. Frost, Boston, Mass.
M. F. Adams, Buffalo, N. Y.
Lewis Collins, Brooklyn, N. Y.
W. E. Rumsey, Morgantown, W. Va.

The following new foreign members were elected:

Chas. P. Lounsbury, Department of Agriculture, Cape Town, Cape of Good Hope.

Fred. Enock, 21 Manor Gardens, Holloway, London, England.

Dr. Enzio Reuter, Fredriksgatan 45, Helsingfors, Finland, Russia.

Frederick B. Theobald, Wyecourt, Kent County, England.

Dr. Antonio Berlese, R. Scuola Superiore de Agricoltura, Portici, Italy.

Dr. Paul Marchal, 16 Rue Claude Bernard, Paris, France.

W. C. Grasby, Parkside, Adelaide, South Australia.

The active membership of the Association now numbers 86, and includes practically all of the leading workers in economic entomology in the United States and Canada. The foreign membership numbers

29, and comprises the leading official economic entomologists of the world.

A number of resolutions were passed; among others, the following: (1) Resolutions relating to the death of Dr. C. V. Riley, the originator and first President of the Association; (2) urging the publication by the U. S. Department of Agriculture of the general index to the seven volumes of Insect Life; (3) recognizing the importance of the work being done by the State of Massachusetts in the control of the gypsy moth, urging the continuance by the State of work in this direction and expressing the greatest confidence in the officers now charged with it.

The annual address of the President, Mr. C. H. Fernald, professor of entomology, Massachusetts State Agricultural College, Amherst, Mass., was entitled 'The Evolution of Economic Entomology,' and was devoted to a historical resumé of the progress in the practical control of insects from the earliest times to the present. It is printed in this JOURNAL.

The following papers were read and discussed:

Some Temperature Effects on Household Insects; *On the Futility of Trunk and Crown Washes for the Elm Leaf-beetle*; *Remarks on Steam Spraying Machines.* L. O. HOWARD.

Three Years' Study of an Outbreak of the Chinch Bug in Ohio; Insects of the Year in Ohio. F. M. WEBSTER.

A New Insecticide. A. H. KIRKLAND.

Comparative Tests with New and Old Arsenicals on Foliage and with Larvæ; Insecticide Soaps. C. L. MARLATT.

Enemies of the San José Scale in California. J. B. SMITH.

Insect Enemies of Forest Trees; *Notes on Some Observations in West Virginia.* A. D. HOPKINS.

Notes on Insect Attacks of the Year. J. A. LINTNER.

Entomological Notes from Maryland. W. G. JOHNSON.

The following papers, the authors of which were not present, were read by title, but, it is expected, will be included in the published proceedings of the Association:

The Grasshopper Disease in Colorado. C. P. GILLETTE.

The Development of the Mediterranean Flour Moth. F. H. CHITTENDEN.

Notes on the San José Scale. W. B. ALWOOD.

A New Garden Smynthurid. F. L. HARVEY.

A Simple Device for the Preparation of Oil Emulsions. H. A. MORGAN.

The following officers were elected for the ensuing year: President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

In accordance with the established custom, the next session will be held on the two days preceding the general sessions of the American Association for the Advancement of Science, Detroit, Mich., August 6–7, 1897.

C. L. MARLATT,
Secretary.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ADDRESS BY THE VICE-PRESIDENT BEFORE SECTION I.—SOCIAL AND ECONOMIC SCIENCE.—HORTICULTURE AND HEALTH.

I SHOULD be lacking in ordinary sensibility did I not appreciate the compliment of being elected Vice-President of Section I of the American Association for the Advancement of Science.

To be called to this office in an Association that has for years stood for the scientific thought and scientific progress of this continent; an Association whose list of officers and members has contained the names of some of the most distinguished men and women of our time; an Association whose proceedings are an index of the marvellous advances made by scientific research during the latter half of the nineteenth century, is truly an honor that any man or woman might covet.

Since accepting the honor, there are two words that have appealed to me with equal force and signal persistency.

These words are *responsibility* and *opportunity*. The former I have tried to discharge in an earnest effort to secure papers, and arrange an equally interesting and profitable program for this sectional meeting, and the latter I try to meet in the address which follows.

This year the title of Section I is changed, and its scope enlarged. It is no longer the Section of Economic Science and Statistics, but the Section of Social and Economic Science.

This change was precipitated by a series of resolutions presented before the Brooklyn meeting of 1894. The purport of the resolutions was, that inasmuch as the stated object, no less than the true function of the American Association, is to promote the advancement of *all science*, including the science of society, it was in duty bound to aid and assist all desirable reforms, to the end that the progress of modern society, by the application of scientific principles and methods, might be advanced and its perpetuity assured.

At the same meeting an amendment to the constitution was proposed, which changed the name, as already stated, and so enlarged the field as to include all those branches of knowledge which deal with the political, commercial, economic and social life of mankind. This amendment was adopted at the Springfield meeting of last year, and we now meet for the first time as a section of social and economic science. Permit me to add that, in my judgment, the all-inclusive term 'social science' would have been sufficient, for the word 'economic' only defines a branch of the larger science already named.

We live in an era of reforms. At first man was a reformer by primal necessity. He transformed or reformed nature to meet his bodily wants. His life was a mere struggle for existence.

In time he turned his eyes inward and studied himself. He first dimly saw that there were higher ends and nobler purposes than mere sensual enjoyment. He slowly learned that his passions and appetites were created to serve and sustain, not to master and destroy.

Then, turning his eyes outward, and scanning his relation to others, he found, not justice, much less love and good will, but necessity on the one hand and advantage on the other, controlling the dealings of man with man. He met no recognition of the brotherhood of the human race. But progress is a law of our being, and we have now reached a point where ethical laws are being applied to practical life.

To this end are the various special reforms of this day and generation mainly directed. There are reforms in church and state polity, reforms in municipal government, educational reforms, prison reforms, dress reforms, reforms in eating and drinking, and numerous other special reform movements, which challenge our attention.

What the true, genuine reform spirit of our age is seeking to establish is the equality of human rights; an equality that disregards all disparities of race, sex or color, of strength, knowledge or creed; an equality that is plainly and tersely expressed in the Declaration of Independence:

> "We hold these truths to be self-evident: that all men are created equal; that they are endowed by their Creator with certain unalienable rights; that among those are life, liberty and the pursuit of happiness."

As a people we may be selfish, shortsighted and sinful, yet there is a strong undercurrent of moral obligation to live for the highest good of humanity, to cooperate with that 'power which makes for righteousness.'

Through all the folly and evils of our time there comes to every discerning ear a voice which speaks to us in no uncertain tone. Its message is this: Teach the child and you will not be obliged to hang the man; find the vagrant orphan a home and teach him a useful trade, and you will not have to punish him as a thief, or watch him as a criminal; furnish work to all who need it, and there will be but few to support as tramps, paupers and parasites; remove temptation from the path of the weak, and you will not be obliged to punish them for having stumbled and fallen; it is better to counsel than to condemn, better to lift up than to crush down, better to be shielded by love and gratitude than to be protected by soldiers and police. Thus testifies the moral genius of our age. Let us try to understand and heed it.

The great, all-embracing reform of our age and country, one that naturally follows the banishment of human chattelhood from our soil—one that is palpably demanded by every instinct of justice and humanity—is that which will lift the industrial classes from the plane of servility to one of self-respect, self-guidance and independence. Its object is to lift the laborer, not out of labor, but out of ignorance, inefficiency and want. This great end cannot be attained at once, but the development of a truer and more profound social and economic science should help to pave the way.

The socialist has his dream of an ideal world. He believes it possible to have a social and industrial order wherein all freely serve and all are served in return; where no drones or sensualists can abide; where education is as free and common as air and sunshine; where nothing but service secures approbation, and nothing but merit wins esteem; where mental development and moral culture is the aim, as well as the possible attainment of all. Is such an order possible? What says social science?

It may be well to repeat here the question discussed by Vice-President Fernow at the last meeting of this Section.

Have we a social and economic science? Have we enough observations, facts, laws, principles, subservient to social and economic conditions, so well arranged and classified as to warrant the use of the term *science?* I believe we have. Let me not be misunderstood. I am not a teacher of such science. I rank low in the class of learners. What I know of science as applicable to society and economics is slight indeed. Yet I know there is such a science, and I believe that each succeeding year enlarges, improves and perfects it.

If some of the recent applications of this science appear shallow and seem almost to partake of the nature of quackery, this should not bar the way to our advance to the acquisition and development of a true social and economic science, which shall be neither shallow nor empirical.

In this spirit, and with no little hesitation, I present a few thoughts on 'Horticulture and Health.'

Ours is an eminently practical age. The energy of our people is mainly expended in the production, manufacture and distribution of articles that nourish the body, gratify the senses, or in some way contribute to the comfort and convenience of mankind.

Mind is steadily dominating matter, and this extension of the sovereignty of man over the material forces of the earth we call civilization.

The art of horticulture consists primarily in transforming, by means of cultivation, crude and worthless materials into substances valuable as food products, or useful in ministering to our love of the beautiful. This raw material is furnished by the soil, and such substances as may be added thereto, together with certain elements of the air.

Etymologically speaking, *horticulture* means the cultivation of a garden. The real scope of this definition depends upon the meaning of the word *garden*. According to philology, this word comes directly from the Anglo-Saxon *gyrdan*, to enclose. It is the root of the verb *to gird*, meaning to encircle.

Gardening and horticulture, like farming and agriculture, are synonymous terms. We should remember, however, that the full scope of the meaning of a word is not determined by its derivation. This must be sought in its general use and common application. By this standard horticulture readily separates itself into four great divisions, each of which may be many times subdivided.

These principal divisions are:

I. Pomology, or fruit culture.
II. Olericulture, or vegetable gardening.
III. Floriculture.
IV. Landscape-horticulture.

The first two of the above divisions belong to the realm of industrial or domestic art. The third, floriculture, is both an industrial and a fine art. While the last, landscape-horticulture, lies wholly within the province of fine art.

Horticulture is more than a mere trade. It is more than a productive industry. Its successful practice is based upon great laws which have been deduced from the natural and physical sciences.

Many of these laws may be arrested, modified or set in motion at will.

The horticulturist, as he learns the control of these laws is largely in his own hands, becomes an enthusiastic student and investigator, and can scarcely fail to develop a love for rural life—a love that is deep and abiding. Horticulture may justly rank as a science, as well as an art. Not to speak of the science of the propagation of plants, or the science of tillage, the great fundamental principles of evolution are exemplified in horticulture as nowhere else. Over 6,000 species of plants are cultivated by the horticulturist, and these have produced almost an infinite number of distinct forms.

In these forms, with their wonderful and intricate variations, we can study the laws of genesis, and the master mind of Bailey and others are rapidly reducing the wealth of the facts found in greenhouse, garden and orchard to the semblance of an orderly, systematic and progressive science. The influence of natural and artificial selection, the effect of soil, climate and moisture upon development, the transmission of acquired characters, the formation of new species, are revealed in horticulture as in an open book. Here facts take the place of conjecture, and demonstration is substituted for theory.

In discussing the relation that horticulture bears to health, not physical health alone, but intellectual and spiritual health, have been considered. In like manner, the products of horticulture, as well as horticulture as a vocation or recreation, are taken into account. First, let us consider the effects of the use of our common garden and orchard products, as a part of an every-day diet.

There is a great deal of talk about health and diet that is equally foolish and hurtful; foolish because it subserves no good end, and hurtful because it tends to fortify the pernicious idea that our bodies are in such wretched condition as to need constant tinkering, and that some sort of self-medication is a positive duty.

Like malaria, this affection is everywhere. How shall it be treated? In the place of this widespread delusion there should be an inbuilt conviction that there are certain articles known as foods, in the choice of which and in the quantity used each one has daily opportunity to exercise the virtues of common sense and moderation. But foods are not medicines.

A medicine is something which is taken into the body to produce a certain specific and unusual effect, the object being to counteract some injurious tendency or abnormal state. If taken when not needed, its effect is likely to be directly injurious. In order to maintain strength and vigor, and repair waste, the normally healthy body craves what is *wholesome*, not what is *medicinal.* When a thing has real medicinal value, it is almost certain to be unwholsome as a general article of diet. There is an old tradition, even now quite generally believed, although gradually fading away, that anything that affords us simple physical pleasure is dangerous, if not absolutely sinful.

So when one eats freely of fruits he does not feel justified in simply saying he does so because he finds them agreeable; he likes and craves them, but is constrained to look wise and solemnly observe that 'fruits are very healthy.' Some even go so far as the German prince, and have for each bodily ailment a different variety of fruit. The prince said, "Whenever I meet with any misfortune or affliction, and am disposed to give way to my grief, I order a young goose nicely roasted, and eat as much thereof as I can; I always find that I rise from the table far less unhappy." Let us banish the idea of making a drug store of our fruit-gardens and orchards, and cease looking upon the family fruit basket as a sort of homœopathic pill box!

"Blessed are they that hunger and thirst," can be said as truly of our bodily wants as of our spiritual necessities; not blessed because they shall be medicated, but because "they shall be filled," with what tastes good, with what gives genuine and lasting pleasure.

In satisfying our hunger for fruit, fruit that is well matured, juicy and fine flavored, we get perhaps the highest form of palate gratification with the least possible digestive effort.

Our ordinary fruits contain the following substances in greater or less proportions:

1. A large percentage of *water*.

2. *Sugar*, in the form of grape and fruit sugar.

3. *Free organic acids*, varying slightly according to the kind of fruit. For example, the predominating acid is malic in the apple, tartaric in the grape, citric in the lemon.

4. *Protein or albuminoids*, substances containing nitrogen, which resemble the white of eggs, and are its equivalent in food value.

5. *Pectose*, the substance which gives firmness to fruit, and which upon boiling yields various fruit jellies.

6. *Celluluse or vegetable fibre*, the material that forms the cell walls, and which is found in all parts of plants.

7. A very small percentage of *ash* or *mineral salts.*

The substances named above are, with the exception of cellulose, essential constituents of a perfect diet. The percentages of the different nutrients are so small, however, that most of our fruit has little actual food value. For example, the nutrients contained in the strawberry, according to analysis made at the Ohio State University, are as follows:

Carbohydrates	8.0	per cent.
Protein	.3	" "
Fat	.0	" "

It has been estimated that the minimum daily ration of nutrients for a man of average weight, in performing an ordinary day's work, is:

Carbohydrates	500 grams,	or 17.6	ounces.
Protein	118 "	" 4.2	"
Fat	36 "	" 2.0	"

A simple calculation will show that a person would have to consume about 200 ounces, or 13 pounds, of strawberries daily in order to obtain the proper amount of carbohydrates from this source.

In order to secure the necessary amount of protein from the same source, a daily consumption of 1,400 ounces, or 88 pounds, of strawberries would be required.

This would be a task that even the most ardent admirer of this fruit could scarcely be prevailed upon to attempt. Take another illustration from the vegetable, rather than the fruit garden.

The nutrients contained in the tomato are as follows :

Carbohydrates	2.5	per cent.
Protein	.8	" "
Fat	.4	" "

Applying the same calculation as before will show that one would have to eat 500 ounces, or 31.2 pounds, of tomatoes each day for the requisite fat; he would have to eat 525 ounces, or 32.8 pounds, for the necessary protein, and for the carbohydrates it would require 704.4 ounces, or about 44 pounds. In other words, if one should eat 44 pounds of tomatoes every day, he would consume slightly more fat and protein than were absolutely necessary for a day's supply and just about the right amount of carbohydrates.

This demonstrates that, however valuable strawberries and tomatoes may be as a part of an every-day diet, they cannot be considered as foods. Their actual nutrient value is exceedingly low. In order to support life and maintain strength, strawberries and tomatoes must be eaten in connection with other substances which have more concentrated nutrients. Wherein does their dietetic value consist? Let us briefly consider. The qualities which render fruit and many of the more delicate garden vegetables wholesome, and cause us to have a natural apetite for and hence to enjoy them, are their acid juiciness and flavor. The juice is mainly water, but it comes to us in a grateful and refreshing form. The flavor is due in part to the organic acids already mentioned, but mainly to certain volatile oils or aromatic ethers. It is to these latter that those delicate characteristic flavors of various varieties of fruit are chiefly due.

Chemistry and physiology have taught us that, when these 'fruity acids,' oils, and ethers are taken into the body, they undergo oxidation, which process tends to lower the temperature of the blood, or at least to modify our temperature sensations, and thus correct, or allay, any slight feverishness that may exist. They also tend to keep the organs of secretion, the liver, kidneys, etc., in a healthy condition. We are justified, therefore, in saying that fruits are 'cooling, aperient and grateful.' In our climate, subject as we are to rapid changes and extremes of temperature, passing abruptly, as we often do, from an arctic winter to a tropical summer, the physical system is naturally more or less debilitated.

In this condition we are predisposed to malarial troubles, particularly if we live where the drainage is poor. Fruits and acid vegetables are found to be good correctives for this debilitated condition of the system. The free acids of fruits, especially citric and malic acids, are highly antiseptic bodies. They tend to prevent disease germs from finding a lodgment and developing in the body.

The full beneficial effects of these acids are only to be found in mature fruits. Green, unripe fruits, although they have an abundant supply of acids, are usually injurious, on account of their indigestibility. This arises, mainly, from the coarse and hard condition of the cellulose. When fruits are perfectly developed and properly matured the cellulose is soft and fine. We know that unripe fruit is not wholesome. It digests slowly, often ferments in the stomach, and is the cause of painful disorders. It is unwise to take into our stomachs that which will ferment and decompose; it is certainly no less unwise to eat over-ripe or wilted fruit, in which these destructive changes have already begun. The question is often asked whether such or such a fruit is *healthy*, even when the question has no special reference to the condition of the fruit itself. All fruits that are eaten ought to be healthy. That is, they should be well matured, sound, and free from disease. As a rule, such 'healthy fruits' are for most of us *wholesome*, although they are neither food nor medicine.

The best results possible from the dietetic use of fruits and vegetables come from eating those that are fresh, healthy and properly matured, and which have been produced by our own skill and industry.

I am dwelling too long upon the relations of the products of horticulture to health.

Let us consider how horticulture as a vocation stands related to the physical, intellectual and moral well-being of mankind. In order to maintain physical strength and vigor, at least four things are needful. These are pure air, nutritious food, unbroken sleep and muscular exercise.

That vocation which comes the nearest to supplying these requisites of good health can scarcely be other than a desirable one. Judged by this standard, horticulture stands at the very head of the list. Its quiet, its segregation from strife and jealous rivalry, its unequaled opportunities for nature study, make it at once attractive and healthful. Blessed is he who works in greenhouse, garden or orchard. As a rule, his day's exertion ends with the evening twilight, and he rises each morning with his physical energies renewed for fresh activity. To him is given that full measure of health only vouchsafed to those who spend most of their waking hours in the free, pure air and renovating sunshine of the open country.

Health is not only wealth, but happiness, and the superior advantages of horticulture as a healthful vocation cannot be too strongly urged.

Floriculture and small fruit culture are preeminently adapted to women. There are few industries where fairer returns for capital and labor expended are more certain; few that can be so well begun with small means, and still remain capable of indefinite extension. Fine fruits and flowers are in universal demand. They are the necessities of the rich and the appreciated luxuries of the poor.

Our densely populated commercial centers, our thronged and fashionable summer resorts, are rarely, if ever, adequately supplied with them. As a rule, they take all they can get, and then look around for more. You might double the largest annual yield of good berries, or fine roses or carnations, with profit to the producers. The home market for products of this sort is signally elastic, the demand ever keeping well abreast of the supply.

The same is true of winter forced vegetables. In the light of a personal experience of over twenty years, I can confidently affirm that the vocation of horticulture, when wisely and energetically followed, is a profitable one. I believe there are few pursuits which afford as bright prospects, or as full an assurance of reward for intelligent, persistent effort, as does this.

Listen to a few facts. The vegetable forcing-houses belonging to the horticulture department of the Ohio State University have an aggregate glass area of a little less than 4,000 square feet. There are two plain structures which could be built at the present time for about $900 each. The total bench space in these two houses is a trifle more than one-twentieth of an acre. During the past five years the annual sales from these forcing-houses have averaged about $600.

The following are among the more important crops commercially grown the past year, and the receipts of each:

Lettuce	$406.10
Radishes	52.25
Beets	45.00
Cucumbers	48.50
Hyacinths	59.25
Total	$611.10

When we consider that these forcing-houses are used but little more than one-half of the year the result attained is encouraging. It should be stated that in addition to the above crops there were grown in less quantities, and chiefly for experimental purposes, parsley, peppers, egg-plant, cauliflower, string beans, onions and a few other vegetables, including mushrooms, as well as a somewhat smaller list of flowering plants.

The cultivation of the small fruits is likewise peculiarly suitable for women. It is a business for both old and young. Examples are not wanting to show signal successes attained in strawberry, currant and gooseberry culture, by women as well as men, when begun in the decline of life.

Small fruit culture is an industry that especially commends itself to poor women who are struggling to support their children in frugal independence. Almost any one can obtain control of a cottage with a half acre, more or less, of warm southward-sloping land, which can be planted with early vegetables and small fruits, in such a way as to be a source of continuous profit. If a small forcing-house can be added, and to this can be accorded that constant supervision without which no industry is likely to prosper, it will be an added source of revenue. In this way many a widow could find a healthful, congenial occupation which did not require her to spend her days away from home, or subject her to the caprices of a selfish or thoughtless employer. I believe there is no other occupation in which, for the capital invested, success is so nearly certain as in horticulture. Of every one hundred men who embark in trade, carefully collected statistics report that at least ninety fail. Why? Mainly because competition is so sharp and traffic so enormously overdone. If one hundred men endeavor to support themselves and families by merchandise in a town which affords adequate business for only ten, it is absolutely certain that a large majority must fail, no matter how able their management or how economical their living. On the other hand, the number of horticulturists in almost any community might be doubled without neccessarily dooming one to failure, or even abridging his income. If one-half of the day laborers in the country were to embark in horticulture to-morrow, I do not believe it would render the industry one whit less profitable, while it could scarcely fail to add to the health, wealth and comfort of all.

I shall have little to say regarding the relation of horticulture to intellectual health. Any true knowledge of the art or practice must be based upon science.

The horticulturist stands face to face with problems which require for their solution the amplest knowledge of nature's laws, the fullest command of science, and the best efforts of the human intellect. In this art, study and mental acquisition, together with a habit of observation and reflection, are equally essential and serviceable. However it may be with others, the horticulturist imperatively needs a knowledge of the character and constitution of the soil he tills, and the plants he cultivates, and the laws which govern their relations to each other.

Geology, chemistry and botany are the sciences which unlock for him the secrets of nature, and a knowledge of these is among the most vitally urgent of his needs.

Horticulture is an intellectual pursuit, and in its practice the strongest minds may find scope for profitable employment. The one who chooses this profession must keep his mind open and his mental faculties alert by constant observation and study. Horticulture is esteemed by all, because every useful vocation is respected in proportion to the measure of intellect it requires and rewards, and never can rise above this level.

The relation of horticulture to moral and spiritual health deserves a more extended consideration. The horticulturist deals directly with nature, and finds little or no temptation to juggle or stoop to trickery. "Whatsoever a man soweth, that shall he also reap," is immediately and palpably true in his case. Nature never has and never can be cheated.

The horticulturist, acting as a horticulturist, soon comes to realize that his success depends upon absolute verity, and he is not likely to be lured from the straight path of integrity and righteousness. When he goes into the markets and becomes a trader he is subjected to the same temptations as others, and may be enticed into some of the many devious ways of rascality. The whole tendency of his vocation, however, conduces most directly to a reverence for honesty and truth. It is likewise conducive to a genuine independence and thorough manliness of character.

The horticulturist is not obliged to swallow any creed, support any party, or defer to any prejudice, in order to successfully follow his calling.

He may be a Democrat, Republican, Populist or Prohibitionist; a gold-bug or a silverite ; a free-trader or a protectionist ; Christian or infidel ; yet his fruit and flowers will sell for exactly what they are worth. Social intolerance of adverse opinions is never directed toward him.

But it is horticulture as a *fine art* that has the most abiding influence. Who can measure the effect of the landscape horticulture of our parks and public grounds, or estimate the value of the external adornment of the home?

Horticulture is nature's best interpreter, and through this art the blinded eyes may be opened, the dormant æsthetic powers awakened, and the heart made ready for a just appreciation of the beautiful. It is well to bring art into our homes, to adorn and decorate them with painting and sculpture; but we must not forget that the sense of beauty must be cultivated before the treasures of art can be made our own. If I were called upon to point out one of the most serious weaknesses in our modern system of education, I should answer, "its failure to accustom the eyes of childhood and youth to the beautiful in nature." The beginning of all true education should be a love of nature, and *nature study* ought to be the dominant note in every educationl system.

What a wealth of beauty there is in tree and shrub and flower, a beauty of which we never tire, and which 'is its own excuse for being!' When the art of horticulture arranges trees and shrubs, flowers and lawn, so as to present an expressive picture to the eye, the beauty is multiplied, and this development of the beautiful is the end and aim of all landscape horticulture.

The claims of horticulture in answering our spiritual needs are no less than they are in answering our physical necessities.

In the first and most essential of human arts we are beginning to recognize one of the last and most useful of human sciences.

How and *where* and *when* can this art and science best do its appointed work?

It is a part of my social creed that there need be, and should be, no paupers who are not infantile, imbecile or disabled. Yet the world is full of men and women doing nothing, mainly because they don't know how to do anything. To correct this, youth should be a season of instruction in some trade or useful art, as well as in letters and various sciences. There should be a blending of labor with study, of training with teaching, so as to preserve health of body and vigorous activity of mind.

The pupil or student should be enabled to nearly or quite make his way through high school, academy and college, and go forth qualified to face adversity and maintain a healthful independence. One step toward the accomplishment of this desired end would be the introduction into our country schools of manual training in horticulture. The land required could be easily secured, and the necessary equipment in the way of tools, seeds, etc., would not be expensive.

The work undertaken in these training schools should embrace the cultivation of fruits, vegetables, flowers, shrubs and trees. In connection with the above the various operations of propagating plants by seeds, cuttings, budding, grafting, etc., should be thoroughly taught. The collection and planting of weeds, the breeding of the more common injurious insects and the use of remedies, the study of bees and useful birds, a practical acquaintance with our native trees and shrubs, and other similar subjects, might form a part of the instruction and training.

The introduction of such a course would mean an improvement of our schoolhouse grounds, and the adornment of these would have an elevating effect upon the whole community.

If we have beautiful school buildings, with beautiful surroundings, the inference is almost irresistible that we shall have teachers and pupils of greater refinement. To develop all the faculties of body and mind is the aim of modern education. Manual training in horticulture can signally aid in securing this end.

I sincerely hope that the obvious advantages of forming horticultural colonies will be widely and rapidly improved. It would correct the unhealthy congestion of our towns and cities. In no other way can so many be provided with homes, regular employment and good living. By a horticultural colony I mean the association of from one hundred to five hundred families, in the purchase of a suitably located tract of land, embracing about one acre for each individual. The location, which should be reasonably near some large commercial center, and the purchase of this land should be intrusted to the most capable and honest members of the association. It should be carefully surveyed and divided into a few small lots, centrally located, for the necessary mechanics and merchants, but mainly into areas of from one to ten acres for horticulture. Ample reservations of the best sites should be made for a schoolhouse, town hall and public park. The streets should be embowered with shade trees, and every owner of a lot or garden should be encouraged to beautify and adorn it.

I believe such a cooperative effort would secure a modest but comfortable home for any family that could contribute from $300 to $500. If the contribution ranged from $500 to $1,000 a proportionally better home could be secured. Some of the advantages of such colonization over the isolated system of taking up a homestead may be summarized as follows:

First. One tenth of the land required under the old system would be found abundant.

Second. It could be far better selected with reference to markets, and more suitable allotments for fruits, garden vegetables, floriculture, nursery, etc., could be made.

Third. Few draught animals and little expensive machinery would be required.

And, finally, man's social and gregarious instincts would be satisfied.

While ignorance and miseducation ruin thousands, I believe that poverty resulting from involuntary idleness sends more men and women to perdition than any other cause.

Horticulture may never become a universal panacea for destitution and crime, yet I have a joyful trust that thousands will be awakened by it to a larger and nobler conception of the true mission of labor, and by its practice, along the path of simple, honest, persistent work, life may be made easier, and men and women healthier and happier.

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SECTION I.—SOCIAL AND ECONOMIC SCIENCE.

THE sessions of the Section of Social and Economic Science had rather more interest and attendance this year than usual from the reopening of the question, voted upon the previous year, of an appropriate title, the new proposition being one of nearly identical meaning, but not so clearly defined in the word Sociology. As first used by Comte (not a very respectable paternity, by the way) and adopted by Spencer, sociology is confined to human societary evolution, a species of linear succession in the unfolding of psychology. Giddings, in his recently issued Principles of Sociology, bases it on the 'consciousness of kind,' a basis broad enough to include the societary institutions of animals, especially certain insects. The fact that several American universities have established chairs of sociology, and the name already includes quite a bibliography with the adjunct of a monthly periodical (although the Europeans are still rather shy of the name) brings into prominence the need of some appropriate title for that branch of knowledge which is concerned with demography, vital statistics, polity, economics, ethics, government, crimes, punishments, education, etc. The determination of this point brings up the underlying one of the need of some recasting of the departments of science concerned in psychical development. New classifications continually appear, in greater or less conformity with the broader views made possible by modern research. It is apparent that we are on the threshhold of a New Physics' which threatens to overlap that of the new Astronomy on the one hand and the new Chemistry on the other; and also to invade the domain of Psychology, with all the portentous consequences implied thereby. So of anthropology (another of Comte's progeny) of indefinite extent, as at present outlined, embracing archeology, ethnology, mythology and folk lore, somatology and psychology. Is sociology properly a branch of anthropology; or should it merely, for convenience of consideration, to be erected into a quasi-independent science?

Popular interest in the deliberations of the Section of Economic Science was this year enhanced by the pending National Presidential election and the political partisan platform issues, especially the 'gold *vs.* silver' controversy, which occupies so large a space in the newspaper and periodical press discussions, as if it were a new subject recently dropped into our economic life. Bimetallism is really an old debate which has been within a generation intensified by the nearly concurrent action of (1) the sale of the German indemnity silver after 1871; (2) the suspension of free coinage (at $15\frac{1}{2}$ to 1) by the Latin Union; (3) the dropping of the silver dollar from the legal tender United States coins in 1873; (4) the fall in market value of silver by the increased output of United States mines, due to richer ores, better machinery and superior methods of extraction; (5) the cessation of silver absorption in Asiatic population—one-third of the human race—due in part to the introduction of railroads and telegraphs, and in part to the supply of ready-made jewelry and silverwares, formerly composed of hoarded coin and reconvertible into coin; (6) the law of redundancy or 'glut,' which operates to send down the price of the whole product, and (7) the widespread agitation and discussion of the value of silver as a unit measure of value which has resulted in corresponding apprehension and disestimation. Several of these main contributing causes are not of human or legislative contrivance, and evidently cannot be banished by legislation, certainly not by the United States alone, as Prof. Walker and European students unhesitatingly declare. This is manifestly a question in which the executive and law-making powers might well avail themselves of expert advice, as in the case of weights and measures, nautical almanac, geodetic and coast survey, and other technical matters. European governments habitually do this, but the people of the United States feel quite competent to grapple with it; hence the need of 'a campaign of education,' and the paralysis of industry until the right decision is reached.

Edward Atkinson, as usual, led off in the discussion by two papers, 'What is true Money?' and 'The Crime against Labor;' the first being, for the most part, a condensed history of the various substances which have been used as money in historic, prehistoric and barbaric times, with the pendant that by a process of natural selection, gold and silver had come to be the most convenient and stable; and that all artificial attempts at establishing by enactment a fixed ratio between them had failed, and must fail; any apparent agreement to the contrary being transient and approximate only. The second paper supplemented the first by showing that bad money could not bring benefit to the wage earners, but was more likely to produce paralysis of trade and manufacture, and want and suffering to laborers. A third paper on the same topics, by Dr. Wm. H. Hale, went over the well-worn theme on a much higher level and in better spirit than the average partisan debates. The discussion brought out two or three advocates of the silver heresy, who made the claim that gold had appreciated, all other commodities being by so much lowered in price. No very new and striking evidence was adduced on either side.

Quite a surprising degree of interest was exhibited in the reading and subsequent discussion of a paper on 'The Competition of the Sexes and its Results,' by Laurence Irwell, of Buffalo, an Oxford graduate. His contention that the new woman should abstain from the professions of law, medicine and politics was not merely because she would thereby displace an equal number of men who might have families to support, but also because the child-bearing sex are not physically or mentally qualified to stand the strain. The ladies of the audience seemed to be divided on this point, but agreed that the blame for women pushing into new fields of labor did not rest with their sex.

A paper on the 'Tin-plate Experiment,' by Prof. A. P. Winston, was the result of careful and impartial inquiries as to the working of the clause in the (McKinley) Act of 1890 raising the impost from 1 to 2.20 cents per pound in order to wrest, if possible, the American trade from the Welsh makers. In 1894 the rate was, by the Wilson bill, reduced to 1.20 cents per pound. The statistics show that for the four years ending June 30, 1895, a gratifying and rapid growth of production, viz., 19,000,000, 108,000,000, 145,000,000 and 200,000,000 pounds. Importations showed a marked decline. The conclusion to be drawn from the figures adduced was that, even if no further encouragement of tariff be given, the tin-plate industry, which has a large expectation of natural growth before it, can maintain itself against British competition, partly by superior mechanism and intelligence, proximity of raw material, and incoming of Welsh operatives.

Dr. C. F. Taylor, of Philadelphia, presented a paper entitled 'An Inheritance for the Waifs,' which was an ingenious appeal to the National Congress to tax heavily, by a progressive ratio, the succession of estates exceeding $1,000,000, for the benefit of waifs and strays; or, as the author put it, to make the Nation a joint and preferred heir of the very rich for the benefit of the destitute orphans—a sort of poetic or divine retribution. Attention was called to the fact that evasion would be resorted to by giving, instead of bequeathing, the excess property, which, the author contended, could be thwarted, as by the French law, by taxing such gifts. No one called attention to the fact that aside from general objections of policy and the discrimination against millionaires, this is not a proper subject of Federal legislation, unless the District of Columbia be a trifling exception. Its jurisdiction qualifies that population as a proper seed-plat for experimental legislation, but otherwise all such matters are domestic, appertaining to each State of the United States for its separate trial.

Of similar purport was the argument of James S. Skilton, a practicing attorney at in New York, advocating the incorporation of a 'Sociological Institution,' for which a Bill (H. R. 8,192) has been introduced in Congress. The headquarters of this proposed Association are to be in Washington, D. C., and its first Board of Managers comprised of the heads of the principal political departments. It is modelled closely upon the act incorporating the Smithsonian, with this notable difference that in the latter case there was already in the Treasury a handsome bequest of money, with specific recommendation of the donor (and with nobody's dissent) that it should be used to promote the diffusion of sound learning. No definition of its aims and purposes is given beyond the capacity to receive gifts of money and to loan the same to the public Treasury at four per cent., unless it be found in the words 'for the increase and diffusion of sociological science among men.' Something is said later about 'the duties of librarian and of keeper of the sociological exhibits and material of the Institution.' This raises the very pertinent question : what is sociology, and what is included or excluded in the term? Whether this new term which it is thus attempted to christen and fasten upon the National statutes is likely to stick, and in what sense, or whether it is likely to be restricted in future use to merely human social forces, are questions which will be raised among philosophers, legislators and reformers. The endorsement of the American Association is sought for the Bill and will come up for action of the Council at the next regular meeting. Perhaps the long argument in its favor by its author may meanwhile appear in Dr. Small's *Journal of Sociology*, so that its merits may be more generally known.

Fifteen papers in all were considered, having a wide range of topics, as will be seen by the following, in addition to those specially mentioned above:

'Fashion, a Study,' by S. Edward Warren.

'The Value of Social Settlement,' by Aaron B. Keeler.

'Citizenship, its privileges and duties,' by Stillman F. Kneeland.

'Relics of Ancient Barbarism (legal),' by Stillman F. Kneeland.

'Suicide Legislation,' by W. Lane O'Neill.

'Better Distribution of Weather Forecasts,' by John A. Miller.

'Human Reciprocity (Vanishing Neighborship),' by Mary J. Eastman.

Students and teachers of the group of subjects included in Social Science and Economics are invited to take part in the next meeting at Detroit, so as to lend additional zest and dignity to this important and fascinating field.

Richard T. Colburn,
Elizabeth, N. J. *Secretary.*

ON THE PENIAL STRUCTURES OF THE SAURIA.*

In the course of preparation of a work on the scaled reptiles of North America for the Smithsonian Institution it has become necessary to examine some neglected parts of the anatomy. In the present paper I give the results of an investigation into the structure of the hemipenis of the lizards. Very little attention has been given to the subject hitherto, and our knowledge up to 1856† is thus summarized by Stannius: A duplication or bifurcation of each organ is present in *Lacerta* and in *Platydactylus guttatus*. The copulatory organs of the Chamæleonidæ are distinguished by their shortness. In various Varanidæ which have been investigated, the internal cavity (external when protruded) has transverse concentric folds. A fissure interrupts these folds, so that they are not complete annuli. The extremity is acuminate and expands at the base, forming a kind of glans.

In 1870‡ J. E. Gray describes and figures this organ of *Varanus heraldicus*, giving the best illustration that I know of. In 1886 Wiedersheim§ describes and figures this organ in Lacerta. Besides these references I know of nothing later.

As was to have been anticipated, I have found these organs to correspond with the rest of the structure, and to furnish invaluable aids to the determination of affinities among the Sauria. Reference to them cannot be omitted henceforth in cases where the other characters render the question of affinity uncertain.

In the Sauria the male intromittent organ or hemipenis presents much variety of structure, showing some parallels to the corresponding part in the snakes. It is, however, rarely spinous, as is so generally the case in the Ophidia, the only spinous forms being, so far as I have examined, the American Diploglossinæ and genera allied to *Cophidas*.

The higher Sauria have the apical parts modified, as in the Ophidia, by the presence of calyculi. Such are characteristic of the Rhiptoglossa and Pachyglossa. The Nyctisaura possesses the same feature. The Diploglossa, Helodermatoidea and Thecaglossa have the organ flounced, the flounces often pocketed or repand on the margin. In the Leptoglossa we have laminæ only; in the Tiidæ mostly transverse, and in the Scincidæ mostly longtitudinal. In various genera terminal papillæ are present. The organ may be simple, or bifurcate, or merely bilobate. I have not met with the case so common in Ophidia, where the sulcus spermaticus is bifurcate and the organ undivided.

The structures of the hemipenis have a constant systematic value. As in the Ophidia, the value differs with the character, but it varies from generic to superfamily in rank. E. D. Cope.

* Abstract of a paper read before Sect. F of the Amer. Ass. Adv. Sci., Buffalo, August, 1896.

† Zootomie der Amphibien, p. 266.

‡ Annals Magaz. Nat. Hist., 1870, VII., p. 283.

§ Lehrbuch der Vergl. Anat. Wirbelth.

CURRENT NOTES ON ANTHROPOLOGY.

THE ARCHÆOLOGY OF SWITZERLAND.

A brief and excellent conspectus of the archæology of Switzerland is presented in a recently published lecture by Dr. J. Heierli, of the University of Zurich. A number of important 'stations' are named and described in the appendix.

That the upper valley of the Rhine was peopled in palæolithic and immediately post-glacial times is proved by the extraordinary discoveries in the Kessler-loch, near Thaingen. They include bones of extinct animals, weapons and ornaments, and drawings of unquestionable antiquity. The lake dwellings contribute a rich harvest for the following period, the neolithic; while the bronze and later epochs have numerous remains. By these relics it is not difficult to trace in this area the gradual but certain progress of man from the glacial morning of his life down to the present day, without a break in his productive activity.

Dr. Heierli's address is entitled 'Die Archæologischen Funde des Kantons Schaffhausen in ihrer Beziehung zur Urgeschichte der Schweiz.' (Sauerlander, Aarau, pp. 31.)

THE SVASTIKA SYMBOL.

Dr. von Luschan in the Proceedings of the Berlin Anthropological Society last February described some weights from Ashantee, marked with the sign of the svastika, and also exhibited photographs of a woman of the Basundi tribe (East Africa, valley of the Kuilu River) who was tattooed over her body with a number of figures simulating the same symbol. He was not able to offer the meaning which in these different parts of the continent was attached to the sign, nor the native word for it.

It is quite possible that its occurrence in Africa should be referred to influence from India, which was exerted repeatedly from early times, although the design is a simple one and might have arisen spontaneously.

Dr. Von Luschan refers to its appearance in America as rare. The extremely well cut copper svastika from the Hopewell mound, Ohio, would intimate that it was an important and familiar device for some purpose. At any rate, it can no longer be maintained, as was argued some years ago, that it is an essentially 'Aryan' symbol. It apparently belongs to all races.

HOTTENTOT LYRICAL POETRY.

The Hottentots are often quoted as on or near the lowest round of the ladder of humanity. If that is correct it increases our respect for the race. Those who have studied them closest have in them found much to admire. One such trait is their regard for women. The missionary Hahn tells us that the most sacred oath a man can take is to swear by his eldest sister! So great is his veneration for her that he never addresses her first.

In a recent number of 'Globus,' Dr. Jacobowski collects from various sources some specimens of the lyrical poetry of the tribe. It is of a much higher grade, both in sentiment and expression, than we could have expected from the cultural condition of the people. One poem reads:

"My lioness! Dost thou fear that I will charm thee with magic arts? Soft is thy hand which milkest the cow. Bite me (*i. e.*, kiss me). Pour me the milk, my lioness, thou daughter of a chieftain."

Other songs of love are chanted alternately by men and women. Some express hate and the desire for revenge, others jealousy and defiance, approaching the 'nith songs' of the Eskimos. This interesting study reveals anew how profoundly the poetic faculty is rooted in the nature of man as one of his earliest and most universal modes of expression.

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CURRENT NOTES ON METEOROLOGY.

COLONIZATION BY EUROPEANS IN THE TROPICS.

It is at present the almost universal opinion among those who have studied the relations of climate and man that complete acclimatization of Europeans in the tropics is impossible, and that therefore true colonization by the white race in the tropics is also impossible. In this connection Arthur Silva White, in an article on 'British Unity' in the *Scottish Geographical Magazine* for August, speaking of tropical countries, says that northern Europeans cannot establish permanent homes in climates so dissimilar to their own. Permanent homes have been established by Europeans in the West Indies, but their descendants have undergone inevitable deterioration by partial assimilation with local elements, and India, although Europeans have been able to live there for prolonged periods, is not a colony of settlement, but a dependency. In accordance with this view of permanent settlement and colonization of Europeans in some countries, and of their non-acclimatization and of their being unable to live permanently in other countries, the author divides British colonies into two groups: Colonies of Settlement and Tropical Dependencies. Under the first are included Canada, Australia, and, to a modified extent, Cape Colony and Natal, all of which, except the northern part of Australia, lie in the Temperate Zones. Under Tropical Dependencies are included India, all Crown Colonies, Protectorates, and the numerous commercial settlements, islands, naval and coaling stations lying within the tropics. In the latter group Europeans form a mere fraction of the population, but owing to their superior attainments and resources, they act as rulers and overseers. The native population is necessarily servile, because the European colonist cannot perform hard labor out of doors in tropical climates, and as long as this large servile native population exists, a high civilization and political independence are out of the question. This whole subject of acclimatization and of colonization is of very great importance at the present day, when Great Britain, Germany, France and Italy are so actively extending their possessions in Africa. In many of these newly acquired territories true colonization by Europeans is and always will be impossible.

CHANGES OF TEMPERATURE DURING THE RECENT SOLAR ECLIPSE.

Nature has recently published two communications on the changes of air temperature during the solar eclipse of August 9th. One set of observations, made by H. R. Mill at Vadsö, is thus summarized: Speaking roughly, the eclipse began at 4, was total at 5, and was over by 6 o'clock. At 4:18 the temperature was 44.0° F.; at 4:23 it was 43.5°; at 4:28 and 4:33, 43.2°. From 4:35 to 4:43 the sun was shining brightly and the temperature rose to 43.3°; at 4:53 and 4:59, glimpses of the sun were caught before and after totality. The temperature from 4:48 to 4:58 was steady at 43.0°; and at 5 it had dropped to 42.1°; from 5:3 to 5:13 it stood at 42.3°. By 5:33 it had risen to 43.8°, and at 5:48, when the observations ceased, to 45.0°. The thermometer hung from the tripod of a 3-inch telescope, the bulb being about 18 inches from the ground. No special precautions were taken to shield it from the sun's rays, but, owing to the cloudiness, none were necessary.

The second set of observations was made by H. W. Blake, also at Vadsö, and both a sun and shade thermometer were used. The fall of the former, which was fully shaded by cloud, was, from 4:10 to just after totality, 2°, and its recovery from that point to 5:56, last contact, was 3.6°. The shade thermometer showed greater variations, viz., a fall of 3.35°, and a subsequent rise of 5.6° at 5:50.

It is to be hoped that other meteorological data may have been collected by the various expeditions sent out to observe the eclipse. The variations of pressure, the changes in wind direction and the deposition of dew are interesting facts, already observed in previous eclipses, and further data in regard to them would be valuable.

INDIAN METEOROLOGICAL PUBLICATIONS.

Among the recent publications of the Meteorological Department of India are Parts IV. to VII., inclusive, of Vol. IX. of the *Indian Meteorological Memoirs*. These volumes contain discussions of the hourly observations made respectively at Nagpur and Poona; Belgaum and Bellary; Trichinopoly, and Rangoon and Aden. They were prepared by John Eliot, F. R. S., Meteorological Reporter to the Government of India.

AUSTRALIAN WEATHER.

Mention was recently made in these *Notes* of a little volume entitled *Australian Weather*, containing three essays of considerable importance on matters connected with Australian meteorology. We have since been informed that the book can be purchased of G. Robertson & Co., George street, Sydney, N. S. W., for 2s. 6d. Meteorologists are certainly under a debt of gratitude to Hon. Ralph Abercromby, under whose auspices and at whose expense the book was published. Mr. Abercromby, though now incapacitated for active work by reason of poor health, still keeps up his interest in meteorology by providing means for others to do the work he is no longer able to accomplish.

NOTES.

Among other publications are the following:

O. Petterson: *Ueber die Beziehungen zwischen hydrographischen und meteorologischen Phänomenen.* Met. Zeitschr., August 1896, 285–321. An important paper, containing much of interest on the temperature and other conditions of the ocean surface in their relations to meteorological phenomena.

J. L. Cline: *The Climate of Texas and the Cultivation of the Apple.* Reprinted from the Galveston *Daily News*, August 22, 1896. 8vo. Pp. 7. The author concludes: "There appears nothing in the climate of the greater portion of Texas to prevent successful apple culture except that irrigation will be necessary."

H. F. Williams: *Temperatures Injurious to Food Products in Storage and during Transportation, and Methods of Protection from the Same.* Prepared under the direction of the Chief of the Weather Bureau, Weather Bureau Bull. No. 13, 8vo., pp. 20. This is a revised and enlarged edition of a publication bearing the same title and originally issued as a circular of the Weather Bureau.

R. DeC. Ward.

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ASTRONOMICAL NOTES.

Among recent American publications we notice Vol. IX. from the Washburn Observatory. It contains Prof. Comstock's investigation of the constants of aberration and refraction by means of a modification of M. Loewy's method. This consists in measuring with a micrometer the distances of stars which are about 120° apart on the sky. In order to bring the images of such distant stars simultaneously into the field of view of the telescope, a prism is placed outside of the object glass. From the variation of the distances throughout the year it is possible to deduce a value of the aberration which should be independent of any assumed star places. In order to make the refraction constant likewise independent of assumed star places, Prof. Comstock has employed sets of pairs of stars so situated that it was possible to take advantage of the fact that the sum of the successive differences of right ascension of any series of stars will be exactly 360°, provided the series begins and ends with the same star.

It is to be regretted that we have not space to devote to Prof. Comstock's work an extended review. Very high praise is due, however, to the skill and care with which the whole very large piece of work has been accomplished. It is a praiseworthy thing to turn out a large series of observations well made and reduced, with instrumental methods and with methods of reduction which have been well settled by the experience of successive generations of astronomers. But it is a very different thing to take up a new method of observing with a new form of instrument, and to carry out successfully an investigation of one of the fundamental constants of astronomy. While therefore we give to the present research very high praise, we do not doubt that Prof. Comstock himself would make not a few changes, if he had the work to do over again.

Among the things which might perhaps with justice be subjected to criticism is the insufficient manner in which the thermometers and the determination of the temperature of the air have been treated. This is, of course, a matter of vital importance when the constant of refraction is to be determined. Yet the thermometers from whose indications the refractions were computed were simply compared with a standard thermometer for the determination of their division errors, as well as their other errors. The standard thermometer itself was examined at the Signal Office in Washington, but no details are given as to the method used in the examination. In a research involving the fundamental astronomical constants all such details should be published. As a matter of fact, Prof. Comstock should have used only standard thermometers, and he should have determined their division errors and their fundamental points himself. He makes no statement as to his method of comparing his thermometers with the standard, and this very important omission leaves us entirely in the dark as to the possible uncertainty of the temperature determinations.

Another rather unusual thing is the manner in which Mr. Flint's observations have been treated. All of these observations which differed more than 1″ from the mean of Mr. Comstock's own observations were rejected, and the others were given half weight. This was done because it appeared 'from an inspection of his (Mr. Flint's) individual results that they are peculiarly subject to large accidental errors.' It would probably have been better to have rejected all Mr. Flint's observations, especially as their number was not very large in comparison with Mr. Comstock's. The retaining of these observations will probably diminish somewhat the confidence felt by astronomers in the result of the research regarded as a fundamental constant. Yet they have probably had but very little effect on the final values obtained for the refraction and aberration, in view of the unusual method of weighting used.

The *Astronomische Gesellschaft* has just published the eleventh part of its great star catalogue. It gives the positions of 9,789 stars in the zone from 15° to 20° North declination, observed at Berlin by Prof. Auwers. This brings the total number of stars in those parts of the Gesellschaft catalogue already published up to 72,951. The published zones now cover all the sky between the equator and 80° North declination, with the exception of the zones 5° to 15°, 25° to 40°, and 70° to 80°. The Cambridge (England) zone, 25° to 30°, is announced as in press, so that its publication may be expected during 1897.

We note the appearance of the 1896 volume of the *Anuario publicado pelo Observatorio do Rio de Janeiro*, and of the 1890 volume of the Washington Observations. The latter contains as an appendix the new catalogue of stars derived from the zone observations made at Santiago de Chile by the U. S. Naval Astronomical Expedition under Lieut. J. M. Gilliss, in the years 1849 to 1852. The catalogue gives the place of 16,748 southern stars.

The Cape of Good Hope Meridian Observations for the years 1888 to 1891 have also appeared, as well as the volume of Greenwich Observations for 1893. H. J.

SCIENTIFIC NOTES AND NEWS.

FIELD WORK OF THE GEOLOGICAL SURVEY.

The field work of the United States Geological Survey is still going actively on in all directions. There are about 30 geologic and paleontologic parties in the field, a large force of topographic surveyors and a large force engaged in the several branches of hydrographic work. The scope of the work of stream gauging and investigating the subject of underground currents and artesian wells has been materially extended this year.

The Director spent several weeks studying the Cambrian rocks and faunas of southwestern Nevada, and at last reports was in the desert region in Inyo county, Cal. He will not return to Washington before November 1st. In his absence Col. H. C. Rizer, the Chief Clerk, is the executive head of the Survey.

Mr. R. T. Hill, who went to Indian Territory to continue his studies of the geology of the region, was soon forced to discontinue by a severe attack of malarial fever. His condition was for sometime a precarious one, but he is now on the road to recovery. The topographic force in Indian Territory suffered a great deal from malarial fever in August and September.

POPULAR INSTRUCTION IN NATURAL HISTORY.

According to the London *Times* an experiment has been undertaken in London which might with advantage be tried in America. The Library Commissioners of the public library of St. George's, Hanover Square, London, have set apart a large room for the study of natural history on a plan presenting several novel features. The essential point is the combination of a complete library with a museum so arranged as to be self-explanatory. The two are the proper complements of each other, and together form a thorough introduction to natural history, or *gradus ad naturam*, as it may be called, the like of which has never yet been offered to the public. Both the books and the specimens are an anonymous gift, and they represent the labors of a lifetime.

The collection is so arranged and classified as to give the elementary student an intelligent grasp of the whole domain of natural history or of any section of it. The general idea is to lead on from one thing to another. A few choice cases are placed on the landing outside the room to attract the attention of the casual visitor, and a plan of the collection meets his eye before entering. Inside he finds himself confronted by a general scheme of the whole subject, equally clear, simple and comprehensive. It strikes the keynote of the collector's purpose, which is to 'start with the foundation of a systematic classification,' and it enumerates with illustrations 'the 25 classes of the animal world.' A few quotations from this scheme will exemplify the method adopted. The 25 classes are grouped in five divisions, and the first of these is described as follows:

Division I. (the backboned animals) contains Classes 1 to 5—namely: (1) mammals; (2) birds; (3) reptiles; (4) amphibians; (5) fishes. They are all alike, because they have: (*a*) an inside framework of bone; (*b*) a long backbone; (*c*) a spinal cord; (*d*) four limbs; (*e*) red blood; and they are called BACKBONED ANIMALS (*vertebrata.*)

Each class is further described in a parallel column and illustrated by a specimen. Thus, Class 1 is illustrated by a dormouse, with the following description:

This dormouse and similar backboned animals feed their young with milk, are covered with hairs, prickles or spines; their four limbs end in feet, hands, scrapers or paddles; they have a four-chambered heart and warm blood; they breath with lungs, and (as they feed their young with milk) they form Class 1, MAMMALS (*mamma*, a teat).

THE U. S. COAST-LINE BATTLE-SHIP 'OREGON.'

The *Journal of the American Society of Naval Engineers*, in the issue of August, 1896, contains an article of great value and interest, by Mr. Leo D. Morgan, on the Contract-Trial of the 'Oregon.'

This is a sister ship to the 'Indiana' and the 'Massachusetts,' a twin-screw, armored coast-line battle-ship, displacing 10,250 tons at 24 feet draught, and was built by the Union Iron Works of San Francisco, at a cost of $3,180,000 plus $43,000 for changes in construction while under contract. The contract-trial of this great iron-clad took place in May last, and the recorded and officially accepted speed was reported as 16.79 knots. The guaranteed speed was 15 knots, and the contractors won a bonus of $175,000 on the excess above that figure. Had the speed fallen below the guarantee, they would have forfeited the same figures—$25,000 for each quarter knot variation from the contract. The speed attained exceeded that reached by either of the sister ships. The armor of the 'Oregon' is of nickel-steel, 18 to 8 inches thick on the sides, amidships, tapering from its upper to its lower edge. The casemate armor is 4 inches thick, backed by plates 2½ inches thick. The turrets are covered by armor of from three and four inches thickness over the smaller guns up to 15 and 17 inches over the 13-inch rifles.

The battery is made up of four 13-inch B. L. rifles, eight 8-inch, and four 6-inch guns, with a quantity of 'rapid-fire' and 'machine' guns.

The engines are two triple-expansion, inverted, direct-acting machines, placed side by side in compartments fitted with water-tight doors. Their plan is that usual, in the main, in naval machinery, and they are made exceptionally light and strong by the employment of steel in frames and running parts wherever practicable. Each engine has three cylinders of 34½, 48 and 75 inches diameter, respectively, and a piston-stroke of 42 inches. The ratios of cylinder areas are 1,957 and 2,455, or a total ratio of high to low of 2,697. The clearances are from 14 to above 15 per cent. The screws are of 15 feet diameter and 16 feet mean pitch. They are of the Griffith form, 3-bladed, and increasing in pitch fore and aft. The cooling surface of the condensers is 6,352.5 square feet, in each engine; the boilers have a total of 16,832 square feet of heating surface, one-third more than the total cooling surface of the condensers. The grate-surface is of 552 square feet area, and the ratio of H. S. to G. S. is 30.5 to 1. A forced draught is employed at full speed. Three electric light and power 'plants' are installed—24-kilo-watt, G. E., machines, making 400 revolutions a minute and generating an output of 300 amperes at 80 volts. They are driven, each, by a vertical, compound engine, 8½ and 13 inches diameter, by 8 inches stroke. Six hundred and six lights are distributed about the ship, and four 25,000 candle-power search-lights are mounted on the pilot house and bridge. They take an 80-ampere current at 50 volts. The contractor's engine-room force was one chief engineer, in charge, one in the fire rooms, four engineers in the engine and fire rooms, 16 oilers, 16 machinists, 4 storekeepers, and 4 wipers in the engine room; 37 firemen, 37 coal passers, 8 water tenders, in the fire rooms; 16 oilers and 11 machinists and 4 helpers, on the deck and in the smaller engine rooms—a total of 161 men. The steam pressure on the trial was continuously 163 pounds per square inch by gauge. The engines made 128 revolutions per minute, and developed 10,890 I. H. P. total.

The coal consumption amounted to 2,123 pounds per I. H. P., 38.3 per square foot of grate, and 1.22 per square foot of heating surface; while the cooling surface of the condensers had a ratio of 1.22 per I. H. P., and the boiler heating surface 1,745 per I. H. P.

This is a good example of the best work of modern naval establishments, and illustrates well the ability of the construction and engineer's bureau of our own navy department. The ship combines speed and offensive and defensive power in a degree which excites the wonder and admiration of even those who are most familiar with the advances made in recent years in the arts of naval construction and steam engineering.

R. H. T.

GENERAL.

A STATUE to Pasteur has been unveiled at Alais, in the center of the French silkworm district.

At the opening of the *Versammlung Deutsche Naturforscher und Aertzte*, at Frankfurt, on September 21st, there was laid the foundation stone of a monument to von Sömmering, the eminent physiologist and anatomist, who died in 1830.

Nature states the monument to Lobachevsky, erected at Kazan, in a square which bears the name of the great geometer, was unveiled on September 13th, in the presence of the Bishop of Kazan, the Governor of the province, the University, the local Physical and Mathematical Society, and a great number of sympathizers. The Mayor of Kazan made a statement as to the funds raised for the erection of the monument. Prof. Suvoroff referred to the scientific work of Lobachevsky in mathematics and physics, and Prof. Vasilieff spoke of the great geometer as one whose life was worthy of emulation, and as an energetic worker for spreading scientific knowledge. In the evening the Physical and Mathematical Society held a special commemoration meeting before a distinguished gathering of visitors of both sexes.

The following is an official list of men of science who are expected to attend as delegates the sesquicentennial celebration of Princeton College:

Henri Moissan, Member of the French Academy of Sciences and professor of chemistry in the University of Paris.

Felix Klein, professor of mathematics in the University of Göttingen.

Joseph John Thomson, Cavendish professor of Natural philosophy in the University of Cambridge.

A. A. W. Hubrecht, professor of zoology in the University of Utrecht, Holland.

Edward Baynall Poulton, Hope professor of zoology in the University of Oxford.

Wilhelm Dörpfeld, First Secretary of the German Archæological Institute, Athens, Greece.

Sir J. William Dawson, emeritus professor of geology in McGill University, Montreal, Canada.

J. Willard Gibbs, professor of mathematical physics in Yale University.

George Lincoln Goodale, Fisher professor of Natural History and director of the Botanic Garden in Harvard University.

George William Hill, President of the American Mathematical Society.

Herman von Hilprecht, Curator of the Babylonian antiquities in the University of Pennsylvania.

S. P. Langley, Secretary of the Smithsonian Institution.

Joseph LeConte, President of the American Geological Society and professor of geology and natural history in the University of California.

John W. Mallet, professor of chemistry in the University of Virginia.

Dr. Silas Weir Mitchell, Philadelphia.

Simon Newcomb, editor of the Nautical Almanac and professor in Johns Hopkins University.

Henry A. Rowland, professor of chemistry and director of the physical laboratory in Johns Hopkins University.

Members of the Biological Section of the New York Academy of Science have subscribed $250 to the Huxley Memorial Fund.

The Council of the New York Academy have extended an invitation to Prof. Henri Moissan, the distinguished French chemist, who represents the University of Paris at the Princeton sesquicentennial, to lecture before the Academy and the other scientific societies of New York.

At the meeting of the New York Academy upon Monday evening, October 5th, the number of honorary members was increased to 43 by the election of Prof. Felix Klein, of Göttingen; Prof. J. J. Thompson, of Cambridge, and Prof. Henri Moissan, of the University of Paris.

The Academy of Natural Sciences of Philadelphia has conferred the Hayden Memorial Geological award for 1896 on Prof. Giovanni Capellini, of the University of Bologna.

Mr. E. Gerrard, who, for more than fifty years, has been an attendant in the British Museum, has retired.

With the October number *Science Progress* becomes a quarterly, instead of a monthly, as hitherto. The journal, conducted by Mr. Henry C. Burdett and edited by Mr. J. Bretland Farmer, with the cooperation of an able editorial committee, was founded two and a-half years ago, and has maintained a uniformly high standard of scientific excellence.

A new medical monthly journal is to be started shortly in Edinburgh. The prospectus has not yet been issued, but it is understood that the journal is to represent and be owned by the Scottish medical profession.

Sir George M. Humphry, professor of surgery and formerly professor of anatomy at Cambridge University, died on September 24th.

The death is announced of Mrs. Darwin, the widow of Charles Darwin.

Mr. Henry D. Van Nostrand, a New York business man, died on October 9th. He had made contributions to conchology and leaves a collection of shells of great value.

Natural Science states that G. A. Baer, of Paris, has gone to Peru to investigate the insect fauna.

Dr. R. DeC. Ward, of Harvard University, has exhibited in the museum of the University a collection of about seventy photographs which he has taken to show the damage done by the St. Louis tornado, May 27, 1896, with special reference to its scientific aspects.

At Blue Hill Observatory, on October 8th, Messrs. Clayton, Ferguson and Sewatland sent a series of kites carrying a meteorograph to a height of 9,385 feet, more than three miles of piano wire being used. The temperature fell from 46° at the hill to 20° at an altitude of 8,750 feet.

It is proposed to organize at the University of Pennsylvania a mathematical club. A preliminary meeting will be held on October 16th, at which a paper setting forth the objects of such an organization will be read by Dr. E. S. Crawley.

The seventh Congress of the Italian Medical Society will be held in Rome, beginning October 20th. The ninth Congress of Italian Alienists was held at Florence, beginning October 5th.

It is stated that in the great cyclone which passed over Paris on Thursday, September 10th, damage to the extent of $15,000 was done at the Musée d'histoire naturelle.

The archæological and paleontological museums of the University of Pennsylvania have recently received from H. W. Seaton-Karr, of England, by exchange, a collection of flint implements secured in Somali Land, South Africa.

It is announced in *Nature* that it is proposed to establish an International Botanical Station at Palermo, under the superintendence of Prof. Borzi, who desires the cooperation of botanists of all countries.

Mr. George F. Becker, of the United States Geological Survey, has returned to Washington after an absence of six months in South Africa. He visited the diamond mines at Kimberley, but spent most of his time near Johannesburg, studying the gold deposits. A projected trip through the Chartered Company's territory was prevented by the Kaffir war. Mr. Becker expects to print some of his results during the winter, but probably, in England; his data having been collected at the expense of English capitalists.

It is stated in the daily papers that the Mt. Lowe observatory at Echo Mountain, California, has been placed in the hands of a receiver, and that Mr. Lewis Swift, the astronomer, will probably remove his telescope and other instruments to some other point.

The *Lancet* states that the memorial stone of the Hope Hospital for Langholm was laid on the 21st inst., by Miss Hope, of New York. The hospital is one of the results of a sum of £100,000 left by the late Mr. Thos. Hope, of New York, to Langholm as his native place, the capital to be administered by trustees for the benefit of the inhabitants. The building is to be a very handsome one, and the plans are in every respect drawn on a most liberal scale. The cost is estimated at £17,000.

According to the New York *Sun*, Rockall, a desolate rock rising only seventy feet above the sea, between Iceland and the Hebrides, is to be made an English meteorological station. It lies 250 miles from land, the nearest point to it being the little island of St. Kilda, 150 miles away, and itself nearly a hundred miles from the main group of the Hebrides. Rockall is in the path of the cyclonic disturbances on the Atlantic, and the station there would give timely warning of storms approaching the British coast.

We announced recently the resignation of the professor of hygiene in the University of Moscow, F. F. Jerisman. It is reported that he has been excluded from further service at the University by the Ministry of Instruction, owing to his liberal views in political matters.

The international race for horseless carriages from Paris to Marseilles and back, on October 3d, was won by carriages propelled by Daimler motors. The distance of 1,100 miles was covered in seventy-two hours. Of the thirty-eight carriages that started two were run by steam and the others by petroleum.

According to the *Progrès médical* vaccination is carried out in Texas by sending a squad of policemen with the physician who cover the patient with their revolvers while the operation is being performed. The French paper thinks that this system has many merits and should be adopted in France. We are also informed by a French journal, *La Nature*, that silver has been transformed into gold in America, not referring to the recent action of one of our political parties nor even exclusively to the case recently reported in the newspapers, but naming two of our most prominent inventors and two of our leading men of science among the alchemists.

A BACTERIOLOGICAL laboratory has been established at Angiers, France, with an annual appropriation of about $500.

PROF. H. NEWELL MARTIN'S 'The Human Body,' one of the text-books in Henry Holt & Co.'s admirable American Science Series, has been revised by the author for the seventh edition just issued. It is the longer of the three courses in the subject, all of which have long been accepted by men of science and teachers as model text-books. In this edition new matter has been added, especially on the cardiac and vascular nerves and on the physiology of the brain, and many pages have been rewritten. The author's style is unusually clear, the subject-matter is free from both dogmatism and indefiniteness, and the book remains the best compendium we have covering the anatomy, physiology, psychology and hygiene of the human body.

THE rapid development now sure to take place in the manufacture and use of auto-mobile carriages has been long delayed. As early as 1834 the British Parliament appointed a select committee to "enquire into and report upon the tolls and prospects of land carriages by means of wheeled vehicles propelled by steam or gas on common roads." According to *Power and Transmission*, the report of the committee may be summarized as follows: 1. "That carriages can be propelled by steam on common roads, and at an average of ten miles an hour. 2. That at this rate they have conveyed upwards of fourteen passengers. 3. That their weight, including engine, fuel, water and attendants, may be under three tons. 4. That they can ascend and descend hills of considerable inclination with facility and ease. 5. That they are perfectly safe for passengers. 6. That they are not (or need not be if properly constructed) nuisances to the public. 7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses. 8. That, as they admitted of greater breadth of tire than other carriages, and as the roads are not acted upon so injuriously as by the feet of horses in common draught, such carriages will cause less wear of roads than coaches drawn by horses. 9. That rates of toll have been imposed on steam carriages which would prohibit their being used on several lines of road were such charges permitted to remain unaltered."

WE have already called attention to the memorial to the late Dr. D. Hack Tuke, which will probably take the form of a library in connection with the British Medico-psychological Association, to which Dr. Tuke's library has already been given. An American committee has been formed and subscriptions for the memorial may be sent to Dr. Charles W. Pilgrim, Poughkeepsie, N. Y.; Dr. Charles G. Hill, 317 North Charles Street, Baltimore, Md., or Dr. Frank C. Hoyt, Clarinda, Ia.

THE *Lancet* states that, in the *Berliner Klinische Wochenschrift* of August 31st, a paper is published by Dr. C. Kaiserling, describing a process for preserving tissues which he has introduced, and with very encouraging results. The organ to be preserved is first placed in a solution of the following composition; Formalin, 750 c. cm.; distilled water, 1,000 c. cm.; nitrate of potash, 10 grammes; acetate of potash, 30 grammes. The organ is disposed in such a position as to preserve its form as far as possible, and the fluid should be large in proportion to the size of the specimen. This solution does not abstract any color, but remains quite clear, and can be used for a large number of specimens. An immersion of twenty-four hours in the fluid is sufficient for any tissue, but double this period will not do any harm. The organ is then allowed to lie for twelve hours in 80 per cent. alcohol and then for two hours in 95 per cent., and is subsequently preserved in equal parts of water and glycerine, with the addition of thirty parts of acetate of potash. Very delicate tissues, such as intestine, are best kept in equal quantities of glycerine and water after the addition of absolute alcohol in the proportion of one part of alcohol to ten of the mixture. By this method Dr. Kaiserling has succeeded in retaining the natural color of blood and the transparency of nearly all organs. The substance of the brain is particularly well preserved, areas of softening, hemorrhages, and pus in the pia mater being very well demonstrated.

UNIVERSITY AND EDUCATIONAL NEWS.

The fourth annual report of President Schurman, of Cornell University, has been presented to the trustees at an early date. The report extends to 79 pages with appendices of about the same length and gives a full account of the recent progress and present condition of the University. We have already noted the new appointments and other enlargements such as the establishment of the State Veterinary College. The total number of students in the university last year was 1,702. The absolute and relative increase in those taking scientific courses is shown to be as follows:

	1891–92	1892–93	1893–94	1894–95	1895–96
Arts	142	141	138	133	146
Philosophy	100	110	121	136	153
Science	82	89	89	115	144
Letters	94	82	85	65	50

There has, however, been a decrease in the number of students attending the technical courses, owing to the fact that the requirements for admission were advanced in 1894.

In view of the destruction of the main building of Mt. Holyoke College by fire, the trustees are considering the removal of the College from South Hadley. Springfield and Worcester have been mentioned as possible locations for the College.

The councils of University College and King's College, London, have inaugurated a series of lectures and demonstrations of university character for the benefit of students unable to attend in the day time. The program for the present session includes courses on mechanical engineering, on electrical engineering and on practical chemistry by the professors at University College, and courses on civil engineering, on architecture, on experimental and practical physics and on pure mathematics by the professors at King's College.

The Woman's College of Baltimore has recently received, as a gift from the Rev. George C. Stull, of Butte, Montana, a collection of about 200 Montana ores and minerals. The specimens are carefully determined, labeled and catalogued, and are accompanied by chemical analysis. Gold, silver, copper and antimony are well represented, and the whole collection makes a nearly complete series of the ores and useful minerals from Montana.

The Enoch Pratt Free Library, of Baltimore, has just completed the building of its sixth branch library. It is situated near the Woman's College, and will be largely used by the students. The librarian, Dr. Steiner, has requested lists of desired books from the professors of the College. Lists of scientific books have been sent by Dr. Metcalf and Miss Bunting, of the biological department.

Bishop J. J. Keane, rector of the Catholic University of America, in Washington, has resigned at the request of Pope Leo XIII.

William S. Eichelberger, Ph. D., for the past four years instructor in mathematics and astronomy at Wesleyan University, has resigned, to accept a position in the Nautical Almanac Office in the Naval Department at Washington, D. C.

At the New York University Dr. T. W. Edmondson has been appointed associate professor of physics, and Mr. J. H. MacCracken instructor in philosophy. Prof. W. M. Warren has been promoted to a full professorship of philosophy in Boston University. At Williams College Dr. H. M. Knower has been appointed instructor in biology and Mr. J. R. Congdon assistant in physics.

DISCUSSION AND CORRESPONDENCE.

THE GEOLOGY OF BLOCK ISLAND.

An article with the above title by Prof. O. C. Marsh, in the *American Journal of Science* for October, 1896 (pp. 295–298), is chiefly remarkable for the manner in which the work of previous observers is ignored and the ingenuous way in which well-known facts are stated as if they were original discoveries by the author. The structure of the Island was described by both Upham* and Merrill,† and the parallelism be-

* *Am. Journ. Sci.*, xviii. (1879), p. 92.

† *Trans. N. Y. Acad. Sci.*, xv. (1895), pp. 16–19.

tween the Block Island strata and those of Long Island and the islands to the eastward was commented upon by them and by others. If the article in question went no further than this it would attract but little attention. The conclusions which the author draws, however, are so startling that they require the earnest consideration of everyone who has ever had any experience in the geology of the region.

For example: "The well-known clay deposits of Long Island I have not carefully examined in place. *There is much in the published description of them, however, to indicate that they may represent some of the same Jurassic beds.*"

Inasmuch as the present writer thought that the Cretaceous age of the clays at Glen Cove, Northport, etc., had been thoroughly proven and the Tertiary age of others had at least been satisfactorily indicated,* the above surmise is highly interesting and any proofs of their Jurassic age are anxiously awaited.

Again, "The clay bluffs at Gay Head, in Martha's Vineyard have many characteristics of the same series, but the presence of Cetacean remains in one portion of them indicates that this is Tertiary. There are, however, some reasons for supposing that the most of the clays are much older, *and I believe that they contain representatives of the same great Jurassic formation.*"

As these deposits have been amply proven, by David White,† Merrill,‡ Shaler,§ and the writer,|| to consist of Cretaceous and later strata, the expression of a mere belief in regard to their Jurassic age seems somewhat superfluous.

In a postscript the author says that since his article was in print he has visited Long Island and Martha's Vineyard, and states: "On Martha's Vineyard I found that the great series of variegated clays forming Gay Head, *and generally regarded as Tertiary, are certainly Mesozoic, and all apparently Jurassic.*"

In view of what has already been proven, the above statement is the most surprising of all, and as he concludes with the promise, "I hope soon to discuss this subject more fully elsewhere," the appearance of the discussion is looked for with great interest.

[The italics in the text are mine. A. H.]

Arthur Hollick.
Department of Geology,
Columbia University.

* *Trans. N. Y. Acad. Sci.*, xii. (1893), pp. 222–337; *ibid.* xiii. (1894), pp. 122–129. *Bull. Torr. Bot. Club*, xxi. (1894), pp. 49–65. *Trans. N. Y. Acad. Sci.*, xv. (1895), pp. 3–10.

† *Am. Journ. Sci.*, xxxix. (1890), pp. 93–101; *Bull. Geol. Soc. Am.*, i. (1890), pp. 554, 555.

‡ *Trans. N. Y. Acad. Sci.*, iv. (1885), pp. 78, 79.

§ *Bull. Mus. Comp. Zool.*, xvi., No. 5 (1889), pp. 89–97.

|| *Trans. N. Y. Acad. Sci.*, xiii. (1893), pp. 8–22; *Bull. Geol. Soc. Am.*, vii. (1895), pp. 12–14.

THE CURVE-TRACING TOP.

In reply to Mr. C. B. Warring's suggestion of smoked surfaces, I would say that two of my students have for some time been engaged in computing the moment of inertia of the top from its mass, the radius of the point, the dip, the instantaneous period of precession and the difference of the cardinal radii of curvature of the curves drawn very nearly the maximum distance between two consecutive spires. They have tried lampblacked surfaces, but have given them up because the substance is apt to flake off at sharp angles and the curves are not satisfactory. Mr. Warring's own design bears this out. Moreover, Mr. Warring seems to have missed the point of my article. I value the result in proportion to the simplicity of the means employed. To use lampblack and varnish is to go much out of one's way.

C. Barus.
Brown University, Providence, R. I.

NEW APPLES.

To the Editor of Science: As a contribution to your freak apple discussion in your issue of September 4th, where the phenomenon is described as a pollen phenomenon, and continued in your issue of October 2d, I send the following cutting from John Lewis Child's Fall Catalogue of 1896:

"*Two-Faced*—We never brought out a more unique novelty than this. It originated in Cayuga county, N. Y., and the original tree has been known for many years, but this is the first time it has ever been propagated and put upon the market. The tree bears an apple which is in size and shape similiar to the Tallman Sweet; its peculiarity being that every fruit is divided. One-half is sour, like a Greening, and the other half is sweet, like the Tallman. This is one of the most peculiar freaks which has ever been observed in vegetation. Its oddity, as well as its fine bearing qualities, and the excellent quality of the fruit, both the sweet and sour portion, will make it immensely popular."

I also send for your examination a Dahlia stem bearing two flowers of different colors.

E. LEWIS STURTEVANT.

SOUTH FRAMINGHAM, MASS., October 6, 1896.

[The one Dahlia is light pink, becoming darker towards the center, the other dark maroon with a few pink petals near the center. ED.]

THE LIMITS OF SCIENCE.

PRESIDENT MEES, in his address before Section B (Physics) of the American Association for the Advancement of Science (printed in the last number of this JOURNAL) states that the progress of science "may be expressed by a curve approaching truth asymptotically, probably never in human experience approaching to its *complete* knowlege. So long as investigators find that they are working upon the steep part of the curve where it approaches truth rapidly, there is no lack of interest; this, however, seems to die out quickly when much labor and great patience are required to extend experimentally the curve now more slowly approaching complete knowledge, or straighten out some of its irregularities."

I should myself regard the progress of science from a very different point of view. Knowledge does not seem to me to approach final truth as an asymptote, but rather to be an irregular sphere in endless space. The more we enlarge our little sphere the greater is the surface at which our knowledge touches our ignorance. The more we learn the greater is the area immediately awaiting exploration.

It is true, as President Mees states, that a man or group of men of unusual insight carry forward our knowledge, and the details must be filled in until the average has arrived at the point reached by the positive variations. Then new positive variations carrying our knowledge further are more likely. But there has never before been a time when it was possible for a man of genius to make such great advances and in so many directions.

J. MCKEEN CATTELL.

COLUMBIA UNIVERSITY.

RUTGERS COLLEGE MUSEUM.

TO THE EDITOR OF SCIENCE: The Geo. H. Cook Museum of Geology occupies the two upper stories of Geological Hall, which was built in 1871. The museum proper is 84 feet long, 40 feet wide and about 23 feet high, with a gallery 6 feet wide on all sides. The upper and lower class rooms open directly into the museum by double doors.

The Cook collection of minerals occupies six cases on the east side of the room, and numbers over 4000 specimens. The fossils, and specimens illustrating geology, are arranged in six cases on the west side, which, with two large cases on the floor, of rocks, iron and zinc ores, clays, sands and marls (including fossil bones and shells found in the marls) of New Jersey, number 5250 specimens.

The Lewis C. Beck collection of minerals fills two large cases on the floor, and contains 3000 specimens, mostly collected over fifty years ago. Many of them are the original specimens used in some of the old State reports and text-books, and it is really a historic collection of great value to the mineralogist. The pseudomorphs are specially valuable to the lithologist and mineralogist. The center of the floor is occupied by a case of Ellenville quartz crystals, showing also crystals of Chalcopyrite, Sphalerite and Galenite. This collection is a gem!

On the floor near the entrance is a mass of Jura-Trias sandstone 8x18 feet, from Morris Co., N. J., showing fifteen species of dinosaurian footprints. This is said to be the largest and best specimen of saurichnites in this country.

The Mannington (N. J.) mastodon, which was set up last June, covers a space 8x20 feet at the north end of the room.

A diamond-drill core in the gallery shows a section of the rock at the Franklin zinc mines, 1378 feet in depth.

Cases are being built for the large collection of paleolithic implements numbering about 1500 specimens, which include many fine pipes and ceremonial and ornamental objects.

At various places around the room are basaltic columns, fossil tree trunks, large rock specimens, etc.

Besides the mineralogical and geological specimens, there is a collection of 1550 recent mollusks, a botanical collection, large mahogany and tulip tree sections, charts showing Japanese drawings of fishes, a Japanese spider crab (Macrocheirus Camperi), which measures 11 feet 6 inches, skeleton of a Right Whale, caught in the Raritan, large antlers, etc.

Prof. A. H. Chester, curator of the museum, has his fine collection of over 4000 mineral specimens, in cases, in one of the class rooms.

All of the collections are being relabeled and classified, and all but three cases are finished.

Accessions are constantly being made by purchase, exchange and gift. The museum is free to all students or visitors every week day from 8 to 12 a. m. and 1 to 5 p. m. A collector and student of forty years' experience is constantly in attendance, to show and to answer any questions pertaining to the collections.

W. S. Valiant,
Rutgers College Museum. *Assistant Curator.*

SCIENTIFIC LITERATURE.

An Illustrated Flora of the Northern United States, Canada and the British Possessions from Newfoundland to the parallel of the southern boundary of Virginia, and from the Atlantic Ocean westward to the 102d meridian. By Nathaniel Lord Britton, Ph. D., and Hon. Addison Brown. In three vols. I., Ophioglossaceæ to Aizoaceæ. New York, Charles Scribner's Sons. 1896.

This, the first volume of Dr. N. L. Britton's magnificent descriptive flora, establishes a new level for plant-taxonomic publications in America. It emphasizes the passing of the old régime and introduces, in most fitting style, the new ideas in book-making, in description, in arrangement and in nomenclature. Wisely published at a price that places it within the reach of all, and certainly to be completed within a few months, it must become at once the standard for the region which it covers. There is no work extant in the whole series of American botanical publications which deal with descriptions of the flowering plants that can for a moment be compared with it either for a skilful and delightful presentation of the subject-matter or for modern, scientific and accurate mastery of the thousand-fold mass of detail of which such a work must necessarily consist. Such a volume marks the existence of a world's botanical center at New York City not to be unfavorably compared with any other anywhere. The publication of such a work is a proper occasion not only for personal and institutional, but also for national congratulations.

Dr. N. L. Britton, assisted (especially on the financial side) by Hon. Addison Brown, has in this first volume described and figured 1,425 species of plants under 332 genera. This number includes 109 species of ferns and fern-allies, 25 species of conifers and 1,011 species of monocotyledons, the remainder being dicotyledonous plants in the families from Saururaceæ to Aizoaceæ inclusive. The descriptions of Pteridophyta are by Professor Lucien M. Underwood, of Juncaceæ by Mr. F. V. Coville, of Polygonaceæ and Euphorbiaceæ by Dr. John K. Small, of Graminaceae by Mr. G. V. Nash, of Lemnaceæ by Mr. E. P. Sheldon, while the text of Typhaceæ, Sparganiaceæ, Naiadaceæ, Scheuchzeriaceæ, Araceæ, Eriocaulaceæ, Pontederiaceæ, Smilaceæ and Orchidaceæ, 'was prepared by the late Rev. Thomas Morong and printed with very little change from his manuscript.' Notwithstanding the element of collaboration which has entered into the production of this illustrated flora, there has, by careful editorial supervision, been maintained a wonderfully regular, direct and transparent style of description, so that the form under which one species is described will *mutatis mutandis* suffice for any other species. The appropriate sequences are observed and for each species there are given in order the Latin name, the English name, the synonym and citation of original publication, the description of the plant as a whole, of the vegetative tract, of the inflorescence, flowers and fruit, closing with the habitat followed by the range and time of blooming. These compact and masterly descriptions are in pleasing contrast to the rambling unsystematic accounts which are too often put forward instead of descriptions by taxonomists who lack the highest gifts of insight or expression.

The figures always mortise in beside the descriptions with which they belong, and are all that could be asked. Sharp and clear, without being conventional or diagrammatic, they give an exact and adequate notion of the plant. By such aids, especially in a family like that of the grasses, the beginner can not but be stimulated and assisted where assistance is so much needed. And for the advanced student of species these figures, presenting so cleverly the plant at a glance, cannot fail to be of the greatest interest. It is an exceedingly difficult matter to plan illustrations of this sort that shall at once *illustrate* and be practicable in size and shape. In this instance all the difficulties seem to have been met intelligently, and the figure in each instance strikes one as exactly what was wanted.

The generic and family descriptions are constructed upon a systematic and logical plan similar to that of the species descriptions. Following the generic description in each case where more than one genus is represented in the general range of the work, is a key to the genera. This in many instances is a simple enough matter, but in some cases is constructed with great care under conditions of extreme difficulty. This is notably true for the genus *Carex*, where the key covers six pages and a half and is subdivided with much nicety. A few tests of this key to *Carex* induces one to believe that it is the most practicable one that has been fashioned for the genus. The same encomium may be afforded the keys to *Salix*, *Poa* and *Panicum*. That of *Scirpus* has bothered the reviewer when tested, principally on account of the frequency, in his region, of depauperate forms. In such a flora the keys are of great practical importance, and it is a source of much astonishment to the reviewer that a careful examination of them fails to show any important oversights, for such failures on the part of analytical keys have come, by experience, to be considered plainly essential and of the very inner and peculiar nature of such mechanisms.

The wise principles of generic limitation adopted in this flora need no especial comment, for they will commend themselves to all modern minded students. Nor is it necessary to allude to the scientific nomenclature. This is very conservative, adhering closely to the Rochester agreement and not even accepting such improvements as the decapitalization of the specific name. It is not too much to say that with the appearance of this work there ceases to be a nomenclature question in American plant taxonomy. There does not now exist any other nomenclature than the nomenclature of the Rochester agreement. Such a result can not but be a cause for extreme felicitation, for while everywhere admitted to be a non-essential and to a degree a triviality of botanical science, nomenclature has been one of the matters that pressed strongly for final and logical settlement. This flora of Dr. Britton, far the best yet published in America, so admirably combines right nomenclature with right description that there can be no further difficulty, nor, I suspect, will there even be regret over the final interment of the whole question.

Here and there adverse criticism could be directed against this Illustrated Flora if one were anxious to make out a case against it. It might be grumbled at as a 'picture book;' it might be accused of formalism, or one might point out that genera were divided where they should be combined or combined where they should be divided. But the whole plan of the enterprise so exactly corresponds to what the reviewer believes to be the best scientific standard that he is disarmed even from criticizing the ranges—which are sometimes, as always in local floras, too restricted—and point out that (for example) *Cystopteris bulbifera* grows in Minnesota, while the Flora brings it west no farther than Wisconsin. Just such a book as this has been needed for the past ten years—a period of great botanical expansion—and the authors may feel that they have earned the thanks of all those who desire botanical interest to continue to grow in the future as it has in the past.

The publishers of the Illustrated Flora have brought it out in a dignified form, printed upon a carefully selected paper and neatly bound. At the really nominal price which has been set, this work ought to be in the library of every high-school, academy and college in the country.

Indeed if a high-school library could afford to buy but one work in botany this Illustrated

Flora should be that work. It is among the young, among those beginning to take an interest in the plant creatures of their vicinage, that this book will yield the very best results. The figures add so much to the attractiveness of the descriptions that plant-analysis, even as it used to be conducted, could hardly be so dry and profitless as we have been accustomed to believe it. Such books make botanists everywhere respect the botanical advancement of America. CONWAY MACMILLAN.

UNIVERSITY OF MINNESOTA.

L' Année psychologique. 2me Année, 1895. Publiée par MM. H. BEAUNIS et A. BINET. Alcan, Paris. 1896. Pp. 1010.

This Année is two-thirds larger than it was a year ago. In the value of its original contributions and the thoroughness and helpfulness of its analyses it has at least not fallen below its high standard. Its perusal leaves an impression of immense and fruitful industry on the part of M. Binet and his fellow-workers, who have made it an indispensable aid to all interested in the field it covers. Its contents include 16 original articles (pp. 1–500); analyses of about 240 books and articles of the year (pp. 501–912), for the most part brief and just, though also some important ones of considerable length and a bibliographical index of 1394 titles, which, by special arrangement, is the same as that published by *The Psychological Review.*

The original contributions alone will be briefly summarized.

A. Articles by various contributors.

(1) TH. RIBOT: *Abnormal and Morbid Characters.* (Pp. 1–17.) M. Ribot is one of several French thinkers—Perez, Paulhan, Fouillée—who have recently attempted classifications of temperaments or characters. An analysis of their systems appears later in this Année, pp. 785–793. M. Ribot here calls particular attention to Seeland's hierarchical division into the strong (gay and calm), the neutral and the weak (melancholic, nervous and choleric), in which the former are more perfect, the latter approach more nearly to the abnormal. The truly abnormal he then divides into (1) successive contradictory characters; (2) coexisting contradictory characters; (3) unstable or polymorphous, 'infantile' characters. Each class is further subdivided and described.

(2) A. FOREL: *Comparative Psychology.* (Pp. 18–44.) A vigorous protest against "transferring the content of our superior consciousness into the acts of insects and of animals in general, with the partial and very reserved exception of the highest mammals." This tendency "arises from two confusions, first that of instinct with plastic reasoning, and second that of a series of acts observed in the animal with the psychological subjectivity of the animal." Nervous centers can act in two different ways to arrive at the same end: (*a*) automatically; (*b*) in the adaptive or plastic manner, which we call intelligence or reason. For the latter is demanded the inheritance of a much larger number and complexity of neurons than for the former. Man is highly plastic, though he has also inherited automatisms more or less complete. The social instinct of insects, especially of ants, belongs to the category of complete inherited automatisms, which do not need to be learned; yet these insects show also some small degree of adaptive activity. In studying them "we should content ourselves with exact biological observations and note carefully the facts of plastic and of automatic activity, endeavoring to understand and appreciate them as thoroughly as possible." So-called comparative psychology should be made rather a comparative biology.

(3) TH. FLOURNOY: *Note on times of reading and of omission.* (Pp. 45–53.) It takes twenty-five per cent. longer to omit the names of a class of objects A and pronounce the non-A's than to pronounce the A's and omit the non-A's in lists of equal length, where both appear an equal number of times. This is due to an antecedent subexcitation of the images, visual and articulatory, belonging to the concept A, and the impossibility of such subexcitation for all non-A's. There can be no actual concept, aside from its verbal formula, of an indefinite class non-A.

(4) B. BOURDON: *Investigation into intellectual phenomena.* (Pp. 54–69.) A study of the comparative frequency of different kinds of association. Most frequently aroused are verbal or non-verbal images; the latter by the more con-

crete words, the former by words which designate more abstract ideas. Besides these, there may be in rarer cases a complete absence of images, a vague feeling of knowing a name or word, or a feeling of the meaning of a word. Abstract ideas are essentially constituted by verbal images.

(5) E. Gley: *Study of some conditions favoring hypnotism of animals.* (Pp. 70–78.) Describes experiments with young and with enfeebled frogs, and infers: (1) that there is greater danger in hypnotizing children than older persons; (2) that the ideas of the Nancy school must be modified by admitting somatic as well as psychic influences in producing hypnosis.

(6) Van Biervliet: *Measurement of illusions of weight.* (Pp. 79–86.) Shows that when we know the volume of an object, by sight or touch, we estimate not its absolute weight, but its density; and concludes, as against Flournoy and others, that this proves the existence of the much-disputed 'sense of innervation.'

B. Studies from the Psychological Laboratory of Paris.

(1) Binet and Courtier: *The capillary circulation of the hand; its relation to respiration and to mental processes.* (Pp. 87–167.) An important study, very carefully and thoroughly conducted. After describing their method and the various sources of error which must be eliminated or allowed for, the authors discuss the influences exerted by various psychical phenomena—state of repose, sensory stimulation, mental calculation and the emotional state which accompanies it—upon the capillary circulation, the arterial circulation and the respiration. These influences are very marked, but vary greatly in different individuals. In some the vaso-motor reaction is strong and quick; in others it is slow, weak or even wanting. In some it is absolutely regular; in others there is constant capillary activity and irregularity even in repose. In some the various mental processes modify most strongly the respiration (more rapid, shallow, regular, with suppression of expiratory pause); in others the heart (increased rapidity, diminished force of propulsion); in others the vaso-motor system, either arterial (increase of tension, often vaso-constriction, greater clearness of respiratory undulations) or capillary (disappearance of respiratory undulations, less amplitude of pulsations, change in form of pulsation, vaso-constriction). The influence of emotion has as yet been little studied, but the fact that in case of a sudden shock of surprise the emotion is at its height almost uniformly before the vaso-motor reaction has begun, shows that Lange gave too great prominence to vaso-motor phenomena in the mechanism of emotion.

(2) V. Henri: *Experiments in the localization of tactile sensations.* (Pp. 168–192.) A study by various methods, and with a record of introspective observations, of the accuracy of tactile localization. Certain prominent parts of the bodily surface—folds of skin, protuberances of bone, joints, etc.—are selected by most subjects as points-de-repère, with reference to which other localizations are made. The direction of error is usually toward the point-de-repère made use of; the degree of error is less, the more points-de-repère there are near the point touched, and the more characteristic the quality of the contact. The least distance at which two simultaneously stimulated points of the skin can be distinguished as two, is not a measure of accuracy in localization. Quality of contact and movement of part touched are essential factors in localization.

(3) P. Xilliez: *Continuity in the immediate memory for figures and numbers in auditory series.* (Pp. 193–200.) Not all series of numbers are equally easy to memorize. The size of the differences between the successive numbers of the series has much influence. There is a tendency, especially marked in children, to diminish the size of these intervals, an approach toward continuity, especially ascending continuity, in the series.

(4) Binet and Courtier: *Graphic Investigaion of Music.* (Pp. 201–222.) Describes a registering apparatus for recording variations in force, rate, intervals, form, combinations and successions of notes and other details of a performance. Besides its value to the musician, the apparatus is admirably adapted to the psychological study of complex voluntary movements.

(5) Binet: *Fear in Children.* (Pp. 223–254.) Discusses, as a result of actual observations, the various objects and circumstances which excite

fear; its bodily effects and expression; its relation to health (the weak are more subject), to intellectual development (no relation), and to development of imagination (active imaginations are more subject); the proportion of children subject to it (all, in some degree; exceptionally, about 10 per cent. of boys and 30 per cent. of girls, by rough estimate); the influence of contagion, over-excited imagination, ill-treatment, in its production; and the best method of cure. As to cure, the method must vary; in some cases the best means is attention to the state of health; in others, the naturally curative effect of time; in others, moral treatment. For the latter the most important precepts are: Avoid corporal punishment, threats and mockery; suppress the circumstances which produce fear; guard against over-excitement of imagination; give the child self-confidence; train him gradually and progressively in acts of courage.

C. General Reviews.

(1) Dr. Azoulay: *Recent theories, histological and mechanical, of the functioning of the central nervous system.* (Pp. 255–294.) A resumé of the present state of knowledge in regard to the structure of the nervous system, followed by a detailed exposition and criticism of the theories as to its mechanism recently advanced by Rückardt, Lepine, Duval and Cajal.

(2) V. Henri: *The sense of locality of the skin.* (Pp. 295–362.) Reviews the literature of the subject and the results of experiment, from the time of Weber (1834) to the present; and gives a bibliography of 156 titles.

(3) J. Passy: *Olfactory sensations.* (Pp. 363–410.) An account of the as yet very incomplete researches in this field.

(4) Binet and Henri: *Individual Psychology.* (Pp. 411–465.) Insists on substituting for the a priori classifications of characters which have heretofore prevailed, deductions from actual measurements of individual differences in fundamental mental processes. Gives a brief historic summary of the questions thus far studied in individual psychology; and maintains that investigations in this field have confined themselves largely to sensations, whose individual differences are slight and insignificant compared with those of the higher mental processes. A series of more fundamental tests is recommended which include: memory—for geometrical forms, for paragraphs, for music, colors, series of figures nature of mental images; imagination, passive and constructive; attention, its duration, extent, concentration; power of understanding, observing, defining and distinguishing; suggestibility; æsthetic feeling; moral feeling; muscular force and force of will; motor ability and accuracy of estimates made by the eye. Explicit directions are given for each of these.

(5) V. Henri: *The calculation of probabilities in psychology.* An able paper, developing formulæ for the calculation of such probabilities as have importance for psychology: determination of averages, of the possibility, nature and laws of variations from the average, of probable errors, of the existence of causes other than pure chance in certain results, etc. The author criticises current interpretations of veridical death-coincidences, and of 'thought-reading' experiments, and more at length the methods of calculation used for many psychological investigations.

E. B. Delabarre.

Brown University.

The Gas and Oil Engine: By Dugald Clerk. Sixth Edition, revised and enlarged. New York, John Wiley & Sons. 1896.

This important work was first issued ten years ago by its author, who was at once recognized as an authority on the subject chosen for his study. Mr. Clerk is an engineer of large experience in this field, an inventor of great talent, and a builder of steam and gas-engines of reputation and success. He has, in this work, given to his profession and to the public an admirable account, historical, scientific and practical, of this remarkable and increasingly important class of heat-engines which is at once one of the most complete, accurate and detailed yet published. It has found a large sale in this country as well as in Europe, and constitutes one of the most generally satisfactory and useful of all existing treatises on the subject in any language. While not as complete in its collection of working drawings for use in the engine-builder's establishment as is the work of Mon. Richard, and while in some respects less elaborate in some portions of its purely scientific discussion of the theory of the machine than others, it is, on the whole, unexcelled by any.

Since the issue of the first edition many inventions and improvements in this class of engine have been made, and the oil-engine, particularly, has been enormously perfected and widely introduced. The author has introduced into this edition two additional parts, has discussed the modern gas-engine more fully in the second part, and has devoted the third part entirely to the now well-established forms of oil-engine. He has drawn largely from his personal experience in this work, and has given a very thorough and remarkably judicial discussion of the merits, absolute and relative, of existing and commercially successful types and forms. Appended to the text is a complete list of British patents, from 1791 to its date, which will be found by the professional reader an exceeding valuable feature of the book.

The illustrations have been reproduced from working drawings and by expert draughtsmen. The originals have been obtained from many prominent makers as well as from the author's own portfolios.

The practical value of the work is, perhaps, best indicated by the fact that it has been translated into foreign languages and is adopted as a reference and text-book by many technical schools and colleges. For this latter use it is particularly well-adapted by its thoroughly logical form and exceptionally scientific methods. The author is entitled to the hearty thanks of all who are interested in his subject, and the publishers are no less deserving of credit for their admirable and conscientious work in making up the book. It is well-written and well-published, and will be found a real accession to every engineer's library in which it may find a place. It may well be questioned if any other work on this subject will prove more generally useful. R. H. Thurston.

Ithaca, N. Y.

SCIENTIFIC JOURNALS.

PHYSICAL REVIEW, VOL. IV., NO. 2, SEPT.–OCT.

The Velocity of Electric Waves: By C. A. Saunders. In this article Dr. Saunders describes experiments by which the velocity of electric waves traveling along wires was directly determined. The method involved the measurement of the length of stationary waves developed on long copper wires, and at the same time the determination of the frequency of these waves. The latter determination was made by photographing the oscillatory spark from which the waves in question originated. The method used seems quite similar to that employed by Prof. Trowbridge and Mr. Duane, and the results indicate about the same value for the velocity, viz., from 2.954×10^{10} cm. per sec. to 2.998×10^{10} cm. per sec. The method used is seen to be a *direct* one, and does not depend upon any assumption regarding the manner in which the oscillations are set up. The close agreement obtained between the velocity of electric waves and velocity of light is for this reason especially satisfactory.

On the Measurement of the Expansion of Metals by the Interferential Method, II.: By E. W. Morley and W. A. Rogers. In the first part of this paper the general outline of the method used, as well as many of the important practical details, were discussed. In the present article the numerical data are given for a test of the method, and the computations of the results are presented. Using a bar of Jessop's steel, the authors find for the coefficient of expansiou between the temperatures of 0 and 65° a value of 10.45μ. This result compares quite favorably with the values 10.58 and 10.51 obtained by other methods. The authors do not consider, however, that the method has been given a fair trial, since a series of accidents caused the temperature measurements to be far less accurate than was to be desired.

An Experimental Study of Induction Phenomena in Alternating Current Circuits: By F. E. Millis. In the present article Dr. Millis has devoted his attention especially to the phenomena of charge and discharge in condenser circuits, making use of the alternating current galvanometer previously described by himself and Mr. Hotchkiss. The current curves for charge and discharge, under a variety of conditions, have been photographed. The needle used, which was so light as to follow the variations in current almost instantly, was adjusted in these experiments so as to have a natural period of vibration of 8,500 complete periods per second. Under these circumstances it can hardly be questioned that the curves obtained represent the actual variations of current in the circuit. In measuring the oscillatory charge and discharge of condensers, Dr. Millis has obtained some beautiful curves, reproductions of which accompany the article. The agreement between the computed and observed period of oscillation is in most cases within two or three per cent. Curves showing the effect of an iron core in the self-induction coil are especially interesting. The damping of the oscillations, caused by the eddy currents developed in the iron, is very noticeable, and it is found that a thin tube of iron is as effective in producing this damping as is a solid core.

Admittance and Impedance Loci: By F. Bedell. This paper deals with the application of the principles of geometrical inversion to the graphical treatment of alternating current problems. As a result of the reciprocal relation between admittance and impedance Dr. Bedell shows that it is always possible to proceed from a polar diagram representing one problem, to a second diagram which may be interpreted in connection with what might be called the *inverse* problem. Several special cases are discussed, but their presentation here would carry us beyond the limits of this extract.

Visible Electric Waves: By B. E. Moore. While repeating some of the experiments of Lecher on stationary electric waves along wires Mr. Moore found that under certain conditions the whole wire became luminous, the nodes and loops of the electric waves being clearly indicated by the form of the hazy light surrounding the wire. This article describes the conditions under which the phenomena are obtained. This method of showing the presence of electrical waves will doubtless prove most instructive and useful for lecture illustration.

Note on the Refractive Index of Water and Alcohol for Electric Waves: By J. F. Mohler. The writer calls attention to a source of error in experiments previously described by Prof. Cole (Phys. Rev., Vol. IV., p. 50).

Book Notices. Nernst: Theoretical Chemistry; Landauer: Spectralanalyse; Gage: Principles of Physics.

NEW BOOKS.

Elements of Physics. Vol. II. *Electricity and Magnetism.* Edward L. Nichols and William S. Franklin. New York and London, The Macmillan Co. 1896. Pp. ix+272. $1.50.

Alternating Currents and Alternating Current Machinery. Vol. II. Dugald C. Jackson and John Price Jackson. New York and London, The Macmillan Co. 1896. Pp. xvii+729. $3.50.

Problems in Elementary Physics. E. Dana Pierce. New York, Henry Holt & Co. 1896. Pp. vii+194.

A Manual of Quantitative Chemical Analysis. Frederick A. Cairns. Third Edition. Revised and enlarged, by Elwyn Waller. New York, Henry Holt & Co. 1896. Pp. xii+427.

Trigonometry for Beginners. By Rev. J. B. Lock. Revised and enlarged by John A. Miller. New York and London, The Macmillan Co. 1896. Pp. 147+ 63. $1.10.

The Report of the Michigan Board of Agriculture, 1895. Pp. 900.

General Principles of Zoology. Richard Hertwig. Translated by George W. Field. New York, Henry Holt & Co. 1896. Pp. xii+226.

The Human Body. H. Newell Martin. Seventh edition, revised. New York, Henry Holt & Co. 1896. Pp. vii+685.

A Handbook of Rocks for Use without the Microscope. James Furman Kemp. New York, Printed for the author. 1896. Pp. vii+176. $1.50.

Pioneers of Science in America. Reprinted with additions by William Jay Youmans. New York, D. Appleton & Co. 1896. Pp. viii+508.

Erratum: In the report of the papers read by Prof. D. T. MacDougal before Section G., A. A. A. S., the last two paragraphs (on page 624) should be placed after the first paragraph on the second column on page 435.

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

*SOME QUESTIONS OF NOMENCLATURE.**

INTRODUCTION.

I HAD originally selected for the address which it is my duty and privilege to give to-day a very different subject† from that which I am now to discuss; but the renewed and lively interest which is being manifested at present in the ever-troublous subject of nomenclature has led me to take it as my theme. I have been especially influenced, too, by the consideration that a committee was appointed at the last Zoological Congress, held at Leyden, to consider the subject, and suggestions have been asked for.‡ Of the multitudinous

*Address by Vice-President of Section F.—Zoology.

I avail myself of the opportunity to correct the proof of my address for SCIENCE, to add a few typographical corrections (not made in the proofs for the *Proceedings* of the Association) as well as some additional notes.

†Animals as Chronometers for Geology.

‡The Third International Zoological Congress, (Leyden Sept., 1895), appointed an International Commission of five members to study the various codes of nomenclature in use in different countries. This commission is composed of Dr. Raphael Blanchard (France), Prof. Carus (Germany), Prof. Jentink (Holland), Dr. Sclater, (England), and Dr. Stiles (United States). Dr. Stiles requested the appointment of an American Advisory Committee. This Advisory Committee has now been completed and is made up as follows:

"Dr. Gill, representing the National Academy of questions that offer for review time will only permit us to examine a few.

Nomenclature, in the modern sense of the word, did not trouble naturalists till near the middle of the last century. The animals and plants of the Ancient world were mostly treated of under the names which the Greeks or Romans had used, or were supposed to have used. The forms that became first known after the discovery of America were introduced into the literature under names more or less like those which they bore among the aboriginal inhabitants of the countries from which those forms had been obtained. Only a few names were coined from the Latin or Greek, and used for forms not mentioned by classical authors. Examples of such are *Ammmodytes* and *Anarrhichas*, invented by Gesner. But none of those names were employed as true generic designations. Genera, in fact, in the strictest sense of the word, were not used, by zoologists at least,* till the time of Linnæus.

There were certainly very close approximations to the idea manifest in some of the older authors, such, for example, as Belon and Lang; but their analogous groups were not strictly defined and limited, as the genera of Linnæus and his followers were. The system has been one of slow growth, and has developed in accordance with our knowledge of Nature, and in response to the need for expressing the various degrees of complication of the organisms. The species known to the naturalists of early times were few in number—at least, comparatively—and the old students had no idea of the excessive diversity of form and structure familiar to us.

A census of animals and plants was taken by Ray, shortly before Linnæus commenced his career, and enumerated less than 4,000 animals, exclusive of insects; and of those it was estimated that there were about '20,000 in the whole world.' He evidently believed that the entire number living would not be found greatly to exceed this. But let Ray speak for himself.

According to the author's classification, animals were divided into four orders—'beasts, birds, fishes and insects.' The number of *beasts*, including also *serpents*, that had been accurately described, he estimated at not above 150, adding that, according to his belief, 'not many that are of any considerable bigness, in the known regions of the world, have escaped the cognizance of the curious.' (At the present day, more than 7,000 species of 'beasts,' reptiles, and amphibians have been described.*) The number of *birds* 'may be near 500; and the number of *fishes*, secluding shell-fish, as many; but, if the *shell-fish* be taken in, more than six times the number.' As to the species remaining undiscovered, he supposed 'the whole sum of beasts and birds to exceed by a third part, and fishes by one-half, those known.' The number of *insects*—that is, of animals not included in the above classes—he estimated at 2,000 in Britain alone, and 20,000 in the whole world. The number of *plants* described in Bauhin's 'Pinax' was 6,000; and our author supposed that "there are in the world more than triple that number; there being in the vast continent of America as great a variety of species as with us, and yet but few common to Europe, or perhaps Africk

Sciences; Dr. Dall, representing the Smithsonian Institution; Prof. Cope, representing the Society of American Naturalists; Prof. Wright, representing the Royal Society of Canada; Prof. Packard, representing the American Association for the Advancement of Science." (New note.)

* The genera of plants in Tournefort's work are perfectly regular, as well as defined and illustrated, but the nomenclature is certainly not binomial.

* In a recent estimate of described species, 2,500 species of mammals are enumerated and 4,400 species of reptiles and amphibians—the several classes thus aggregating 6,900; this is probably an underestimate. P. Z. S., 1896, 306. (New note.)

11 ed, p. 25

and Asia. And if, on the other side the equator, there be much land still remaining undiscovered, as probably there may, we must suppose the number of plants to be far greater. What," he continues, "can we infer from all this? If the number of creatures be so exceeding great, how great, nay, immense, must needs be the power and wisdom of Him who formed them all!"

About 375,000* species of animals are now known, and of insects we still know the smaller portion.†

As knowledge of species of animals and plants increased, the necessity of system in registering them became apparent. Linnæus and Artedi especially appreciated this necessity, and early applied themselves to the correction of existing evils and the reformation of the classification and nomenclature of all the kingdoms of Nature. The Latin language had been long the means of intercourse among the learned, and was naturally selected as the basis of nomenclature. Instead of Latin words used as equivalents or translations of vernacular, by Linnæus and Artedi they were taken especially and primarily for scientific use. The various *kinds* of animals became the more exact *genera* of naturalists. A new language, or rather vocabulary of proper names, was developed with the Latin as the basis. As no adequate idea was at first had of the magnitude of the subject, rigorous codes of laws were formulated on the assumption that philological questions were involved rather than the means for the expression of facts. But soon the bonds that had been framed for the restriction of the new vocabulary were broken. The idea dawned upon men that they had to do with natural objects rather than philological niceties, and that which was most conducive to facile expressions or exhibitions of facts was more to the purpose than Priscianic refinements. Linnæus himself eventually refused to be bound by the laws which he had originally framed. The early companion of Linnæus—Artedi—who had co-operated with him, and also framed a similar code for Ichthyology especially, was prematurely lost to science. The fact that Artedi devised the first code of laws affecting zoology has been generally overlooked, and a few of his 'canons' may be noticed here. The extent to which each one of the two—Linnæus and Artedi—influenced the other cannot now be learned, nor will it be necessary to consider here who of the two was the abler naturalist. It must suffice that there was almost perfect agreement between Artedi and Linnæus in the spirit of the laws they respectively framed.

COMMENCEMENT OF BINOMIAL NOMENCLATURE.

The question that has been most agitated of late is, what time shall we recognize as the starting-point for the binomial nomenclature? Even now not all will be bound by any such limit for generic nomenclature; but those who will are divided into two main camps—those who start from the tenth edition of the Linnæan 'Systema Naturæ,' published in 1758, in which the binomial nomenclature was first universally applied, and those who advocate the twelfth edition of the 'Systema,' published in 1766, the last which appeared during the life of Linnæus.

But it may be premised here that even the fact that Linnæus was the first to devise the system of binomial nomenclature is not conceded by all. It has been claimed that about two centuries before Linnæus published his 'Philosophia Botanica,' Belon

*A census of animals recently taken under the superintendence of Dr. Sclater gave 386,000 species. P. Z. S., 1896, 307. (New note.)

†The late Dr. C. V. Riley even went so far as to say "that there are 10,000,000 species of insects in the world would be, in (his) judgment, a moderate estimate." The largest previous estimate, by Sharp and Walsingham, 2,000,000, was termed by Riley 'extremely low.'

had uniformly and consistently applied the binomial nomenclature to plants as well as animals, fishes and birds.* It has been also urged that C. N. Lang (Langius),† in 1722, used the binomial nomenclature for shells. I have not been able to confirm either statement, and therefore have to side with the great majority who accord to Linnæus the credit of that achievement.

Almost all the naturalists of the United States accept 1758 as the starting-time for nomenclature, and now most of the naturalists of Europe take the same view. But the English generally accept 1766 for the commencement of their orismology. It was 'after much deliberation' that the Committee of the British Association for the Advancement of Science determined on the edition of 1766. It was only because that edition was 'the last and most complete edition of Linné's works, and containing many species that the tenth did not,' that it was so selected—surely an insufficient reason. A principle was subordinated to an individual.

Logically, the actual period for the commencement of the binomial nomenclature should be when the rules for that nomenclature were distinctly formulated; and that was 1751, when the 'Philosophia Botanica' was first published. Practically, however, it makes little difference for most classes,‡ whether we take that date or 1758, when the next succeeding edition of the 'Systema' was published. But it does make much difference whether we take the tenth

* Crié (Louis) Pierre Belon et la nomenclature binaire. Rev. Sc., xxx., 737–740, 9 Dec., 1882.

† My efforts to see a copy of Lang's 'Methodus nova Testacea marina in suas Classes, Genera, et Species distribuendi' (Lucern., 1722) have not been successful. Maton and Rackett say that 'he is the first whose generic characters are founded on commodious distinctions,' but expressly state that 'there are no trivial names.' (See Trans. Linn. Soc., vii., 156, 157.) He may have properly appreciated genera.

‡ Arachnology would be most affected, for Clerck's work was published in 1757.

or twelfth edition. There is really no good reason for keeping Linnæus on that lofty pedestal on which he was enthroned by his disciples of a past century. His work does not justify such an elevation. In every department of zoology contemporaries excelled him in knowledge and in judgment. May we not hope that, ultimately, this truth will be recognized, and the tenth edition universally accepted for the first work of the new era?

TRIVIAL NAMES.

The binomial system has come into prominence through a sort of developmental process. Although now generally regarded as the chief benefaction conferred by Linnæus* on biology, it was evidently considered by him to be of quite secondary importance.

The first extensive use of it occurs in the 'Pan Suecicus,' published in 1749, where the author mentions that to facilitate the recording of his observations he had used an 'epithet' in place of the differential character.† It was thus a mere economical device for the time being.

In the 'Philosophia Botanica' he also treats it as a matter of trivial importance. He distinguishes between the specific name and the trivial.

His *specific* name corresponds to what we

* Linnæus himself did not claim this as an improvement in his account of the advancement he had effected in science.

† "Possumus nunc ultra duo millia experimenta certissima exhibere, quæ sæpe decies, immo sæpe bis decies sunt iterata. Si autem sumamus FLORAM SUECICAM *Holmiæ*, 1745, & ad quamlibet herbam, ut chartæ parcatur, nomen adponimus genericum, numerum Floræ Suecicæ & epitheton quoddam loco differentiæ, negotium in compendium facile mittitur." Pan Suecicus, pp. 228, 229.

This thesis is attributed to Nicolaus L. Hesselgren in some bibliographies, and naturally so, as it bears his name in the title; but Linnæus probably did not claim more than his own in claiming the authorship, although Hesselgren apparently wrote part of it himself. It is sometimes difficult exactly to fix the authorship in the case of some of the old theses.

would call a *diagnosis* (Nomen specificum est itaque Differentia essentialis); his *trivial* name is what would now be called the *specific*.* It is merely suggested that trivial names may be used as in his 'Pan Suecicus,' and should consist of a single word taken from any source.†

This system was fully carried out in the succeeding editions of the 'Systema Naturæ.' Both names were then given—the *nomen specificum* after the number of the species, under each genus, and the *nomen triviale* before the number, in the margin.

Linnæus placed little store on the trivial names, and accredited such to old botanists; but he took special credit for specific names (or diagnoses), claiming that none worthy of the title had been given before him.‡

DRACONIAN LAWS.

For generic nomenclature a Draconian code was provided by Linnæus and Artedi. It is now a maxim of good legislation that excessive severity of law is apt to defeat the object sought for, and the tendency of civilization is to temper justice with mercy. So has the tendency of scientific advancement been towards a mitigation of the Linnæan code. Nevertheless, its severity is more or less reflected in later codes—even the latest—and therefore a review of some of those old canons will not be entirely a resurrection of the dead, and may contain a warning for the future.

In exclusiveness for generic names Linnæus and Artedi went far ahead of any of the moderns. They provided that no names were available for genera in zoology or botany which were used in any other class of animals or plants, or even which were used for minerals, tools, weapons, or other instruments, or even places.*

Under this rule such names as *Acus*, *Belone*, *Citharus*, *Hippoglossus*, *Lingula*, *Novacula*, *Orbis*, *Orca*, *Remora*, *Solea*, and *Umbra*—all now, or some time, in common use—were specified.

This rule was soon relaxed, and any name not previously used in zoology, or, at most, biology, was considered admissible.

Another rule sends to Coventry all names composed of two names of different animals, because it might be uncertain to which genus an animal really belongs.† The ancient name 'Rhino-Batus' is even mentioned as one of the delicts.

This rule is also without any justification, and the reason given for it baseless. Compound words of the kind exiled are in entire harmony with the genius of the classic languages. As an illustration of their use among the Greeks, we need refer to one group only—that is, compounds with hippos, as *Hippalectryon*, *Hippanthropos*, *Hippardion*, *Hippelaphos*, *Hippocampos*, *Hippotigris* and *Hippotragelaphos*. (*Hippokantharos*, *Hippomurmex*, *Hippopareos* and *Hipposelinon* are

* "217. Nomen specificum *legitimum* plantam ab *omnibus* congeneribus (159) distinguat; *Triviale* autem nomen legibus etiamnum caret." Phil. Bot., p. 202.

† "Nomina Trivialia forte admitti possunt modo, quo in *Pane suecico* usus sum; constarent hæc
Vocabula unico;
Vocabula libere undequaque desumto.
Ratione hac præcipue evicti, quod differentia sæpe longa evadit, ut non ubique commode usurpetur, et dein mutatione obnoxia, novis detectis speciebus, est, e. gr.
Pyrola [5 sp.]
Sed nomina Trivialia in hoc opere seponimus, de differentiis unice solliciti." Ph. Bot., pp. 202, 203.

‡ "Trivialia erant antecessorum et maxime Trivialia erant antiquissimorum Botanicorum nomina.
Character Naturalis speciei est *Descriptio; Character* vero *Essentialis* speciei est *Differentia.*
Primus incepi Nomina specifica Essentialis condere, ante me nulla differentia digna exstitit." Ph. Bot., p. 203.

* "Nomina piscium generica, quæ quadrupedibus pilosis, avibus, amphibiis, insectis, plantis, mineralibus, instrumentis opificum etc. communia sunt, omnino deleantur. Linn. Fund. 230." Art. Ph. Ich., § 193.

† "Nomina generica, ex uno nomine generico fracto, et altero integro composita, exulent. Linn. Fund. 224." Art. Ph. Ich., § 196.

other classic Greek words, but do not belong to the same category as the others, inasmuch as they were used in a sense analogous to horse-chestnut, horse-mackerel and horse-radish with us, the word 'horse' in this connection conveying the idea of strength, coarseness or bigness.)

In another rule, all words are proscribed as generic names which are not of Latin or Greek origin;* and among the proscribed are such names as *Albula*, *Blicca*, *Carassius* and many others, which were later used by Linnæus himself as specific names, and which are now used as generic denominations.

Words with diminutive terminations were barely tolerated, if admitted at all,† and the reason alleged for such treatment was that the cardinal name might belong to another class. Among the examples named were *Anguilla*, *Asellus*, *Leuciscus*, *Lingula*, *Oniscus*, and *Ophidion*, now familiar in connection with some of our best-known genera. One of these—*Ophidion*—was subsequently used by Linnæus himself as a generic name.

All are now tolerated without demur even, and probably by most naturalists never supposed to have been tainted with offense of any kind. For all such words we have also classical examples; and four have already been named—the *Oniscus* and *Ophidion* of the Greeks, adopted by the Romans, and the *Anguilla* and *Asellus* of the Latins.

Generic names, derived from Latin adjectives, were also declared to be unworthy of adoption. *Aculeatus*, *Centrine* and *Coracinus* were cited as examples of words that should be rejected under this rule. Later writers have repeated the denunciations uttered by Linnæus and Artedi, and refused to adopt such words. But hear what Plutarch says of names of men derived from adjectives.

In his life of Coriolanus, Plutarch, in recounting the events subsequent to the capture of Corioli, and the refusal of Marcius to accept more than his share of the booty, comes to the proposition of Cominius:†

"Let us, then, give him what it is not in his power to decline, let us pass a vote that he be called *Coriolanus*, if his gallant behavior at Corioli has not already bestowed that name upon him." Hence came his third name of Coriolanus, by which it appears that Caius was the proper name; that the second name, Marcius, was that of the family; and that the third Roman appellative was a peculiar note of distinction, given afterwards on account of some particular act of fortune, or signature, or virtue of him that bore it. Thus among the Greeks additional names were given to some on account of their achievements, as *Soter*, *the preserver*, and *Callinicus*, *the victorious*; to others, for something remarkable in their persons, as *Physcon*, *the gore-bellied*, and *Gripus*, *the Eagle-nosed*; or for their good qualities, as *Euergetes*, *the benefactor*, and *Philadelphus*, *the kind brother*; or their good fortune, as *Eudæmon*, *the prosperous*, a name given to the second prince of the family of the Batti. Several princes also have had satirical names bestowed upon them: Antigonus (for instance) was called *Doson*, *the man that will give to-morrow*; and Ptolemy was styled *Lamyras*, *the buffoon*. But appellations of this last sort were used with greater latitude among the Romans. One of the Metelli was distinguished by the name of *Diadematus*, because he went a long time with a bandage, which covered an ulcer he had in his forehead; and another they called *Celer*, because with surprising celerity he entertained them with a funeral show of gladiators a few days after his father's death. In our times, too, some of the Romans receive their names from the circumstances of their birth; as that of *Proculus*, if born when their fathers are in a distant country; and that of *Posthumus*, if born after their father's death; and when twins come into the world, and one of them dies at the birth, the survivor is called *Vopiscus*. Names are also appropriated on account of bodily imperfections; for amongst them we find not only *Sylla*, *the red*, and *Niger*, *the black*, but even *Cæcus*, *the blind*, and *Claudius*, *the lame*; such

* "Nomina generica, quæ non sunt originis Latinæ vel Græcæ, proscribantur. Linn. Fund. 229." Art. Ph. Ich. ∮ 198.

† "Nomina generica diminutiva vix toleranda sunt. Lind. Fund. 227." Art. Ph. Ich., §202.

† "Nomina generica imprimis Latina pure adjectiva, sed substantive usurpata, criticorum more improbanda sunt. Linn. Fund. 235." Art. Ph. Ich., ∮ 204.

persons, by this custom, being wisely taught not to consider blindness or any other bodily misfortune as a reproach or disgrace, but to answer to appellations of that kind as their proper names."

What was good enough for the ancient Romans to bestow on the most admired of their heroes is good enough for the nomenclature of our genera of animals. We have also examples of names of adjective form used substantively for animals among classic writers. Such, for example, are the *Aculeatus* (pipe-fish), and *Oculata* (lamprey or nine-eyes), mentioned by Pliny.

Linnæus himself, later, coined many names having an adjective form; and three of his genera of plants of one small family, so designated, occur in this region—*Saponaria*, *Arenaria* and *Stellaria*. Yet even at the present day we have evidences of the lingering of the old idea embodied in the canon in question.

We have also had drawn up for us certain rules for the conversion of Greek words into Latin, which are tinctured with more than Roman severity. Thus, we are told that Greek names ending in *-os* should always be turned into *-us;* that the final *-on* is inadmissible in the new Latin, and should invariably be rendered by *-um.*

In accordance with such rules, *Rhinoceros* has been turned into *Rhinocerus*, and *Rhinocerotidæ* into *Rhinoceridæ*. But *Rhinoceros* was admitted into classical Latinity, and with it the corresponding oblique cases, *Rhinocerotis*, etc.; in fact, the word was current in the language of description, satire, and proverb—as when used by Juvenal for a vessel made of the horn, or by Lucilius for a long-nosed man, or by Martial in the proverbial expression, 'Nasum rhinocerotis habere'; *i. e.*, to turn the nose up, as we would say. These authorities are good enough for me.

The termination *-on* was also familiar to the Romans of classic times, and numerous words with that ending may be found in the books of Pliny. But our modern purists will have none of them; the Greek *-on* in the new Latin must always become *-um.* For example, *Ophidion* was the name given to a small conger-like eel, according to Pliny, and was (without reason) supposed to have been applied to the genus now called *Ophidium;* and this last form was given by Linnæus, who eventually* refused to follow Pliny in such barbaric use of Latin. But Pliny is good enough for me—at least as a Latinist.

Another rule prohibits the use of such words as *Ægir*, *Göndul*, *Moho*, *Mitu*, *Pudu* and the like, and provides that they should have other terminations in accordance with classical usage. But why should those words be changed and surcharged with new endings? As they are, they are all uniform with classical words. *Ægir* has its justification in *Vir*, *Göndul* in *consul*, *Moho* in *homo* (of which it is an accidental anagram) and *Mitu* and *Pudu* are no more cacophonous or irregular than *cornu.* I therefore see no reason why we should not accept the words criticised and corrected by some naturalists in their original form, even if we consider the question involved as grammatical rather than one of scientific convenience.

I have thus defended some of the names of our old nomenclators, and really think the rules laid down for name-making were too severe. But those rules were on the whole judicious, and should not be deviated from by future nomenclators without good and substantial reason; even if too severe, they 'lean to virtue's side.' On the other hand, let old names be respected in the interests of stability, even if slightly misformed.

MISAPPLIED NAMES.

While Linnæus was so exacting in his rules of nomenclature in the cases cited, in

*At first (in the tenth edition) Linnæus allowed *Ophidion*.

others he was extremely lax. It is due to him (directly or indirectly) that our lists of genera of vertebrate animals especially are encumbered with so many ancient names that we know were applied to very different animals by the Greeks and Romans. It is Linnæus that was directly responsible for the misuse of such generic names of mammals as *Lemur*, *Manis*, *Dasypus;* such bird-names as *Trochilus*, *Coracias*, *Phaëton*, *Diomedea*, *Meleagris* and (partly with Artedi) such fish-names as *Chimæra*, *Centriscus*, *Pegasus*, *Callionymus*, *Trigla*, *Amia*, *Teuthis*, *Esox*, *Elops*, *Mormyrus* and *Exocœtus*. These all were applied by the ancients, to forms most of which are now well ascertained, and the animals to which they have been transferred have nothing in common with the original possessors of the names.

The misuse of these ancient names is in contravention of the rule adopted by the International Zoological Congress held in Moscow (1892), that "every foreign word employed as a generic or specific name should retain the meaning it has in the language from which it is taken," and of like rules of other associations. The false application by Linnæus and his followers (and he had many) was due partly to the belief that the ancient names were unidentifiable, but now there are few whose original pertinence is not known. It may be thought by some, however, that we are unduly criticising the doings of the past from the vantage-ground of the present. But such is not the case, for at the commencement of his career Linnæus was taken to task for the fault indicated. Some of those criticisms were so apt that they may be advantageously repeated here.

Dillenius, of Oxford, wrote to Linnæus in August, 1737, in these terms :

"We all know the nomenclature of Botany to be an Augean stable, which C. Hoffmann, and even Gesner, were not able to cleanse. The task requires much reading, and extensive as well as various erudition; nor is it to be given up to hasty or careless hands. You rush upon it, and overturn everything. I do not object to Greek words, especially in compound names ; but I think the names of the antients ought not rashly and promiscuously to be transferred to our new genera, or those of the New World. The day may possibly come when the plants of Theophrastus and Dioscorides may be ascertained ; and, till this happens, we had better leave their names as we find them. That desirable end might even now be attained if any one would visit the countries of these old botanists, and make a sufficient stay there ; for the inhabitants of those regions are very retentive of names and customs, and know plants at this moment by their ancient appellations, very little altered, as any person who reads Bellonius may perceive. I remember your being told, by the late Mr. G. Gherard, that the modern Greeks give the name of *Amanita* (ἀμανῖτα) to the eatable Field Mushroom ; and yet, in *Critica Botanica*, p. 50, you suppose that word to be French. Who will ever believe the *Thya* of Theophrastus to be our *Arbor Vitæ?* Why do you give the name of Cactus to the *Tuna?* Do you believe the *Tuna*, or *Melocactus* (pardon the word), and the *Arbor Vitæ*, were known to Theophrastus? An attentive reader of the description Theophrastus gives of his *Sida*, will probably agree with me that it belongs to our *Nymphæa*, and indeed to the white-flowered kind. You, without any reason, give that name to the *Malvinda;* and so in various other instances concerning antient names, in which I do not, like Burmann, blame you for introducing new names, but for the bad application of old ones. If there were, in these cases, any resemblance between your plants and those of the antients, you might be excused, but there is not. Why do you, p. 68, derive the word *Medica* from the virtues of the plant, when Pliny, book xviii., chap. 16, declares it to have been brought from Media? Why do you call the *Molucca*, *Molucella?* It does not, nor ought it, to owe that name, as is commonly thought, to the Molucca islands ; for, as Lobel informs us, the name and the plant are of Asiatic origin. Why then do you adopt a barbarous name, and make it more barbarous? *Biscutella* is not, as you declare, p. 118, a new name, having already been used by Lobel. I am surprised that you do not give the etymology of the new names which you or others have introduced. I wish you would help me to the derivation of some that I cannot trace; as *Ipomæa*, for instance. Why are you so offended with some words, which you denominate barbarous, though many of them are more harmonious than others of Greek or Latin origin?"

A year later (August 28, 1738) he again wrote :

"It would surely have been worth your while to visit Greece, or Asia, that you might become acquainted with, and point out to us, the plants of the antients, whose appellations you have so materially, and worse than any other person, misapplied. You ought to be very cautious in changing names and appropriating them to particular genera."

How entirely the previsions of the wise old botanist have been realized, I need not explain. We now know what almost all of the names misapplied by Linnæus and his school were meant for of old; and when some more good naturalists collect names and specimens together in various parts of Greece, probably very few of the ancient names will remain unidentifiable.

The only reply that Linnæus could make to the censures of Dillenius appears in the following minutes:

"With regard to unoccupied names in antient writers, which I have adopted for other well-defined genera, I learned this of you. You, moreover, long ago, pointed out to me that your own *Draba*, *Nova Pl. Genera* 122, is different from the plant so called by Dioscorides."

The retort of one sinner that his antagonist is another is no real answer.

The comments of the British Committee of 1865, on this subject, are very judicious and pertinent.

The use of mythological names for animals and plants is far less culpable. The use of such is no worse than that of any meaningless name. Sometimes, even, there may be conveyed an association of ideas which appeals to the imagination in a not disagreeable manner. For example, Linnæus gave the name *Andromeda*, after the Ethiopian maid whose mother's over-great boasts of the daughter's beauty made her the victim of Poseidon's wrath. Linnæus justified his procedure by a remarkable play of fancy:

"This most choice and beautiful virgin gracefully erects her long and shining neck (the peduncle), her face with its rosy lips (the corolla) far excelling the best pigment. She kneels on the ground with her feet bound (the lower part of the stem incumbent), surrounded with water, and fixed to a rock (a projecting clod), exposed to frightful dragons (frogs and newts). She bends her sorrowful face (the flower) towards the earth, stretches up her innocent arms (the branches) toward heaven, worthy of a better place and happier fate, until the welcome Perseus (summer), after conquering the monster, draws her out of the water and renders her a fruitful mother, when she raises her head (the fruit) erect."

The relation of the old myth to the plant may be far fetched, and no other would ever be likely to notice the analogy without suggestion; but at least the conceit is harmless, if not agreeable.

The analogy that gave rise to this fanciful description, contained in the 'Flora Lapponica,' suggested itself to Linnæus on his Lapland journey:

"The Chamædaphne of Buxbaum was at this time in its highest beauty, decorating the marshy grounds in a most agreeable manner. The flowers are quite blood-red before they expand, but when full grown the corolla is of flesh-color. Scarcely any painter's art can so happily imitate the beauty of a fine female complexion; still less could any artificial color upon the face itself bear comparison with this lovely blossom. As I contemplated it, I could not help thinking of Andromeda as described by the poets; and the more I meditated upon their descriptions, the more applicable they seemed to the little plant before me; so that, if these writers had had it in view, they could scarcely have contrived a more apposite fable. Andromeda is represented by them as a virgin of most exquisite and unrivalled charms; but these charms remain in perfection only so long as she retains her virgin purity, which is also applicable to the plant, now preparing to celebrate its nuptials. This plant is always fixed on some little turfy hillock in the midst of the swamps, as Andromeda herself was chained to a rock in the sea, which bathed her feet, as the fresh water does the roots of the plant. Dragons and venomous serpents surrounded her, as toads and other reptiles frequent the abode of her vegetable prototype, and, when they pair in the spring, throw mud and water over its leaves and branches. As the distressed virgin cast down her blushing face through excessive affliction, so does the rosy-colored flower hang its head, growing paler and paler till it withers away. Hence, as this plant forms a new genus, I have chosen for it the name of *Andromeda*."

DOUBLE NAMES.

It was long the custom, when a specific

name was taken for a genus, to substitute a new specific for the one so diverted. There was some reason for this, for sometimes the specific name covered several forms, or at least was equally applicable to several; of late, however, the acceptance of both the generic and specific names, that is, the duplication of a name, has been quite general, and various precedents have been adduced in favor of the procedure. "In the solemn anthem musicians have been known to favor such repetitions, the orator uses them, in poetry they occur without offence, and even our English aristocracy sometimes bears them as an added grace."* It is also a frequent custom in many barbarous and half-civilized races, as well as the young of our own, to double the name for a given subject; and this analogy may be regarded by some of you as a perfect one. But in the last cases some regard is had for euphony, and it is a short word that is repeated, as in the case of the Kiwi-Kiwi and Roa-Roa of the Maoris of New Zealand. the Pega-Pega of the indigenes of Cuba, the Willie-Willie (water spout) of the Australians, and our own familiar Pa-pa and Ma-ma. Many scientific names repeated are long—some very long—but even for such I would now yield the point. Stability of nomenclature is a greater desideratum than euphony or elegance. But here let me add that there is a history behind the *Scomber Scomber*, which has been frequently cited as an example of the duplication of a name by Linnæus. It was *Scomber Scombrus* that was used at first by the early nomenclator, and that occurs in the tenth edition of the 'Systema Naturæ' (p. 297), as well as in the 'Fauna Suecica' (2d ed., p. 119). Linnæus thus combined the old Latin and Greek names of the mackerel, which were formally different, although of course traceable to one and the same root. The name is therefore not repulsive, but interesting as a historical reminiscence of past usage by two great peoples. It was only in the twelfth edition of the 'Systema' (p 492) that Linnæus exactly duplicated the name as *Scomber Scomber*, and thus vitiated the last edition in this as he did in other cases. But it is at least possible that the exact duplication of names in the twelfth edition is the off-spring of typographical inaccuracy or clerical inadvertence.* At any rate, those who recognize the tenth edition of the 'Systema' as the *initium* of nomenclature will adopt the more elegant form.

*Stebbing in Nat. Science, viii. 255.

VARIANTS AND SIMILARITY OF NAMES.

The case of *Scomber* and *Scombrus* naturally suggest consideration of another rule adopted by various societies. By the German Zoological Society it is provided that "names of the same origin, and only differing from each other in the way they are written, are to be considered identical."† Words considered identical are *Fischeria* and *Fisheria*, as well as *Astracanthus* and *Astera-*

*In the last part of the Proceedings of the Zoological Society of London (1896, II.) received, September 5th, the suggestion that *Scomber Scomber* was a lapsus is confirmed. According to Dr. Sclater, "on referring to the two copies of the twelfth edition, formerly belonging to Linnæus himself, and now in the library of the Linnæan Society, it will be found that the second *Scomber* is altered, apparently in Linnæus' own handwriting, into *Scombrus* (See note on this subject, 'Ibis,' 1895, p. 168)." P. Z. S. 1896, 310, 311. (New note.)

† "Etymologisch gleich abgeleitete und nur in der Schreibweise von einander abweichende Namen gelten als gleich.

Beispiele: *silvestris* = *sylvestris*; *cœruleus* = *cæruleus*; *linnæi* = *linnei*; *Fischeria* = *Fisheria*; *Astracanthus* = *Asteracanthus*.

a. Dagegen können neben einander verwendet werden *Picus* und *Pica*; *Polyodon*, *Polyodonta*, und *Polyodontes*; *fluvialis*, *fluviatilis*, *fluviaticus*, *fluviorum*; *moluccensis* und *moluccanus*.

b. Bei Neubildung von Namen möge man solche vermeiden, welche leicht mit schon vorhandenen verwechselt werden können." Regeln * * * von der Deutsch. Zool. Ges., § 4.

canthus; and among words sufficiently different are *Polyodon*, *Polyodonta*, and *Polyodontes*.

When rules are once relaxed in this indefinite manner, the way is at once open to differences of opinion as to what are to be considered identical or too much alike. *Fischeria* and *Fisheria* appear to me to be sufficiently distinct, and would be so considered by some who think that *Polyodon*, *Polyodonta*, and *Polyodontes* are too nearly alike. While the last three are conceded to be sufficiently distinct by the German Zoological Society, analogous forms, as *Heterodon* and *Heterodontus*, are claimed by some zoologists to be too similar, and consequently the latter prior and distinctive name of the 'Port Jackson shark' is sacrificed in favor of the later and inapt *Cestracion*—a name originally coined and appropriate for the hammer-headed sharks, but misapplied to the Australian shark.

I agree with those who think that even a difference of a single letter in most cases is sufficient to entitle two or more generic names so differing to stand. The chemist has found such a difference not only ample but most convenient to designate the valency of different compounds, as ferricyanogen and ferrocyanogen. I am prepared now to go back on myself in this respect. In 1831 Prince Max of Nieuwied named a bird *Scaphorhynchus*, and in 1835 Heckel gave the name *Scaphirhynchus* to a fish genus.* In 1863 I used a new name (*Scaphirhynchops*) for the acipenseroid genus, and that name was adopted by other naturalists. Jordan later considered the literal differences between the avine and piscine generic names to be sufficient for both. I yield the point, and abandon my name *Scaphirhynchops*. But those who hold to the rule in question will retain it.

Another set of cases exhibiting diversity of opinion may be exemplified.

In 1832 Reinhardt gave the name *Triglops* to one cottoid genus, and in 1851 Girard named another *Triglopsis*, Girard apparently not knowing of Reinhardt's genus. In 1860 the later name was replaced by *Ptyonotus*. All American naturalists have repudiated the last name.

In 1854 Girard named a genus of Atherinids *Atherinopsis*, and in 1876 Steindachner, knowing well the name of Girard, deliberately called a related genus *Atherinops*. No one, as yet, has questioned the availability of the later name, but one who refuses to adopt *Triglopsis* because of the earlier *Triglops* must substitute another name for *Atherinops*.

Who shall decide in such cases, and what shall be the standard?

MAKING OF NAMES.

It was long ago recognized, even by Linnæus, that the rigor of the rules originally formulated by him would have to be relaxed. Naturalists early began to complain that the Greek and Latin languages were almost or quite exhausted as sources for new names, and many resorted to other languages, framed anagrams of existent ones, or even played for a jingle of letters.

Forty years ago one of the most liberal of the American contributors to such names* defiantly avowed that " most of the genera [proposed by him] have been designated by words taken from the North American Indians, as being more euphonic than any one [he] might have framed from the Greek. The classic literature has already furnished so many names that there are but few in-

*In lieu of explanations of the etymology it may be assumed that *Scaphirhynchus* was derived from σκὰφειά, a digging or hoeing, and that *Scaphorhynchus* is from σκάφος, anything hallowed, as a boat. (Oct., 1896.) Both *Scaphorhynchus* and *Scaphirhynchus* were derived from 'σκάφη, scapha; ῥυγχος, rostrum' by Agassiz in in his Nomenclator Zoologicus, but the characters of the respective genera would be better expressed by the etymologies here suggested, the bird genus having a bill like an inverted boat and the fish genus a snout like a spade as the popular name—shovel-illed sturgeon—implies.

*Girard in Proc. Acad. Nat. Sc. Phila., viii., 209, 1856.

stances in which a name might yet be coined, and express what it is intended to represent. [He offered] this remark as a mere statement, not as an apology." He gave such names as *Minomus*, *Acomus*, *Dionda*, *Algoma*, *Algansea*, *Agosia*, *Nocomis*, *Meda*, *Cliola*, *Codoma*, *Moniana*, *Tiaroga*, *Tigoma*, *Cheonda* and *Siboma*.

The names have caused some trouble, and have been supposed to be original offspring of the ichthyologist; but those familiar with Longfellow's Hiawatha will recognize in *Nocomis* the name of the daughter of the Moon* and mother of Wenonah† (Nokomis), corrected by classical standard! and in *Meda* the title of a 'medicine man' (not 'a classical feminine name'). Other names are geographical or individual.

In the excellent report to the International Zoological Congress, by Dr. Raphael Blanchard (1889), it was remarked that it would be generally conceded that naturalists have almost completely exhausted the Greek and Latin words, simple and compound, possible to attribute to animals.‡

But the classic languages are even yet, although about one hundred thousand names§ grace or cumber the nomenclators, far from being completely exploited. To some of us, indeed, the difficulty in determining upon a new name is rather that of selection of several that are conjured up by the imagination rather than the coining of a single one.

Besides the methods of name-making generally resorted to, there are others that have been little employed. Among the few who have resorted to other than the regular conventional ways is the illustrious actual President of the American Association for the Advancement of Science. His long list of generic names proposed in the various departments of zoology embraces many of unusual origin, and almost always well formed, elegant and euphonious. I can only adduce a few of the ways of naming illustrated by classical examples.

In ancient Greek there are numerous words ending in *-ias*, and many substantives with that termination are names of animals given in allusion to some special characteristic.

Acanthias is the designation of a shark, especially distinguished by the development of a spine at the front of each dorsal fin; the name is derived from ἄκανθα, spine, and the terminal element.

Acontias is the name of 'a quick-darting serpent,' and the main component is ἄκων, a dart or javelin.

Anthias is the name of a fish found in the Mediterranean and distinguished by the brilliancy of its color; evidently it was based on ἄνθος, a flower. The color of the fish may remind one of a showy flower.

Xiphias is the ancient as well as zoological designation of the sword-fish; it was plainly coined from ξίφος, a sword.

These four names give some idea of the range of utility of the particle in question; they involve the ideas of defensive armature, offensive armature, ornamentation, and action.

A number of names have been framed by modern zoologists in conformity with such models. Such are *Stomias* (named by the Greek scholar and naturalist, Schneider) and *Ceratias*—types of the families *Stomiidæ* (generally written *Stomiatidæ*) and *Ceratiidæ*. *Tamias* is another name, well known in connection with the chipmunk.

But there is room for many more of like

* "From the full moon fell Nokomis,
Fell the beautiful Nokomis."
The song of Hiawatha, III., lines 4, 5.

†Ophiologists will recognize in Wenonah the source of a synonym (*Wenona*) given to the genus *Charina* by Baird and Girard. Oct., 1896.

‡ "On conviendra que les naturalistes ont dû épuiser à peu près complètement la liste des mots grecs ou latins, simple ou composés, qu'il était possible d'attribuer aux animaux." Bul. Soc. Zool. France, XIV., 223.

§ The number one hundred thousand includes duplicates and variants.

structure. For example, peculiarities of various parts might be hinted at by such words as *Carias* or *Cephalias* or *Cotidias* or *Cottias* (for animals having some distinctive character in the head), *Chirias* (hand or hand-like organ, *Gnathias* (jaw), *Podias* (feet), *Thoracias* (thorax), and many others of analogous import.

Another termination which might be used advantageously instead of the too often used *-oides* is the patronymic suffix *-ides*. This would be specially useful where genetic relationship is desired to be indicated. We have many such models in classical literature, as Alcides, the son of Alcæus; Atrides, the son of Atreus; Pelides, the son of Peleus, Æacides; the grandson of Æacus, and the like.

Another source for help in name-making is in the several intensive Greek particles occurring as prefixes of various names. The chief of these prefxes are *agi-*, *ari-*, *da-*, *eri-*, *eu-*, and *za-*. *Eu-* has been so very often drafted into use that relief and variety may be found by resorting to the others.

Ari- (Ἀρι-) occurs often in classical words, as ἀρίδακρυς, very tearful, ἀρίδηλος, very plain, and ἀριπρεπής, very showy.

Da- (Δᾶ) is illustrated by such names as δάσκιος (daskios, shaded) and δαφοινός (daphoinos, deep red) — convert them, if you will, into *Dascius* and *Daphœnus*. Numerous names may be made on the model, although in classical Greek there are few.

Eri- (Ἐρι-) is used in the same way as *Ari-*, and is familiar in ancient Greek as a particle of such words as ἐριαυγής (very brilliant) and ἐριαύχην (with a high arched neck). The common large seal of northern Europe (*Erignanthus barbatus*) has received its generic name, based on the same model, on account of the depth of the jaws. Very few naturalists, however, have availed themselves of this particle for name-making, most of the words in the zoological nomenclature commencing with *Eri-* having other origins.

Za- (*Za-*) is met with in such words as ζᾶής (strong blowing), ζᾶθερής (very hot), ζᾶκαλλής (very beautiful), ζάπλουτος (very rich), ζᾶπότης (a hard drinker). The particle has been utilized in the composition of the generic name (*Zalophus*) of the common sea-lion, distinguished by its high sagittal crest (ζά- and λόφος, crest), familiar to menagerie visitors, and the residents and travellers in San Francisco. Professor Cope has also made use of it for several of his names.

We have been told by ancient writers that Cicero was a name derived from *cicer*, a vetch. According to Pliny, the name (like *Fabius* and *Lentulus*) was obtained on account of ancestral skill in cultivation of the plant; but, according to Plutarch, the original of the name was so called because he had a vetch-like wen on his nose.* Which one (if either) was the fact is of no material consequence. The etymological propriety of both is sanctioned by the supposition's of classical writers. There can then be no valid objection to other names formed on the model.

There is one rule which has been put in such a form (and without proper exceptions) that a number of names, improper according to classical standards, have been introduced. The rule is that the aspirate of Greek should be rendered by *h*. While this is true for the commencement of a name, it is not for the body, where it generally is suppressed, being sonant only after *p*, *t* or *k*. The Greeks, accordingly, wrote *Philippos* (Φίλιππος) and *Ephippus* (Ἔφιππος). In accordance with such models *Mesohippus* and *Orohippus* should have been called *Mesippus* and *Orippus*. *Protohippus* should have been *Prothippus*. *Epihippus* might by some be considered to be preoccupied by *Ephippus*, a genus of fishes. But, in my opinion, all the names should be

*Those familiar with the 'Spectator' may recall Addison's allusion to this (No. 59). See also Middleton's Life of Cicero.

retained as they are (if there is no other objection), on the assumption that more confusion would result from sacrifice of priority than of classical excellence.

From names as names, I proceed to the consideration of fitting them to groups.

TYPONYMS.

The question what is necessary to insure reception of a generic name is one of those concerning which there is difference of opinion. By some a definition is considered to be requisite, while by others the specification of a type is only required. But the demand in such case is simply that the definition shall be made. It may be inaccurate or not to the point; it may be given up at once, and never adopted by the author himself afterwards, or by any one else. Nevertheless, the condition is fulfilled by the attempt to give the definition. In short, the attempt is required in order that the competency (or its want) of the namer may be known, and if incompetency is shown thereby—no matter! The attempt has been made. The indication by a type is not sufficient.

Any one who has had occasion to investigate the history of some large group must have been often perplexed in determining on what special subdivision of a disintegrated genus the original name should be settled. The old genus may have been a very comprehensive one, covering many genera, and even families, of modern zoology, and of course the investigator has to ignore the original diagnosis. He must often acknowledge how much better it would have been if the genus had been originally indicated by a type rather than a diagnosis. Many naturalists, therefore, now recognize a typonym to be eligible as a generic name. Among such are those guided by the code formulated by the American Ornithologists' Union, to which reference may be made, and in which will be found some judicious remarks on the subject under 'Canon XLII.' Certainly it is more rational to accept a typonym than to require a definition for show rather than use. Nevertheless, I fully recognize the obligation of the genus-maker to indicate by diagnosis, as well as type, his conception of generic characters.

FIRST SPECIES OF A GENUS NOT ITS TYPE.

On account of the difficulty of determining the applicability of a generic name when a large genus is to be subdivided, it has been the practice of some zoologists to take the first species of a genus as its type. This, it has been claimed, is in pursuance of the law of priority. It is, however, an extreme, if not illegitimate, extension of the law, and has generally been discarded in recent years. But in the past it had eminent advocates, such as George Robert Gray in Ornithology, and Pieter Van Bleeker in Ichthyology. A few still adhere to the practice, and within a few months two excellent zoologists have defended their application of names by statements that the first species of the old genera justified their procedure. The contention of one involves the names which shall be given to the crayfishes and lobsters.

It is evident that the fathers of zoological nomenclature never contemplated such a treatment of their names, and the application of the rule to their genera would result in some curious and unexpected conditions. Let us see how some genera of Linnæus would fare. The first species of *Phoca* was the fur seal, the first species of *Mustela* the sea-otter, the first of *Mus* the guinea pig, and the first of *Cervus* was the giraffe. These are sufficient to show what incongruities would flow from the adoption of the rule.

CHOICE OF NAMES SIMULTANEOUSLY PUBLISHED.

There is another issue of nomenclature involving many genera. In the same work different names have been given to representatives or stages of what are now considered the same genus. For example, Lacépède, in the third volume of his 'Histoire Naturelle des Poissons,' published two names, *Cephalacanthus* and *Dactylopterus*, the former given to the young and the latter to the adult stage of the flying gurnard. *Cephalacanthus* appeared on page 323, and *Dactylopterus* on page 325. *Dactylopterus* is the name that has been generally adopted for the genus, but some excellent naturalists now insist on the resurrection and retention of *Cephalacanthus*, for the reason that the latter was the first given name. In connection with an analogous case, it was urged that 'the law of primogeniture applies to twins.' There is a fallacy involved in such a comparison, which becomes obvious enough on consideration. In the case of twins, the birth of one precedes that of the other by a very appreciable interval of time. But in the case of names appearing in the same volume (issued as a whole) the publication is necessarily simultaneous. It is therefore, it appears to me, perfectly logical to take the most appropriate name, or to follow the zoologist who first selected one of the names. In the case of *Dactylopterus*, there would be the further advantage that the current nomenclature would not be disturbed.

It is interesting to note that those who have acted on the principle just condemned do not feel called upon to accept the first species of a genus as its type.

MAJOR GROUPS AND THEIR NOMENCLATURE.

Another subject to which I would invite your attention is the amount of subdivision of the animal kingdom which is expedient, and the nomenclature of such subdivisions.

Linnæus only admitted four categories—class, order, genus and species. These sufficed for most naturalists during the entire past century. Only one naturalist—Gottlieb Conrad Christian Storr—went into much greater detail; he admitted as many as eleven categories, which may be roughly compared with modern groups as follows:

Agmen	Rubrisanguia [=Vertebrata]	Subkingdom
Acies	Warm-blooded Cold-blooded	Superclass
Class	Mammalia	Class
Phalanx	Pedata Pinnepedia Pinnata	Subclass
Cohors	Unguiculata Ungulata	Superorder
Ordo		Order
Missus		Suborder
Sectio		Family
Coetus		Subfamily
Genus		Genus
Species		Species

These groups are really not exactly comparable with any of recent systematists, inasmuch as Storr proceeded from a physiological instead of a morphological base in his classification. The only work in which this classification was exhibited was in his 'Prodromus Methodi Mammalium,' published in 1780.

With this exception, the naturalists of the last century *practically* recognized only four categories—species, genera, orders and classes. Families were introduced into the system by Latreille. The word 'family,' it is true, was not unknown previously, but it had been used only as a synonym for order. In botany such usage even prevails, to some extent, at the present day, and persists as a heritage of the past. The French botanists used 'famille' as the equivalent of 'ordo.' Our English and American botanists followed and used 'order' as the more scientific designation, and 'family' as a popular one; Gray, for example, calling the family represented by the buttercups the 'Order Ranunculaceæ,' or 'Crowfoot Family.' But in zoology the two names became early differentiated and, while order was continued in use with the approximate limits assigned to it by Linnæus, family was interposed as a new category, intermediate between the order and genus. At first this category generally was given a descriptive designation; but soon the tendency to employ, as a part of the designation, the stem of the principal generic name became marked, and the use of the patronymic suffix *-idæ* in connection with a generic name was adopted and, as time has advanced, has become more and more general. But the assent to this method is not universal. There are still some excellent zoologists who refuse to be bound by the rule, and who adopt the oldest family name, whether it be denominative or patronymic and whatever may be the termination.

The five categories thus recognized were very generally admitted, and for a long time were the only ones recognized by many naturalists. But gradually suborders, subfamilies and subgenera were taken up. Further, the word 'tribe' was often used, but with different applications. Still other divisions were occasionally introduced, but the most elaborate of all the schemes for gradation of the groups of the animal kingdom were those proposed by Bleeker* and Haeckel.† They are reproduced in the following parallel columns, in which their applications to fishes and mammals are likewise shown:

Vertebrata	Phylum		
Pachycardia	Subphylum		
Allantoidia	Cladus		
	Subcladus		
Mammalia	CLASSIS	CLASSIS	*Pisces*
Monodelphia	Subclassis	Subclassis	*Monopnoi*
		Divisio	*Dirhinichthyes*
Deciduata	Legio	Legio	*Eleutherognathi*
Discoplacentalia	Sublegio	Sublegio	*Ctneobranchii*
		Series	*Isopleuri*
		Subseries	*Kanonikodermi*
		Phalanx	*Alethinichthyes*
		Subphalanx	*Neopoiesichthyes*
		Caterva	*Katapieseocephali*
Rodentia	ORDO	ORDO	*Percæ*
	Subordo	Subordo	*Percichthyini* [sic!]
Myomorpha	Sectio	Sectio	*Paristemipteri*
	Subsectio		
	Tribus		*Percichthyini* [sic!]
Murina	FAMILIA	FAMILIA	*Percoidei*
	Subfamilia	Subfamilia	*Percæformes*
Arvicolida	*Tribus*	*Cohors*	
Hypudæi	*Subtribus*	Stirps	
Arvicola	GENUS	GENUS	*Perca*
	Subgenus		
Paludicola	*Cohors*		
	Subcohors		
Arvicola amphibius	SPECIES	SPECIES	*Perca fluviatilis*
	Subspecies		
Arvicola (amphibius) terrestris	Varietas		
Arvicola (amphibius terrestris) argentoratensis	Subvarietas		

*Enumeratio specierum Piscium hucusque in Archipelago Indico observatorum, p. xi et seq.

† Generelle Morphologie der Organismen, II., 400.

Here we have a total of 31 categories intermediate between the kingdom and the individual of an animal form. The tools have become too numerous, and some were rarely used by the authors themselves. Thus the cohors and stirps were not called into requisition by Bleeker for the Percoidei (though they were for the subdivision of the Cyprinoidei), and in the recent classification of the Radiolarians, Professor Haeckel did not find it necessary to draw upon the tribus or subtribus for the arrangement of any family. None others have adopted in detail either of the elaborate schemes proposed by their distinguished authors, and even those authors themselves have not, in their later works, gone into the details they provided for in their schemes. The only divisional name that has been used to any great extent is tribe. That has been frequently employed, but in different ways—sometimes for the division of an order, sometimes within a suborder, sometimes for a section of a family, again for a part of a subfamily, and even for a fragment of a genus.* In two of these widely differ-

* The words Phalanx, Cohors and Series (if not others) have been used recently in another manner by Dr. F. A. Smith in the 'History of Scandinavian Fishes.' The sequence in that work is Classis, Ordo, Subordo, Phalanx, Cohors, Series, Familia, Subfamilia, Genus, Subgenus, Species.

ing ways it has been used in the systems of Bleeker and Haeckel. It is evident, however, that more groups than the old conventional ones, which alone Agassiz admitted, would be useful at present. A happy mean seems to be realized in the following list:

Branch	Superfamily
Subbranch	Family
Superclass	Subfamily
Class	Supergenus
Subclass	Genus
Superorder	Subgenus
Order	Species
Suborder	Subspecies

There are only two (or three for trinomialists) of these which are 'sonant,' all the others being 'mute' (to use the expression of Linnæus); but a question of termination affects several of them.

All the supergeneric groups, like families, were originally chiefly designated by descriptive names, but the trend in all the years has been towards names which are based on the stems of existing genera.

FAMILY.

In 1796–7 ('an 5 de la R.'), Latreille, in his 'Précis des Caractères génériques des Insectes,' for the first time employed the term 'family' as a subdivision of an order, but only gave the families numbers ('Famille première,' 'Fam. 2,' etc.).* He remarked that it might be desirable to have the families named, but deferred doing so till he could review the subject with greater care.†

In 1798 ('an 6'), Cuvier, in his 'Tableau Élémentaire de l'Histoire naturelle des Animaux,' in the introduction, when treating of graded characters ('*caractères gradués*'), named only the genus, order, class, and the kingdom. In the body of the work, sometimes he used the word family instead of order (as for the Birds), but for two orders of the Insects he formally adopted a division into families which were regularly named. The first (unnamed) order ('ordre'), with jaws and without wings ('Des insectes pourvus de mâchoires, et sans ailes'), was divided into several families ('plusieurs familles naturelles')—'les Crustacés,' 'les Millepieds,' 'les Aracnéides,' and 'les Phtyréides.' The order Névroptères was disintegrated into three families ('trois familles naturelles')—'les Libelles,' 'les Perles,' and 'les Agnathes.' The representatives of the other (six) orders were distributed directly into genera.

This, so far as I have been able to discover, was the first time in which an order of the animal kingdom was regularly divided into named families, designated as such.

In 1806 Latreille, in his 'Genera Crustaceorum et Insectorum,' gave names to families, but on no uniform plan, providing descriptive names for some, as '*Oxyrhinci*' for the Maioidean crabs—names based on typical genera, with a patronymic termination, as *Palinurini* and *Astacini*, and, in other cases, names also based on a typical genus but with a quasi plural form, as *Pagurii*. (In the same work, it may be well to add, Latreille also admitted more categories than usual, using ten for the animal kingdom—Sectio, Classis, Legio, Centuria, Cohors, Ordo, Familia, Tribus, Genus and Species.)

In 1806 A. M. Constant Duméril, who had previously contributed tables of classification to Cuvier's 'Leçons d'Anatomie Comparée,' and published his own 'Elemens d'Histoire Naturelle,' brought out his 'Zoologie Analytique.' In this volume he gave analytical tables for the entire animal kingdom and admitted families for all the classes. The families were generally sub-

* "Les rapports anatomique, ceux de *l'Habitus*, des métamorphoses, ont été mes guides dans la formation des familles. Elles sont précédées d'un chiffre arabe." p. ix.

† "On eut désiré que j'eusse donné des noms aux familles; mais prévoyant que je serois contraint d'y faire plusieurs changemens, j'eusse ainsi exposé la nomenclature à une vicissitude très contraire à l'avancement de la science." p. ix.

ordinated to orders; but when the structural diversity within a class did not appear sufficient to require more than one 'mute' category the order was sacrificed in favor of the family. His families were generally very comprehensive, often very unnatural, and mostly endowed with descriptive names. (He admitted no more than five named categories in the animal kingdom—class, order, family, genus and species.)

As we have seen, Cuvier, Latreille, Rafinesque and others, to some extent, used names ending in *-ides* and *-ini;* but the first to fully recognize the advisability of using patronymic family names universally was William Kirby, who has not often received the credit for so doing, and is probably unknown to most in such connection. Nevertheless, in a note to his memoir on 'Strepsiptera, a new Order of Insects proposed,'* he explicitly introduced this important feature in systematic terminology. He complained that Latreille's names 'have not that harmony and uniformity of termination which is necessary to make them easily retained by the memory.' Continuing, he added, 'If we adopted a patronymic appellation for these sections, for instance, Coleoptera *Scarabæidæ*, Coleoptera *Staphylinidæ*, Coleoptera *Sphæridiadæ*, Orthoptera *Grylledæ*, etc., it would be liable to no objection of this kind.'

The suggestion thus made was heeded. The English naturalists (especially William Elford Leach and John Edward Gray) soon applied the method inculcated, and from them it has spread to the naturalists of every land; but the original impulse has been forgotten. For this reason I have recalled the memory of Kirby's work.

* The suggestion of Kirby is to be found in a footnote (p. 88) to the seventh memoir published in 'the Transactions of the Linnæan Society of London' (XI., 86–122, pl. 8, 9). The memoir was 'read March 19, 1811;' the date of the whole volume is 1815.

But it was long before the expediency of this procedure was universally recognized, and even yet there are dissentients. One objection was that the termination *-idæ* was not consistent with Latin words. Prof. Agassiz was never reconciled to such names, and gave names of Greek origin the termination *-oidæ*, and those of Latin the ending *-inæ*. In his system, too, there was no distinction between families and subfamilies, both having terminations in consonance with the origin of the stems, and not the taxonomic value of the groups.

The endings *-idæ* and *-oidæ* have been often supposed to be identical, and even in highly esteemed dictionaries (as 'The Imperial Dictionary of the English Language') the terminal element of family names ending in *-idæ* is derived from 'εἶδος, resemblance.' As already indicated, however, words so terminated should be considered as patronymics. But those ending in *-oidæ*, *-oidei*, and *-oidea* may be assumed to be direct components with εἶδος.

In answer to the objection (by Burmeister for example) that patronymic names are foreign to the genius of the Latin language, or at least of Latin prose, the fact that such a poet as Vergil has a large number shows that there is no pervading antagonism.

SUBFAMILY.

Next to the family, the term 'subfamily' was the earliest, and has been the one most generally accepted of the groups now adopted. But the name itself was not used till long after 'family' had come into general vogue. The chief subdivision of the family had been named tribe ('*tribu*'), by Latreille, in 1806, and he continued to use that term. C. S. Rafinesque, in 1815, used the word subfamily ('*sous-famille*') for groups of the same relative rank as the 'tribu' of Latreille, but gave generally descriptive names, with modified nominative plural endings (*e. g.*, *Monodactylia*), although sometimes he named the group after the principal genus (*e. g.*, *Percidia*). The subfamily is now generally recognized, and its ending rendered by *-inæ*, or more seldom *ini* or *ina*. This is rather a termination for Latin adjectives involving the idea of relation or pertinence.

has/ But, as been already urged, the language of nomenclature should not be bound by rules of strict philology. One of the most useful devices of scientific terminology is the establishment of terminations which indicate the nature or value of a group or relation to the group to which some entity belongs.

The chemist has his terminations in *-ates*, *-ides* and *-gens*, and does not deem it incumbent to defend his usage or to abandon his system, because some one might object to the want of classical models. Nay, classical scholars themselves have recognized the legitimacy and usefulness of such a method.

The ending *-idæ* has been shown to have classical sanction for both Greek and Latin; *-inæ* has only classical sanction for Latin words, and there is one— *-oidea* for which no models are to be found in either language. But the convenience of all those endings as indicative at once of the taxonomic value of each group far outweighs any objection to them from the philological side. We are now confronted with the groups having the *-oidea* ending.

SUPERFAMILY.

Experience has shown that for the exhibition of difference in value of various groups and characters, more than the generally accepted groups—families and subfamilies—are desirable. Groups above the family, in the generality of their characters, had been frequently adopted. A quarter century ago I searched for an available name and notation for such a group, and found that the groups which I wished to recognize were most like those that Dana had recognized in the Crustaceans, under the name of subtribe, and given the ending *-oidea*. But the term 'tribe' had first been given and most generally used for a subdivision of the family, and consequently was ineligible for a group including the family. Other names had been given to such groups, but there were objections against them. In a communication to the American Association for the Advancement of Science (Volume XX.) I used a new name—superfamily—and the termination *-oidea*. The great advantage of the name was that it relieved the memory, and suggested at once what was meant by relation to a familiar standard—family. The term has been quite generally adopted, but there has been diversity of usage in the form of the names, *-oideæ* being frequently suffixed to the stem, and sometimes a descriptive name has been given. The only reason for the ending *-oidea* is that it was first used in such connection; *-oideæ* has the advantage (or disadvantage?) that it is in consonance with *-idæ* and *-inæ*. No provision has been made by the German Zoological Society for this category, their attention having been confined to family and subfamily nomenclature.*

OTHER GROUPS

Time does not permit of the consideration of the other groups—order, suborder, class, subclass, superclass, branch, etc. Nevertheless, a caveat is in order that there appears to be no reason why the principle of priority now so generally recognized for the subordinate groups should not prevail

* "Die Namen von Familien und Unterfamilien werden fortan von dem gültigen Namen einer zu diesen Gruppen gehörigen Gattung Gebildet, und zwar die der Familien durch Anhängen der Endung *idæ* (Plural von *ides* [gr. εἴδης] masc. gen.), die der Unterfamilien durch Anhängen der Endung *inæ* (fem. gen.) an den Stamm des betreffenden Gattungsnamens." Regeln . . . von der Deutsch. Zool. Ges., § 28.

for the higher. Why should the name Amphibia disappear and Batrachia and Reptilia usurp its place? Amphibia is a far better name for the Batrachia, and in every way defensible for it. The name had especial relation to it originally, and it was first restricted to it as a class. Why should the names Sauria and Serpentes give place to Lacertilia and Ophidia? The first are names familiar to all and correctly formed; the last are, at least, strangely framed. Why should not Meantia be adopted as an ordinal name, by those who regard the Sirenids as representatives of a distinct order, as did Linnæus? Why should not the ordinal names Bruta, Feræ, Glires and Cete prevail over Edentata, Carnivora, Rodentia and Cetacea? If the rules formulated by the various societies are applied to those groups, the earliest names must be revived.

COMPLAINTS OF INSTABILITY OF NOMENCLATURE.

Frequent are the laments over the instability of our systematic nomenclature; bitter the complaints against those who change names. But surely such complaints are unjust when urged against those who range themselves under laws. We are forcibly reminded by such complaints of the ancient apologue of the wolf and the lamb. The stream of nomenclature has indeed been much muddied, but it is due to the acts of those who refuse to be bound by laws or reason. The only way to purify the stream is to clear out all the disturbing elements. In doing so, mud that has settled for a time may be disturbed, but this is at worst anticipating what would have inevitably happened sooner or later. We are suffering from the ignorance or misdeeds of the past. In opposing the necessary rectifications and the enforcement of the laws, extremes may meet; conservatives and anarchists agree. But the majority may be depended upon in time to subscribe to the laws, and the perturbed condition will then cease to be.

It is unfortunate that our nomenclature should have been so wedded to systematic zoology, and devised to express the different phases of our knowledge or understanding of morphological facts. Even under the binomial system the disturbing element might have been made much less than it is. The genera of Linnæus recognized for the animal kingdom were generally very comprehensive; sometimes, as in the case of *Petromyzon*, *Asterias* and *Echinus*, answering to a modern class; sometimes, like *Testudo*, *Rana*, *Cancer*, *Scorpio*, *Aranea*, *Scolopendra* and *Julus*, to a modern order, or even more comprehensive group, and rarely, among Vertebrates, to a group of less than family value. The usage of Linnæus for the animal kingdom was very different from that for the vegetable kingdom. If the successors of Linnæus had been content to take genera of like high rank (equivalent to families, for example), and give other names to the subdivisions (or subgenera) of such genera, which, to use the language of Linnæus, should be mute, less change would have subsequently resulted. But (Linnæus himself leading) his successors successively divided a genus, gradually accepting a lower and lower standard of value, till now a genus is little more than a multiform or very distinct isolated species. Yet the change has been very gradual. It began by taking a comprehensive group, recognizing that the differences between its representatives were greater than those existing between certain genera already established, and therefore the old genus was split up; or it was perceived that the characters used to define a genus were of less systematic importance than others found within the limits of the old genus, and, to bring into prominence such a truth, the genus was disintegrated. The process often repeated, and from successively contracted bases, has led to the present condition.

The existing system of restricted genera, however, is too firmly fixed to revert back to a method that might have been, and which indeed Cuvier attempted to introduce by his revised Linnæan genera and their subgenera. The best thing to do now is to accept the current system, purified as much as possible by judicious and inexorably applied laws. Doubtless in the distant future a less cumbrous and changeable system of notation will be devised, but in the meantime we had best put up with the present, inconvenient though it be.

Theodore Gill.
Smithsonian Institution.

SECTION F.—ZOOLOGY.

The results of the late meeting at Buffalo of Section F, of the A. A. A. S., may be regarded as satisfactory. The average attendance at the sessions, which continued without interruption from Tuesday morning to Thursday evening, was thirty-five. Twelve of the one hundred and ten members elected at Buffalo chose this section. Twenty-five papers besides the address of Vice-President Gill were offered; two, however, were withdrawn—one to be given by the President of the Association as a public lecture and one to be read in Section E. The remaining twenty-three were read by their authors, with the exception of that of Mr. Miles, read by C. C. Nutting.

1. The first paper was by U. S. Entomologist L. O. Howard 'On the Entomological Results of the Exploration of the British West India Islands by the British Association for the Advancement of Science,' detailing the steps by which this important investigation had been brought about, and summarizing the results of the different papers which have been published since the beginning of the investigation. He eulogized the British Committee for its conception of the work and the liberality with which it has been carried on, showed the importance of the results so far achieved, and made a plea for the association of entomologists with scientific expeditions in this country, and for the close collecting of insects, which has apparently been heretofore considered as of less importance than the collection of higher animals and plants.

2. The second paper was by Mr. F. M. Webster, who discussed cases among insects where a species unarmed and in no way capable of protecting itself was, to a certain extent, protected by its resemblance to armed species, or such as are known to be distasteful. Others, by their actions, mimicked the movements of certain other species, and were thereby mistaken for such as are inedible. The ground was taken that birds, after learning that certain insects were not fit for food, would shun any other insects appearing like these, wherever they might come in contact with them, even though at a different season of the year. There may be cases where one species mimics another, when the enemy has become exterminated and no protection is needed. Caution was enjoined against hasty and immature conclusions, as there is much to be learned in the matter, but no facts should be cast aside as mere coincidences, when more facts would enable us to push the problem to a point nearer a solution. That insects, especially, gain protection from their coloration and movements is assured, but much caution is necessary before conclusions are reached. The paper was illustrated by specimens.

3. Prof. A. D. Hopkins, of Morgantown, W. Va., under the title 'On Life Zones in West Virginia,' gave in detail the work he had done in mapping these zones in his State as indicated by the insect fauna.

4. 'The Variations of certain Species of North American Odonata' was a paper

read by D. S. Kellicott giving the results of observations on the variations in size, appendages and coloration of *Enallagma carunculatum* Morse, *Gomphus fraternus* Say, and *G. externus* Selys. It was shown that the size of these odonates is remarkably constant in Ohio. That the male abdominal appendages are almost without variation, affording the most reliable generic and specific characters; and that many color markings commonly used in description are too inconstant to be relied upon independent of structural characters.

5. 'A Case of Excessive Parasitism' was then briefly described by L. O. Howard. He described in some detail the facts concerning the rearing of one hundred and twenty-seven specimens of six species and five genera of Chalcididæ from the *Lecanium* scales on a twig of arbor vitæ received from Ottawa, Canada.

6. 'Notes on the Occurrence of Dragonflies in Ohio in 1896' was a second paper by D. S. Kellicott which stated that *Odonata* have been unusually abundant in Ohio the present season, which was unexpected, inasmuch as the seasons of 1894 and 1895 were those of extreme drouth, causing the water to wholly disappear from ponds and streams over wide areas. It would appear to be a fair inference that the nymphs can sustain themselves in the mud or in cavities of the dry earth during periods of prolonged drouth. Many species appeared weeks, and in some cases months, before the usual date. This was thought to be due to continuous hot weather, beginning April 10th. At Columbus ten species were taken in April.

7. 'Scyllarus and Anemonia—A case of Semi-commensalism,' by Edward L. Rice, referred to a specimen of Scyllarus, confined in the same aquarium with Anemonia, was observed to lie habitually in the vicinity of the anemone, returning to the same when placed in a distant part of the tank among stones or algæ, furnishing ideal nooks for concealment. This case is of interest, in connection with the well-known extreme symbiosis of Pagurus and Adamsia, as showing that the Crustacean seeks the anemone, probably gaining protection from the nematocysts of the latter.

8. This ended the papers and discussions of the first day. The second, Wednesday, was begun promptly with a fair attendance; the first paper was by Prof. C. W. Hargitt, entitled 'Notes upon Cordylophora.' *Cordylophora* has long been known to be capable of existence under a wide range of conditions. In December, 1895, a colony of these hydroids, growing on a bit of slag in company with several specimens of acorn barnacles were brought to the writer in a pint of brackish water. They remained in a jar in the laboratory for several weeks and were twice frozen almost solid; they were then supposed to be dead and were set aside. After some time the water was partly poured off and replaced from the top and once more set aside when the barnacles were seen to be alive; then specimens of *Cypris* were put in the jar for food. Late in May there were no signs of life; the water was again poured off and replaced from the top. After several weeks it was noticed that there were several colonies of the hydroids feeding freely. The barnacles also were alive. Both forms had withstood freezing and confinement in a limited quantity of water which had been gradually changed from sea water to fresh water. The hydroids were still alive August 20th.

9. The first of the morphological papers was read by Mrs. Susanna P. Gage, on 'Modification of the Brain during Growth.' A brief abstract follows:

1. The greater bends of the brain tube are associated with early development of the eye and its nerve fibers, the post-commissure, the ventral commissure and the fifth nerve.

2. The pons-bend is increased by a fold of the membranous roof of the brain which coalesces and extends from the outside of the brain-tube to meson.

3. The thin walls of the cerebrum, the tela and plexuses, are really laterally continuous with the membranous roof of the diencephal.

4. The dorsal and ventral zones of His have not been identified in the forms studied—cat, turtle, bird and Amphibia; rather the indications are of a segmental arrangement of the parts of the brain with a secondary formation of sulci which probably have a wide morphological significance.

10. 'A Note on the Membranous Roof of the Prosencephal and Diencephal of Ganoids,' by B. F. Kingsbury, was an interesting discussion in the neurology of species of fishes named below. Principal stress was laid on the evaginations of membranous roof of the ganoid brain—the *paraphysis*, *dorsal sack* and *epiphysis*. He emphasized the presence of a paraphysis, occurrence and value of the 'dorsal sack' and the existence of a second epiphysial structure in the adult Amia and its innervation. The forms discussed were *Amia*, *Lepidosteus*, *Acipenser* and *Polyodon*.

11. The same author followed with 'The Structure and Morphology of the Oblongata of Fishes.' He discussed the regions which make up the dorsal portion of the oblongata in Ganoids and Teleosts: (1) The spinal, ascending Vth tract, (2) the homologue of the fasciculus communis of the Amphibian brain, (3) center for the auditory nerve and the nerves of the lateral line system. He referred also to the modifications of these regions in *Amia*, *Lepidosteus* and *Acipenser* and in representatives of thirteen families of Teleosts and the fusions that occur. Two results may be mentioned: the vagus nerve derives a small part of its fibers from the spinal V tract (in some). The *lobus vagi* and *lobus trigemini* are but differentiated parts of the same tract (*fasciculus communis*).

Mr. Kingbury's second paper concluded the work of the morning session of Wednesday. The afternoon sessions opened by two papers devoted to methods of science teaching in the secondary schools:

12. 'Differentiation of work in Zoology—in Secondary Schools,' by Wm. Orr, Jr., and

13. 'Field Work and its Utility,' by Jas. G. Needham.

Both papers were received with deep interest and were discussed at length. That the matter presented bids fair to receive due attention in the future is attested by the fact that a joint meeting of representatives of Sections G and F agreed that it is desirable at the next meeting of the Association to have arranged in advance a joint meeting of the Sections for the consideration of questions relating to teaching, etc. The plan was adopted by Section F.

14. The above papers and discussions were followed by an illustrated paper by Miss Agnes M. Claypole on 'Appendages of an Insect Embryo.'

The form used was identified as *Anurida maritima* Guerin, and was collected under stones on the beach at Woods Holl, Mass. It belongs to a wingless group of Insecta, the Collembola, and is the first form of the group as yet studied in microscopic sections.

The cleavage of the egg is complete, holoblastic, a character belonging to this group of insects only, all the others having central cleavage. The appearance of the appendages takes place very early, the antennæ being the first of the series; following the antennæ is a pair of very small appendages on the body segment, carrying what is well known to be the third brain segment. Behind these the mandibles, 1st maxillæ and 2d maxillæ appear successively, in turn followed again by the thoracic appendages. All of these organs increase in size excepting the small pair on the third segment which remains unchanged till the mouth parts and antennæ have assumed almost distinctive characters. Then these small ones begin to grow as a ridge down each side of the three pairs of mouth parts and finally form a wide plate-like appendage enclosing the mandibles and second maxillæ entirely. In the adult the mouth parts are known to be enclosed in a tube or to be 'drawn in' as the condition is usually described. If, as generally acknowledged, the insect antennæ are considered homologous with the first pair of antennæ of the Crustacean, a point of considerable interest is developed. The appendage of the third segment has been found in many insect embryos, but in all cases is a purely embryonic structure; it disappears before hatching. Among terrestrial Crustaceans, the wood lice for example, the second pair of antennæ is reduced to an extremely small size. Hence *Anurida* is an interesting form showing an insect in which the second pair of antennæ of the Crustaceans is present and functional in the adult; the function, however, is completely changed.

15. The first paper Thursday morning was a valuable one by Miss Isabella M. Green on 'The Peritoneal Epithelium in Amphibia.' The principal results of this investigation may be summed up as follows:

1. Cilia were present upon parts of the peritoneum of all the adult females studied.

2. Cilia were constant upon the following parts, hepatic ligament, the ventral wall of the body cavity, the membranes near the mouth of the oviduct and the serosa of the liver.

3. In *Necturus* some of the adult females showed cilia also upon the dorsal wall of the body cavity.

4. Specimens of *Amblystoma* taken both before and after ovulation and in August differed from the other species in having cilia upon the mesoarium and the membranes supporting the oviduct.

From the fact that the cilia are present in the adult female and that the direction of the current produced by them is toward and into the mouth of the oviduct, it seems, without doubt, that the physiological purpose of the cilia is to carry the ova to the oviducts.

16. 'The Heart of the Lungless Salamanders of Cayuga Lake,' by Grant S. Hopkins, followed in which it was shown that the current statement regarding the heart of the amphibia must be modified somewhat, for in the lungless salamanders the post cava (or sinus venosus) does not open into the right auricle any more directly than into the left. The auricles communicate with each other very freely. The writer had not been able to make out the presence of pulmonary veins opening into the left auricle, in the lungless forms. One additional lungless salamander was added to the list.

17. 'Observations on the Chameleon, *Anolis principalis*,' by Geo. V. Reichel. This paper treated of the American anolid with observations made by the author concerning its power to change color, its habits, and suggested the possible use of the chameleon as an exterminator of flies and other dwelling house insect-pests.

18. The afternoon session was opened by a paper by Manly Miles read in the absence of the author by C. C. Nutting. The title was 'The Relative Efficiency of Animals as Machines.' It was an inquiry as to the relative efficiency of different classes of animals in utilizing the potential energy of their food in useful work; approximate quantitative estimates were given of the expenditure of energy in making 100 lbs. of increase in fattening animals and the relative expenditure in repairs of the animal machine. A similar estimate was given of the utilization of energy in milk production.

19. 'Some Abnormal Chick Embryos,' was a paper by C. W. Hargitt, reviewing some of the more striking facts of teratology, of the time. Also noticing the remarkable advances and significance of modern embryology, and the apparent climax as shown in the striking experiments of Driesch, Roux, Wilson and others, shows the probably similar character of experiments of Dareste, Metrophanow, and others on the embryology of the chick.

The paper next dealt with special examples of abnormal chick embryos which have come under the writer's observations quite recently, several specimens of which were exhibited.

Various phases of irregularity were noted, such as imperfectly developed embryos; in some only the head-fold; in others hardly beyond the primitive groove; in some other embryos degeneration of the whole blastoderm, even after considerably advanced stages. Several cases of double and triple embryos were noted.

20. 'On a peculiar Fusion of the Gill-filaments in certain Lamellibranchs,' by Edward L. Rice.

In many folded types of lamellibranch gills the examination of serial sections perpendicular to the filaments shows a large number of filaments in the upper portion of the gill, which gradually meet and fuse to a relatively small number as the free margin is approached. Thus in *Cardium edule* a reduction of 23 filaments to 6 was noted.

The fusion is usually almost exclusively limited to a narrow band in the near vicinity of the free borders of the gill, where the folding of the lamellæ is necessarily much reduced. Another zone of fusion may be noted, in cases where the outer gill is produced to form a dorsal appendage, at the transition from the gill proper to the appendage. Here again the fusion is correlated with a reduction in the folding.

Is this phenomenon really a fusion or a branching of the original filaments? At the free border of the gill the filaments of one lamella go over without interruption into those of the other, and the number in the two lamellæ must in either case be equal. In the 'zone of fusion' the number becomes very unequal. Higher in the gill, where the maximum number is reached, the two lamellæ contain equal numbers of filaments, showing conclusively that the maximum is the original number.

This fusion was observed only in distinctively lamellar gills in which the folding is developed. It is most conspicuous in *Cardium*, *Batissa*, *Psammobia*, *Chama*, *Solenocurtus* and *Donax serra;* less developed in *Cyprina* (strong on the transition line of gill proper and appendage) and *Venus;* very slightly developed in *Solen*, *Mya*, and *Donax politus*. Though fusion was observed in *Cytherea*, *Donax trunculus*, *Ostrea*, and *Thracia*, nor in the *outer gill* of *Cardium* and *Psammobia*.

The fusion seems to have little systematic value, but to be mechanically correlated with the folding and the crushing due to the inelastic gill margin with an increasing number of filaments. The upper part of the gill of *Cardium*, if flattened, would measure some seven times the length of the free margin.

Apparently this fusion has not been noted in the literature, unless figures showing an unequal number of filaments in the two lamellæ, *within one fold*, point in this direction, *e. g.*, *Cardium* (van Haren), *Lima* (Pelseneer), *Donax trunculus* (Sluiter), *Ostrea* (Kellogg).

21. 'Experiments Upon Regeneration and Heteromorphosis,' by Chas. W. Hargitt. This paper reviewed a series of experiments carried on at the Marine Biological Station during the present summer upon regeneration among the Hydromedusae. The experiments of earlier investigators upon hydroids were repeated among various fam-

ilies and genera, and the most important results verified. The experiments upon medusæ were confined to the genus *Gonionemus*, members of which from physiological habit loaned themselves quite readily to such work. While the series of experiments have not been completed, enough has been done to establish the capacity of even such specialized forms to regenerate various parts and organs with great readiness, and that both centrifugally and centripetally. Indeed, an apparent capacity for considerable heteromorphism.

22. The President of the Association read the next paper on 'The Penial Structures of the Saurians,' which was printed in abstract in the last number of this Journal.

23. 'The Relationships of the North American Fauna,' was then presented by the chairman of the section, Vice-President Gill, and discussed at length by Prof. E. D. Cope and others. In the course of his remarks the author said: "The question of the extent and relationship of the North American Fauna have been several times discussed recently and very different conclusions deduced. I do not feel inclined to recede from the position taken years ago. It depends upon the reliance which is placed upon a special group whether we are lead to one view or another; for example, if we take the birds alone we may acknowledge the bonds that bind temperate northern America and Eurasia; if we take the lizards, the North American Group is simply an extension of the Southern; if we take the mammals, the reality of an Arctic region may be insisted on. But the acceptance of an Arctic region by no means clears away the difficulties; it rather doubles them, for we have then the task of defining the boundaries between that Arctic region and the North American, on the one hand, and the Eurasiatic, on the other. It seems best then to consider the Arctic lands as neutral territory and to correlate zoogeographical and geographical data, recognizing the regions admitted by Sclater, Wallace and most other zoogeographers. The most significant evidence in favor of the distinction of the North American and Eurasiatic faunas is furnished by the fishes. Certainly the ichthyologist cannot subscribe to the union of the two into a single Holarctic region."

The Vice-Presidential address, 'On some Points in Nomenclature,' was read Monday p. m. and appears in full in the present number of this Journal.

D. S. Kellicott,
Secretary.
State University, Columbus, O.

THE GEOGRAPHICAL SECTION OF THE BRITISH ASSOCIATION.

Meeting in a great commerical center like Liverpool, and in a city which is the seat of a young but vigorous geographical society, it was to be expected that the Geographical Section of the British Association should be neither less active nor less popular than in former years. It may, perhaps, be the case that the large audiences, on several occasions approaching a thousand, were attracted by an unwontedly liberal use of the lantern for illustration, but no single slide was shown which was not either exhibited for the first time, or was not in a very special manner calculated to fix the impression produced by the papers. The Section met on five days, in the course of which 34 communications were made, almost all of them longer than the average of papers read in other sections. Limitation of discussion was therefore inevitable, and several points which might have led to lively debates had to be passed by in silence. There was no lack of variety in the program; indeed, the difficulty was to secure any sort of logical order in the nature of the papers read on a given day. The provisional program which provided for some such order had to be abandoned on account of the changed plans of authors and the return of so many Arctic expeditions within the month prior to the meeting of the Association. The following brief resumé will serve to indicate the variety and richness of the fare offered in Section E; the papers themselves will in most cases be published in one or other of the British geographical journals.

The President was Major Darwin, one of the Honorary Secretaries of the Royal Geographical Society and son of the great naturalist. Amongst the Vice-Presidents were Sir Erasmus Ommaney, Sir Lambert Playfair, Dr. P. L. Sclater, Mr. John Coles and Mr. E. G. Ravenstein; while Colonel Bailey, Commander Phillips, Mr. H. M. Dickson and Dr. H. R. Mill acted as Secretaries.

Major Darwin's address opened the meeting of the Section, on Thursday, 19th September. He dwelt mainly on the geographical problems involved in the opening up of the interior of tropical Africa to external trade. He was led to consider that parts of tropical Africa in which the average density of population was less than 8 per square mile were unlikely to be of commercial value, and therefore he limited the problem to the study of the best means of communication between regions of higher density of population and the sea. This is practically a question of conjoint systems of waterway and railway, and special attention was given to the various short lines already at work in tropical Africa, and to the larger schemes for longer railways which are now being discussed and commenced. Major Darwin concluded: "All I have attempted to do is briefly to sketch out some of the main geographical problems connected with the opening of central Africa in the immediate future. Such a review is necessarily imperfect, but its very imperfections illustrate the need of more accurate geographical information as to many of the districts in question. Many blunders may have been made by me in consequence of our inaccurate knowledge, and, from the same cause, many blunders will certainly be made in future by those who have to lay out these routes into the interior. In fact my desire has been to prove that, notwithstanding the vast strides that geography has made in past years in Africa, there is yet an immense amount of valuable work ready for anyone who will undertake it.

"Possibly, in considering this subject, I have been tempted to deviate from the strictly geographical aspect of the case. Where geography begins and where it ends is a question which has been the subject of much dispute. Whether geography should be classed as a separate science or not has been much debated. No doubt it is right to classify scientific work as far as possible; but it is a fatal mistake to attach too much importance to any such classification. Geography is now going through a somewhat critical period in its development, in consequence of the solution of nearly all the great geographical problems that used to stir the imagination of nations; and for this reason such discussions are now specially to the fore. My own humble advice to geographers would be to spend less time in considering what geography is and what it is not; to attack every useful and interesting problem that presents itself for solution; to take every help we can get from every quarter in arriving at our conclusions; and to let the name that our work goes by take care of itself."

Mr. H. S. Cowper followed with a short account of a journey made by him in northern Tripoli, in March 1896, in the course of which he had photographed a number of remarkable megalithic structures, some of them never previously described. The Rev. J. C. Robinson gave an illustrated lecture on the Housa people of the Niger district.

In the afternoon Mr. John Coles exhibited two forms of camera for photographic surveying, and explained the principles of the process, expressing his belief that photography was destined to play a very large part in future surveys, especially for rapidly constructing small scale maps of large areas. Mr. H. N. Dickson spoke on his work now in progress on the oceanography of the North Atlantic; and Dr. H. R. Mill brought forward the scheme for the geographical description of the British Isles which has already been noticed in SCIENCE. He stated that the Royal Geographical Society had authorized the compilation of a descriptive memoir of a specimen sheet.

On Friday the proceedings commenced by a paper on old tapestry maps of some English counties contributed by the Rev. W. K. R. Bedford. These maps were woven about the end of the sixteenth century and present many interesting features. Dr. Tempest Anderson described the Altels avalanche of September, 1895, showing a series of slides. Lieutenant Vandeleur gave a careful and valuable description of the remoter parts of Uganda and the country bordering the Upper Nile, where he has recently traveled extensively in the course of his military duties. Dr. F. P. Gulliver, of Harvard, was welcomed as a disciple of the American school of physical geography, and by the aid of a series of lantern-diagrams he gave an interesting account of the coast forms of Dungeness and Romney marsh with deductions as to their origin. In the afternoon Mr. A. Montefiore Brice, Secretary of the Jackson-Harmsworth expedition, gave a full account of the work carried out by Mr. Jackson in Franz Josef Land, which he is determined to thoroughly survey and where he is now spending his third consecutive winter. Slides were shown of the scenery of Franz Josef Land, and of Dr. Nansen and his companion Johansen while the guests of Mr. Jackson.

Mr. Brice announced that Mr. Harmsworth would probably send out two ships next year to attempt to push northward into the sea beyond Franz Josef Land. M. G. F. Scott Elliot discoursed on the influence of climate and vegetation on African civilization, endeavoring to classify and characterize the tribes according to their environment. Mr. Vaughan Cornish completed the day's work by an original memoir of great merit on the character and origin of sand-dunes. He showed the parts played respectively by the wind drifting sand and driving it in showers, by the eddy in the lee of the dune in gouging out the leeward face, and by gravity in reducing to the angle of repose any steeper slopes temporarily produced by wind. He also recognizes negative dunes, hollowed out in sand, which rests on a hard floor, and he draws attention to the homology between sand-dunes formed in the air and sand-banks formed in the water.

On Saturday Mr. A. J. Herbertson showed some monthly rainfall maps of the world, which he is compiling for Bartholomew's great English physical atlas based on Berghaus. The Report of the Committee on African Climatology was read, and Sir James Grant gave a discourse on Canada with special reference to the discoveries of gold in the Dominion.

On Monday several papers of special interest were read. Mr. W. A. L. Fletcher began with a description of the great journey across Tibet from north to south, on which he accompanied Mr. and Mrs. St. George Littledale to the neighborhood of Lhasa. Mr. F. W. Howell and Dr. K. Grossman gave papers on the scenery of the less known parts of Iceland, very finely illustrated by slides of glacial and volcanic land-forms. Mr. G. G. Chisholm read a philosophic paper on the relativity of geographical advantages, in which he showed that at different periods of history, the conditions of physical, economic or political environment which contribute to the prosperity of a place are not necessarily the same. This thesis he supported by a number of striking examples. Mr. Ralph Richardson made some remarks on the various so-called 'Schomburgk lines' which appear on the maps of British Guiana. In the afternoon Sir Martin Conway, who had returned from an expedition to Spitzbergen a few days previously, gave a preliminary account of the first crossing of the southwestern island, and drew a graphic picture of the extraordinary difficulties he had to overcome on account of the slushy nature of the snow and the marshes which covered the valley floors. His companions Dr. J. W. Gregory and Messrs. Garwood and Trevor-Battye had made most important geological, zoological and botanical observations and collections. Mr. H. W. Cave described, with numerous fine photographs, the ruined cities of Ceylon, and Prof. J. Milne gave a paper on earthquakes and sea waves with special reference to recent occurrences in Japan.

The Section met for the last time on Tuesday, September 22d, when, after a paper by Mr. A. E. Fitzgerald (who is about to attempt the ascent of Aconcagua), on his passage of the Southern Alps of New Zealand, General Sir Charles Wilson gave a masterly address on the Egyptian Sudan. He confined himself, of course, to the non-political conditions of the country, and laid stress on the importance of a railway being constructed between the Red Sea and the Nile above the cataracts. The country he looked upon as one with a great future for trade when once a way to the coast has been provided. Mr. A. W. Andrews read a paper on the teaching of geography as the basis of history in schools. From practical experience he stated what could be done if the teacher threw his heart into the work. Mr. E. Odlum, of Vancouver, gave a short description of the border-lands of British Columbia and Alaska, which acquired a special interest from the presence, on the platform, of the first settler in British Columbia, Mr. John Coles, and the surveyor of the southern boundry line of the province, Sir Charles Wilson. In the afternoon Mr. J. Scott Keltie, who had just returned from Christiania, described the triumphal reception of Dr. Nansen and the crew of the *Fram* in the Norwegian capital, and also gave a brief outline of the course of the expedition, citing Prof. Mohn's high tribute to the unique value of the observations made in the course of it. He pointed out that although Nansen had returned in the *Windward* he had anticipated no greater difficulty in crossing to Spitzbergen than in reaching Franz Josef Land itself. Mr. A. J. Herbertson showed a simple piece of apparatus for illustrating map-projections by means of the shadow cast by a wire hemisphere. Mr. B. V. Darbishire showed a new population-map of South Wales, on which all inhabited houses as well as villages and towns were marked. The proceedings were brought to a close by the reading of an interim report of the Committee on the Teaching of Geography in Schools, and the Section was adjourned until Thursday, 19th August, 1897, in Toronto.

It may be mentioned here that it would be a matter of importance if intimation of any papers on geographical subjects to be offered to the Section next year would be made as early as possible to me at 1 Savile Row, London, W., so that as representative a program as possible may be prepared before the meeting. The meeting is looked forward to as one at which it will be possible for Section E of the British Association to learn much as to the recent advances in geography on the American continent.

HUGH ROBERT MILL.

CHEMISTRY AT THE BRITISH ASSOCIATION.

The address of Dr. Ludwig Mond, President of the Chemical Section at the Liverpool meeting of the British Association, was on the History of the Manufacture of Chlorin. After sketching the earlier methods, Dr. Mond treated very fully the Weldon and the Deacon processes, and then gave the details of his own work on the recovery of the chlorin in the Solvay process of soda-manufacture. In outline, Mond's process is as follows: The ammonium chlorid, obtained in a very pure condition by crystallization from the refrigerated liquors of the Solvay process, is passed as a vapor over hot pills of a mixture of magnesia, potassium chlorid and china clay. Ammonia is given off and condensed, while the chlorin unites with the magnesia. The pills are then heated more strongly and hot air passed over them; the magnesia is regenerated and the chlorin given off, to be absorbed by lime for bleaching powder. By this method, which has been in commercial operation for several years at Winnington, the Solvay process is able to compete with the LeBlanc process in the manufacture not only of soda, but of bleaching powder. In conclusion Dr. Mond referred to promising developments along the line of the manufacture of chlorin by electrolysis.

The paper which attracted the most attention in the Chemical Section was that of Prof. Ramsay on Helium. It was mainly devoted to his diffusion experiments, already described in this Journal. He said he was about to carry out experiments on oxygen and nitrogen, in order to determine if they can be resolved by the diffusion process into constituents of slightly different density. In the course of the discussion which followed the paper, Dr. Mond spoke of argon and helium as being a kind of matter different from the ordinary chemical elements, and having no chemical affinities and characteristics. He did not consider it improbable that there might be a whole series of substances not belonging to chemistry, whose existence seemed not only to upset the fundamental law of chemistry, Dalton's Law, but also to cast doubt on the present fundamental notions regarding physical science.

It may be noted that the idea that all the atoms of an element may not have the same weight is not a new one first broached in the case of helium, but it was some years ago suggested by Prof. Crookes in connection with his work on rare earths.

Prof. Dewar read a paper on Low Temperature Research, urging especially the necessity of physical investigation. He described a very accurate method of making specific gravity determinations in liquid oxygen.

Dr. F. Hurter discussed the manufacture of chlorin by means of nitric acid, and said that in spite of its theoretical advantages it had not proved a commercial success, nor did it give promise for the future.

Prof. Liebreich, of Berlin, repeated a series of experiments before the Section with a view to proving the diminution of chemical action resulting from the limitations of space. He advanced the general propositions that liquids, in proportion as they are placed in confined spaces, acquire by equilibric reactions the properties of solids; and that friction in such fluids has a bearing of considerable importance on chemical reaction.

Dr. William Newton, of London, described very fully the nitrate deposits of Chili, and deprecated very strongly the present crude and wasteful methods of mining and working up the products.

One of the most interesting papers was by Sir Henry Roscoe on Chemical Education in England and Germany. England is feeling very keenly the fact that Germany is along most lines monopolizing the chemical industry of the world. While larger government endowments for technical education (at present about $3,500,000 a year), especially for research, are desirable, the author of the paper, as well as those who discussed it, agreed that the greatest need is the improvement of the system of secondary education. J. L. H.

RELATIONS OF THE LEMURS, PRIMATES AND UNGULATES.

PROF. A. A. W. HUBRECHT has contributed to the second volume of the Gegenbaur *Festschrift* an important memoir upon the placentation of *Tarsius*, in which he reaches the conclusion that this animal should be entirely removed from the Lemuroidea, where it has always stood hitherto, and placed with the true Primates or Anthropoidea. The following is a recapitulation of his conclusions:

1. Numerous peculiarities in the formation of the blastocyst of *Tarsius spectrum* show it to be more closely related to monkeys and man than to any other mammalian genus.

2. The ventral stalk in the blastocyst of man and monkeys, with the ontogenesis of which we were up to now most imperfectly acquainted, is explained both onto- and phylogenetically by the facts which we observe in *Tarsius*.

3. By its dentition *Tarsius* takes an intermediate place between the monkeys and mesozoic Insectivora; the upper molars are purely tritubercular, the lower ones tuberculo-sectorial with well-developed pr^d, me^d, pa^d, hy^d and en^d.

4. Among fossil Mammals the genus *Anaptomorphus* Cope takes up an intermediate position between *Tarsius* and man. Cope was thereby actuated to choose the specific name *homunculus*.

5. The Mammalian order of the Primates should henceforth be looked upon as fully distinct from that of the Lemures; the former reaches back into the Mesozoic Period and has been independent of all the other Mammalian orders through the whole Tertiaries.

6. To the order of Primates belong (1) man, (2) the monkeys, (3) the two genera *Tarsius* (recent) and *Anaptomorphus* (fossil, lower Eocene), which have been hitherto classified with the Lemures.

7. Undoubtedly a greater number of fossil genera will have to be classed with the Primates; great prudence should, however, prevail before we assign that place to any of them. It is better to wait for more complete skeletons before we attempt to establish any sharp distinction between fossil Primates and Lemures.

8. The Lemures (inclusive of Cope's extinct Mesodonta) have in their turn close relationships to numerous Primitive Tertiary mammalian types, such as the unspecialized Ungulata, Condylarthra, Creodonts, etc. The placentation and the blastocyst are in the Lemures fundamentally different from those of *Tarsius*, but are at the same time undoubtedly phylogenetically comparable to those of the latter mammals.

9. The placentation and the formation of the blastocyst in the Primates cannot be derived from what we find in the Lemures. They can, however, without difficulty be brought into genetic relationship with processes such as we notice in central Insectivorous genera, such as *Erinaceus*.

CURRENT NOTES ON PHYSIOGRAPHY.

GRAPE BELT OF WESTERN NEW YORK.

GRAPE raising is an important industry along the Erie shore of western New York, and it appears that, in addition to the favoring climatic influences of the lake, the gravelly bars of the ancient expanded lake offer the best soils for vineyards, as described by Tarr (Bull. 109, Cornell Univ. Agr. Exp. Station). These ancient lake shores lie on the Erie plain, an inner lowland denuded on the weak lower Devonian strata, between the rising upper Devonian inface that ascends to the Alleghany plateau, on the south, and the falling Niagara inface that descends, on the north, to the Ontario plain, the latter being another inner lowland of the very ancient coastal plain of which the Laurentian highlands of Canada are the oldland.* A large part of these inner lowlands is under the water of the lakes, but where emerged they support a thriving agricultural population; fruit being extensively cultivated on the Ontario plain north of the Niagara infacing escarpment (locally known as 'the mountain'; a good illustration of the geographical poverty of our language), as well as on the Erie plain. Although the ancient lake shores hereabouts are characterized by gravel bars, the present Erie shore is mostly a cliff, cut in shales. Besides the reasons suggested by Tarr for this contrast, the greater time of action at the present level may be considered. The ancient shore lines of Lake Erie in the fruit belt did not advance beyond the youthful stage of building off-shore bars on a shallow bottom. The present shore lines have advanced to the mature stage of low cliffs cut into the gently sloping mainland. Whether the present shore lines went through the preparatory phase of building off-shore bars cannot be said without further study, but there does not appear to be any reason why they should not have witnessed all the normal stages of shore-line development up to their existing maturity.

THE GORGE OF THE AAR.

A. R. Wallace, an earnest advocate of the glacial origin of lake basins, illustrates the competence of ice streams to erode rock basins by the relation of the gorge of the Aar, cut through a rocky barrier that traverses its valley above Lake Brienz, to the broad valley-basin further upstream (*Fortnightly Review*, Aug., '96). The basin is covered with a plain of alluvium, estimated to be 200 feet deep. The rocky barrier averages 450 feet higher than the alluvial plain, and is thought to have lost 350 feet of height by glacial erosion. The rock floor of the basin is thus shown to be 1000 feet deeper than the preglacial height of the barrier, and this depth is taken as the measure of glacial erosion above the barrier.

The extension of valid argument of this kind to the conclusion that all lakes in glaciated regions are of glacial origin, seems illogical; and the derogatory references to the explanation of lakes by subsidence or deformation seems hardly candid in face of the facts reported by many Swiss geologists. Indeed, the generality of glacial erosion in certain regions may be so forcibly met by the generality of glacial deposition in others, that lakes must be individually studied if their actual origin is to be explained. The citation of the essays by Lincoln and Tarr concerning the Finger Lakes of New York, and the silence concerning such essays as Aeppli's on Lake Zurich, give Wallace's essay an air of special pleading.

ALAÏ AND PAMIR.

F. de Rocca summarizes recent explorations of the elevated portion of central Asia, in which he has himself taken part (Rev. de Géogr., xix., 1896, Jan., April). The Pamir is described as an immense uplift, trenched by profound valleys, and surrounded by colossal mountain ranges; thus differing from the definition given by Curzon (Science, Aug. 21, 1896). The mountains are characterized as colossal, grandiose, imposing; but relation of form to structure and denudation is hardly touched. The long valleys descend gradually eastward to the interior basin, but abruptly westward to the open lowlands. The main divides are sometimes on the valley floors.

* Oldland, inner lowland and inface are convenient terms in the description of denuded coastal plains.

The name, Alaï, is applied to an extensive intermontane plain, and to the range enclosing it on the north. This plain and the similar elevated intermontane plains of the Pamir further south are spoken of as 'plateaus,' without explicit indication of structure, whether rock-floored or built of waste from the adjoining mountains, but the latter origin is implied. Lakes are said to be numerous, but they are briefly mentioned without sufficient indication of their associated features.

In a word, this series of articles forms a good example of the style of geographic de scriptions in vogue to-day. It furnishes much general information as to the conditions of a region that has in recent years attained more political importance than its intrinsic value would give it; but the physiographic basis of the information is most elementary where it it is not vague or wanting.

NOTES.

THOSE who attend the Geological Congress at St. Petersburg next summer will find an instructive summary of the movements of the earth's crust in Russia by Karpinsky (Ann. de Géogr., v., 1896, 179–193). It is pointed out that the most tranquil area lies on the northwest, and that troughs of depression elsewhere show a notable sympathy in direction either with the Ural or the Caucasus mountains.

THE fertile subject of the physical subdivisions of the Alps is discussed anew by Haug (*Ibid.*, 167–178). He emphasizes the importance of synclinal basins, such as that of the Dolomites, as well as of anticlinal central *massifs*. An instructive map accompanies the essay.

FAIRCHILD describes several kame areas of pronounced form in western New York (Chicago Journ. Geol., iv., 1896, 129–159) and a number of temporary glacial lakes and their southward overflow channels in the region of the Genesee valley (Bull. Geol. Soc. Amer., vii., 1896, 423–452).

W. M. DAVIS.

HARVARD UNIVERSITY.

CURRENT NOTES ON ANTHROPOLOGY.

RUINS IN SOUTH AFRICA.

AN instructive article by Mr. R. M. W. Swan, in the Journal of the Anthropological Institute for August, gives further information about the ruined cities in the Zambesi country. They exist in great numbers throughout that territory, and are usually of small dimensions. The principal edifice is of rough stone, and is carefully oriented to the quarters of the heavens. For this reason it is probable that they served some religious propose, and some of them were 'symbols of reverence erected by solar and phallic worshippers.'

They can no longer be attributed to the Phenicians. "Both in their plans and masonry, they are quite unlike anything that we know of that is Phenician." All the evidence indicates that their builders came for gold, and many specimens of that metal have been found in the ruins. A number of the sites are, however, in regions which are not auriferous. This Mr. Swan explains by the supposition that the attraction was the search for gems, which are found in moderate abundance. He does not attempt to identify the builders, but inclines to the belief that they will be shown to have come from southern Arabia.

ANTIQUITIES OF COSTA RICA.

THE National Museum of Costa Rica has commenced the publication of a series of articles descriptive of the antiquities of that republic. The first number (pp. 37) is by Señor Anastasio Alfaro, the competent director. It is illustrated and divided into three chapters, the first general, the second on the gold work of the Guetares Indians, the third on arms and ornaments in stone.

The Guetares were a tribe of moderately high culture in the interior. One of their cemeteries was excavated by Mr. Alfaro, and a large amount of material obtained. They were skilful in dressing stone, and one of their tables (or seats?) pictured in the report is remarkable for symmetry and finish. It is forty centimeters high and seventy-one in diameter. As goldsmiths they were not equal to the tribes near the Chiriqui lagoon, and decidedly inferior to those of Colombia, the Chibchas and Quimbayas. Their pottery, a number of specimens of which are figured, was superior in design and technique. It was of curious forms, and often ornamented with figures in polychrome.

The affiliations of the Guetares are still uncertain, as, except a few proper names, we have no specimen of their language, and they are apparently extinct.

D. G. Brinton.

University of Pennsylvania.

ASTRONOMICAL NOTES.

The Astronomical Journal of October 6th contains the announcement by Dr. See of his re-discovery of the companion of Sirius at the Lowell observatory. The other astronomers of the observatory have also seen and measured the companion. Dr. See says that, according to these measures, the companion has fallen no less than 30 degrees behind its predicted place in position angle. We suspect that this statement may be due to a misprint or a slip of the pen.

We have received Vol. IV. of the publications of the Kuffner observatory in Vienna. It contains zone observations between 6° and 10° south declination, together with mean positions derived from them. There are also descriptions, by Messrs. Repsold, of the new prime vertical instrument of the observatory, which is provided with a vertical circle, and of the new heliometer. Dr. S. Oppenheim contributes to the volume a paper on special periodic solutions in the problem of three bodies, and Dr. de Ball has an investigation of the orbit of Comet 1882 III.

H. J.

SCIENTIFIC NOTES AND NEWS.

A scientific session of the National Academy of Sciences will be held in New York, at Columbia University, beginning November 17th, 1896, at 11 o'clock a. m. Members who have papers for this meeting may send the titles to Dr. C. F. Chandler, Columbia University, New York City. A special stated session of the Academy is called for Wednesday, November 18th, in New York, to consider the President's Annual Report to Congress, and other business that may come before the Academy.

The Honolulu correspondent of the United Associated Presses writes that Mr. C. R. Bishop has authorized the trustees of the Bishop Museum to expend $750,000 in building an aquarium and marine biological station at Honolulu, for the scientific study of marine life in the Pacific. Prof. W. T. Brigham has just returned from visiting European aquariums and is prepared to complete the plans. A body of professors and investigators will be maintained, and students will doubtless be attracted from Europe and America.

Major J. W. Powell and Mr. Frank Hamilton Cushing have recently completed a season's archæologic work on the coast of Maine. A number of interesting shell mounds were explored, and their contents are now *en route* to Washington for installation in the National Museum. In addition to the artifacts exhumed from the shell mounds, the collectors were able to obtain, through the aid of the Passamaquoddy or Abenaki Indians, an aboriginal birch-bark lodge, constructed by the natives in primitive fashion, native implements being chiefly employed in its construction.

Dr. Albert S. Gatschet, also of the Bureau of American Ethnology, has recently returned from an ethnologic trip through eastern Maine and contiguous parts of British territory. His scientific results include a rich collection of linguistic material obtained among the Passamaquoddy Indians.

The United States Coast and Geodetic Survey has completed the measurement of the base line known as the trans-continental arc lying along the 39th parallel of north latitude and extending from a point on the Atlantic coast ten miles south of Little Egg Island lighthouse, below Cape May, to six miles north of Punta Arenas lighthouse, on the Pacific, several miles above San Francisco. The base line is much the longest hitherto surveyed, and has cost the government about $1,000,000.

Mr. J. E. Spurr, of the U. S. Geological Survey, who, with Mr. H. B. Goodrich and Mr. F. C. Schrader, went to Alaska, in May last, to study the geology of the gold deposits of the Upper Yukon region, reports the completion of his work and his arrival in San Francisco. The party spent the entire summer in the field. They reached the Upper Yukon in the middle of June and passed down that river to its mouth, stopping at the various mining settlements on the way. Mr. Spurr satisfied himself that the prospects for profitable quartz mining in the region examined are very good. There is a great ledge running northeast and southwest through the country, similar to the Mother lode in California. Mr. Spurr's report on the Yukon country, and that of Dr. Becker on the good prospects of the region lying along the Pacific coast, may both be looked for during the coming winter or spring, and will, doubtless, together constitute an important contribution to the knowledge of the gold resources of Alaska.

Of his recent extended study of the gold resources of the Transvaal region of South Africa, Dr. Becker says that the Transvaal Republic contains the largest gold deposits in the world. Within fifteen miles of Johannesburg, on what is called the main reef series, there is an amount of gold, practically in sight, estimated to be worth $3,500,000,000, or nearly as much as the entire volume of gold coin now in the world. The gold is extraordinarily uniform, as uniform as coal in an ordinary deposit, as shown by shafts which have been sunk to a depth of 1,800 feet, and diamond drillings which have gone much further. At present the gold is being taken out at the rate of $100,000,000 a year. But the most surprising news which Dr. Becker brings is the testimony of an American, who was formerly his assistant in the Geological Survey, and who is now engaged in mining in the Transvaal, where he has made several millions of dollars. This American mining expert says that, to the best of his knowledge and belief, the gold deposit, instead of being thirty miles long—the region now in sight—is practically 1,200 miles long, except that in the rest of the region later deposits, have come in over the gold. This, however, will not prevent economical mining, but will simply delay it.

The *Lancet* states that Prof. Liversidge, professor of chemistry in Sydney University, has made an exhaustive series of experiments, finding evidence in favor of gold being present in sea-water of the New South Wales coast in the proportion of ½ to 1 grain per ton, which in round numbers would make 230 to 260 tons per cubic mile. Our contemporary thinks the discovery deserves recording in its columns, "since recently the value of gold salts in therapeutics has been recognized, and it cannot be doubted that the cheapening of gold would lead to their application being extended in this direction." It seems, however, probable that the value of salts of gold in medicine as compared with those of other metals is largely psychological and would not increase with its cheapening.

It has been found that the weather at Flagstaff, Ariz., is not satisfactory for astronomical observations during the winter, and Mr. Lowell will this month or next remove his observatory to a hill about three miles north of the City of Mexico.

The International Congress of Hydrology, Climatology and Geology met on September 28th at Clermont-Ferrand. Dr. de Ranse, president of the committee of organization, made a speech and was subsequently elected president of the Congress. The three foreign vice-presidents are Prof. Ludwig, Prof. Kubern and Dr. Rotch, of the Blue Hill Observatory. The Congress meets in three sections, Hydrology, Climatology and Geology, for each of which there is a French and foreign honorary president.

We regret to record the following deaths: Gustav Kieseritski, professor of mathematics at the Polytechnic Institute in Riga, aged 67 years; C. J. Boone, professor of geometry and higher elocution at Georgetown College, D. C., at the age of 30 years, and Dr. J. P. E. Liesgang, the writer on photography.

A committee has been formed in London to arrange an international memorial commemorating the connection of Mr. Cyrus Field, Sir John Pender and Sir James Anderson with submarine telegraphy.

The Botanical Museum in Berlin, says *Die Natur*, will be enlarged by leasing seven rooms in a neighboring building. There is no longer room in the museum for research work, as the collections have recently grown rapidly and the exhibits from the recent industrial exposition have now been added.

We learn from *Nature* that the newly formed Society of Sicilian Naturalists will publish a journal of natural history entitled *Il Naturalista Siciliana.* The first number contains articles in Italian and in French on entomology, malacology, botany and crustaceæ. The Society, of which Prof. E. Ragusa is president, proposes to meet monthly in Palermo, and once a year in some other city of Sicily.

The Progressive American is the title of a new monthly journal devoted to the progress of science and invention, published by Hern & Co., New York, and edited by Mr. G. H. Hern. The first issue is largely made up of short items, some new and some old, some good and some bad. All signs of interest in science are encouraging and, though the ground of the new journal seems to be amply covered by *The Scientific American*, we hope that *The Progressive American* will make a place for itself and fill it with credit.

There have just been issued two works doing great credit to science in America. One of these is *An American Text-book of Physiology*, published by W .B. Saunders, Philadelphia. It is edited by Prof. W. H. Howell, who had the cooperation of the leading American physiologists. The other is the first volume of a *System of Diseases of the Eye*, published by the J. B. Lippincott Co., Philadelphia; and edited by Prof. W. F. Norris and Dr. C. A. Oliver. We hope to give adequate reviews of these works, but in the meanwhile it is pleasant to call attention to such admirable results of scientific collaboration.

A committee, with the Prince of Oldenburg as honorary president, has been formed to collect subscriptions for a monument to Pasteur in Russia.

The Croonian Lectures before the Royal College of Physicians of London will be delivered in 1897 by Dr. Hale White. Dr. Sidney Martin will give the course in 1898.

There has been published at Paris, in commemoration of the 100th anniversary of the faculty of medicine, a work giving the history of the school. It is written by Dr. A. Corlien with the cooperation of a committee, and entitled *Le Centénaire de la Faculté de Médecine de Paris* (1794–1894).

The general treasurer of the British Association, Prof. Rücker, has reported that the treasurer's receipts for last year were £3,773 2s. 3d. The payments included: expenses of Ipswich meeting, £148 10s. 5d.; rent and office expenses, £50 5s. 2d.; salaries, £505; printing, binding, etc., £1,007 5s. 4d.; payment of grants made at Ipswich, £1,104 6s. 1d. The investment account had remained unaltered, and stood thus on June 30, 1896: Consols, £7,537; India Three per cents., £3,600.

We learn from *La Vie Scientifique* that M. Etienne will shortly present in the French Chamber a bill introducing the decimal subdivision of time. The subject seems to be considered seriously in France, as a maker of watches has patented a double-faced watch, giving on one side the present sub-divisions and on the other the proposed decimal system.

The *Auk* states that Mr. James M. Southwick, well known as a commercial naturalist, has recently been appointed curator of the Museum of Natural History, lately established by the authorities of the city of Providence, R. I., in Roger Williams Park. A building has been erected at a cost of $40,000, a portion of which will be devoted to museum purposes, as required. Mr. Southwick will devote special efforts to securing representative collections of the local fauna, and later to the formation of small loan collections which can be used by teachers in their class rooms.

According to *Cosmos*, a new alpine meteorological observatory will be established on the summit of the *Rochers de Naye*. The arrangements are now being made by MM. Ruffy and Hagenbach Bischoff, of Bâle, members of the Swiss Meteorological Commission.

The Middletown Scientific Association held a meeting on October 13th, at which suitable notice was taken of the death of G. Brown Goode, the founder of the Association.

As announced some time since, Miss Helen Kellar, who, blind, deaf, dumb, has now reached the age of sixteen years, has been removed from a school for the deaf and dumb, and has been placed in Mr. Gilman's Cambridge School for Girls. It is not correct, as stated, in many of the daily papers, that she has entered Radcliffe College or passed the examinations for this, but in a private examination she showed herself competent to answer the questions of examination papers in English, French, German and history.

At the Church Congress (Church of England) which met at Shrewsbury, on October 6th, a session was set apart for the discussion of the bearing of the theory of evolution on Christian doctrine. The Bishop of Litchfield presided, and addresses were made by Archdeacon Wilson, Prof. Bonney and Canon Gore. There seems to have been complete unanimity. Canon Gore said, 'Evolution had taken hold of theology; it had modified our way of thinking about it.' Archdeacon Wilson said, "Christian doctrine could adopt the evolutionary view of creation," that the theory of evolution had taught us to properly interpret "what was related as 'The Fall' *sub specie historiæ*."

We have already called attention to the formation of the New York State Science Teachers' Association, whose object is the promotion of science teaching and the mutual acquaintance of those interested. A provisional committee has been appointed to conduct the affairs of the Association until the first annual meeting, which will probably be held during the Christmas holidays in connection with the State Principals' Association at Syracuse. All those interested in the teaching and promotion of science should join the Association and make efforts to attend its first meeting. The officers are: Simon H. Gage, President; Chas. W. Hargitt, Vice-President; Franklin W. Barrows, Secretary and Treasurer (45 Park St., Buffalo, N. Y.).

The Chicago Institute of Education has appointed a committee of sixty whose duty it shall be to develop some feasible plan for carrying on systematic outdoor, or field work, in connection with nature study. The committee held its first meeting on September 19th, and a permanent organization was effected by the election of Mr. Wilbur S. Jackman as President and Mrs. M. L. T. Baker as Secretary, and the appointment of a number of sub-committees. One of the first works of the committee will be the preparation of maps of the evirons of Chicago, which will assist the pupils and teachers of the public schools in a systematic study of the country which lies within a convenient radius of the city. Syllabi will also be compiled giving information for reaching the different points of interest and for study.

UNIVERSITY AND EDUCATIONAL NEWS.

According to the Boston *Transcript* the registration at Harvard University is about 3,590, of which number 1,260 are new names. There is a slight decrease in the college, but an increase of about 10 per cent. in the scientific school. There is also an increase in the graduate and medical schools. In the latter 50 per cent. of the students hold college degrees, as compared with 35 per cent. last year.

Mr. George M. Ward has been elected President of Rollin's College, Winter Park, Fla.

Dr. R. Meade Bolton, now bacteriologist of the Philadelphia Board of Health, has been elected instructor in bacteriology in the University of Missouri.

It is reported that the University of Edinburgh has conferred the degree of M. A. on two women graduates, Miss MacGregor and Miss Geddes.

At the University of Cambridge Mr. W. T. N. Spivey, of Trinity College, has been appointed to succeed Dr. A. Scott as demonstrator to the Jacksonian professorship of organic chemistry.

The lectureship in chemical physiology is vacant by the resignation of Dr. A. Sheridan Lea, F. R. S., on account of ill health.

PROF. BUBNOF, of Dorpat, will succeed Prof. Erismann in the chair of hygiene in the University of Moscow. Dr. S. Bianchi has been appointed full professor of anatomy at Vienna, and Dr. B. Boccardi associate professor of microscopical anatomy in the University at Naples.

DISCUSSION AND CORRESPONDENCE.

COMPARISON BETWEEN THE USE OF FIXED AND MOVABLE CIRCLES, IN THE DETERMINATION OF DECLINATIONS BY MERIDIAN CIRCLE.

ONE advantage claimed for the use of a movable circle is, that it tends to eliminate the effect of graduation errors.

This effect will not be entirely eliminated by any number of changes in the position of the circle; but considering it as one of the sources of accidental error, the mean of a large number of observations will be affected by the mean of the errors of graduation for the increased number of divisions.

The relation of this error, to that due to other conditions, should also be considered; and in establishing the advantage of using the movable circle, in so far as graduation errors are concerned, one should be confident that no other sources of error are introduced.

In dealing with instrumental errors it is undoubtedly sounder policy to arrange observations so that they may be eliminated, rather than to determine the effect of such errors and correct for them.

But this policy refers to errors that can be actually eliminated, and without introducing others of unknown character or amount. Where both methods may be used, actual elimination of error, and, its determination and subsequent correction, the advantage is recognized, in the knowledge thus gained of the general laws governing errors and their correction.

In the case of a fixed circle the instrument is a homogeneous one throughout a series of observations, which may extend over many years. The laws of flexure may be studied by consecutive determinations, as part of a united series; and, in general, the performance of the instrument can be investigated, under the varied conditions arising from extended use, with the certainty that some errors are truly systematic in character.

With a movable circle there is the advantage of variation of conditions, which may produce results nearer the truth, in the average, by absence of certain systematic errors.

It will always be a matter of judgment based upon experience, whether one can deal better with results affected by systematic errors, or with observations in which they are replaced by accidental ones.

In practical observing one method is usually adopted for general work. While there are other conditions that may determine which method will be used, a comparison of their respective accuracy is not without interest, using such material as may have a bearing upon such a test.

For the purposes of illustration the probable error of graduation, for the mean of four divisions, may be assumed to be $\pm 0''.15$, the value obtained in the measurement of the 1° arcs, of the Repsold Meridian Circle of the Lick Observatory. If this error were entirely accidental, throughout, a reading made upon two adjoining divisions should have a smaller error; but as there appears to be evidence of a periodic character in the graduation, this value may be adopted for the present comparison.

Representing by g the *probable error* due to graduation, for the general case of a measure of zenith distance we should have to consider the error of the Nadir reading, and g would be $\pm 0''.21$.

With a fixed circle, however, if the value of the latitude, used in determining star declinations, is that obtained by observations of standard stars with the same instrument, the graduation error of the Nadir reading is actually eliminated from the results. Or, if when the instrument is reversed the same divisions come under the microscopes at the Nadir reading, the graduation error of those divisions is then eliminated from the measurement of any particular zenith distance in both positions. Under these conditions, the probable error g of a determination of a star's declination, by means of reading on the Nadir will be $\pm 0''.15$ for one position, $\pm 0''.10$ for both positions, quantities which will not be diminished by an increase in the number of observations.

In the use of a movable circle, since new divisions are brought under the microscopes for the Nadir reading, each measure of declination will be affected by the probable error g of $\pm 0''.21$.

The mean of four observations would have the probable error g of $\pm 0''.10$, whether made in one position of the instrument or in both, By increasing the number of observations the movable circle would gain in accuracy over the fixed circle, in so far as this source of error is concerned. Thus, for eight observations, four made in each position of the instrument, for the fixed circle g would be as before $\pm 0''.10$, while for the movable circle g would be $\pm 0''.08$.

For differential determinations of declination the result, in both cases, will be affected by the probable error of graduation for the mean of the stars used as standard. If eight fundamental stars are used, the probable error g of the mean would be $\pm 0''.05$, and the probable error g in the resulting declination would be $\pm 0''.16$, from one observation.

With the fixed circle in both positions of the instrument the declination would have g equal to $\pm 0''.11$.

The movable circle would give g,
for two observations $\pm 0''.11$,
for four observations $\pm 0''.08$,
and for eight observations $\pm 0''.06$.

The above treats of a movable circle shifted for each night of observation. The custom of changing the position at stated intervals will have an advantage, only, in bettering the determination of stars observed as standard over long periods.

In order to obtain a more complete comparison, it will be necessary to combine the effect of graduation error with the accidental error from other sources. The purely accidental error may be assumed to be $\pm 0''.25$ for one observation, including that of the determination of the reference point, by either standard stars or nadir readings. While it may be smaller in some cases, this value can be used as a basis of comparison.

The probable errors of declinations, determined with fixed circle and with movable circle, by both methods, would be predicted as follows :

	Nadir.	Differential.
Fixed Circle :	$''$	$''$
One position, 2 observations......	± 0.23	± 0.24
4 "	± 0.19	± 0.20
8 "	± 0.17	± 0.18
Fixed Circle :	$''$	$''$
1 observation in each position....	± 0.20	± 0.21
2 " " " "	± 0.16	± 0.17
4 " " " "	± 0.13	± 0.14
	$''$	$''$
Movable Circle : 2 observations....	± 0.23	± 0.21
4 "	± 0.16	± 0.15
8 "	± 0.12	± 0.11

With an increase in the number of observations the movable circle would gain slightly. But, on the whole, it is doubtful whether the gain is not more than compensated by the advantages of having a permanent relation between circle and telescope. Some of these advantages become apparent when old observations are to be discussed for light upon some of the refinements of investigation. This permanency and consistency give a definite basis to work upon, when treating methods or results.

As an individual illustration, since the usual method of determining telescope flexure includes the sine term of the circle flexure, this last does not need to be independently measured; the effect of both may be determined, and their laws studied together. With a movable circle the flexure would need separate treatment for each position.

This comparison has been suggested, in part, by a note in this Journal, in which the preference for the movable circle is indicated ; and the utility of the measurement of Division error is questioned. (H. J., Science, Jan. 31.)

The actual measurement of errors of graduation would, presumably, replace those errors by the probable uncertainty of the measurement. With the method employed for this instrument, the probable error of the measurement of the 1° arcs is less than $\pm 0.''04$.

Since each division may be measured, as has been done thus far, from two others, the probable error can be kept within small limits by making a sufficiently large number of measures. Practically it would probably increase as the subdivision of arcs is carried on. There are some statements in the note referred to, which appear to be misleading. To quote:

"Even if the division error of any given line could be determined with complete precision with the telescope pointed at the zenith, this division error would not hold true when the telescope is pointed elsewhere. Nor is this brought about by flexure alone. It is found that if we determine the division errors of a straight scale, these errors are completely changed when the scale is reversed end for end. No doubt unavoidable difference in the illumination and the eye of the observer are responsible for these unfortunate facts. But facts they are, and the cause of much wasted labor."

While the measurement of the division errors of a straight scale might not hold true if the scale were reversed end for end, this apparently damaging condition has nothing whatever to do with the measurement of the division errors of such a divided circle, since it cannot possibly be reversed; but is always read, facing it, in the same position.

As the instrument is moved to various settings, any single division passes under the various microscopes, and is read at various inclinations to the vertical, under various conditions of illumination, and to make the illustration as wide as possible, by various observers. The reading at any microscope will be affected by all the conditions of phase of that microscope, and by the personal equation of the observer, which may be, and probably is, peculiar to that microscope.

But there is no reason that these conditions should differ for the various divisions, which come in succession under the same microscope, or set of microscopes. In every case of star observation, or of determination of graduation error, the difference is measured between a reading of the circle at the required setting, and some standard reading.

Personal equation and phase should affect each reading alike, and should be eliminated from the results.

As to the effects of differences in the illumination and the eye of the observer, if they exist, they must be equally injurious to all observation with this instrument, as, in fact, they must be in every class of observing. Such sources of error fall within the class admitted as accidental; with proper care and well designed illumination, they are not believed to be large enough to invalidate the results obtained with fine instruments in astronomy of precision.

R. H. Tucker.

Lick Observatory.

SCIENTIFIC LITERATURE.

Elements of Geology, a text-book for colleges and for the general reader. By Joseph Le Conte. Fourth edition, revised and enlarged, with new plates and illustrations. New York, D. Appleton & Co. 1896.

For nearly twenty years Le Conte's Elements of Geology has stood side by side with Dana's Manual in the working libraries of American geologists and teachers. It has found equal favor in the class-room and the study room, and has been widely read by the cultured layman. Holding this enviable position, it needs neither introduction, encomium nor criticism; but the appearance of a new edition may rather serve as an occasion to enquire what are the qualities on which its success depends.

I conceive that one of the first of these is a wise choice of material. The author is fortunate in possessing the power to select the more essential and ignore the less essential, so that the principles he expounds are not obscured by clouds of detail. Moreover, he devotes all his space to his proper theme, the science of geology, assuming, on one hand, that the reader has all necessary knowledge of physics, chemistry, astronomy, meteorology, biology, and even mineralogy, and not undertaking, on the other, to teach him either the technology of the professional geologist or the economic application of geologic results.

Of equal importance, perhaps, is the order of presentation, which deviates somewhat from the strictest system so that it may follow lines of least resistance. One who writes on a complex subject is always embarrassed by the fact that the easy explanation of each part seems to require the previous explanation of some other part; and in geology this contest for priority lies between processes of change and the structures, etc., which result from change. Le Conte gives a general outline of processes under his first heading, Dynamical Geology, but reserves much of their amplification to be introduced under Structural Geology in explanation of the principal products of change, namely, rocks, rock structures and mountains.

A few subjects are developed by the presentation and discussion of alternative theories, and these serve the important end of illustrating the method of scientific progress. Others are not carried beyond the safe ground of established result, and yet others are confessedly treated from the personal standpoint of the author, who supports his views by argument. For the professional and critical reader the passages last mentioned are doubtless the least convincing and satisfactory of the treatise, but they strengthen it in another way by exhibiting the author in his proper character as an able investigator and original thinker. Moreover, the literary style, which, albeit, is ever lucid and direct, often assumes the characteristics of a spoken address, so that the reader is distinctly conscious of the writer's individuality.

Only five years have elapsed since the last revision of the book, and the amount of change now introduced is not large, though enough to require a complete resetting of type. Perhaps it is best expressed by saying that in a total of one thousand figures sixty are new. Among the subjects amplified are earthquakes, igneous rocks, geologic climates, trilobites and Mesozoic and Cenozoic vertebrates. The Cambrian is given higher taxonomic rank than before, but the Algonkian is not recognized.

It is, of course, easy to pick flaws, for the broadest investigator and most scholarly student is not omniscient. Our author tells us that tideless waters are essential to the production of deltas, and the flux and reflux of tides to the creation of estuaries. Even Chesapeake Bay and the fiords of Norway are ascribed to tidal action, and the function of submergence in the origination of estuaries is almost ignored. Not only is the old view retained, that gneiss is a stage in the making of granite, and that the Archean consists essentially of metamorphosed sediments; but no mention even is made of the view prevalent among modern investigators, that gneiss is usually altered granite, and that the Archean complex consists largely of altered igneous rocks. The student of mountain dynamics could wish that the author's hypothetic explanation of the Basin ranges were stated with less confidence; the physiographer that crude sketches by early explorers of the Grand Canyon of the Colorado and the Mauvaises Terres were replaced by more realistic drawings; and the biologist that a more modern classification of living forms were employed.

But these and other blemishes may freely be forgiven to a book that sets forth the broad generalizations and fundamental principles of its particular science in orderly and attractive form, and at the same time illustrates and embodies the true and essential spirit of all science.

G. K. GILBERT.

The History of Mankind. By PROF. FRIEDRICH RATZEL. Translated from the second German edition by A. J. Butler, M. A. With introduction by E. B. Tylor, D. C. L., with colored plates, maps and illustrations. Vol. I. pp. 468. London and New York, Macmillan & Co. 1896. Price, $4.00.

Prof. Ratzel, of Leipzig, has achieved a well-earned reputation as a writer and teacher of geography in its relation to man and human culture. His chief work, 'Völkerkunde,' appeared in 1885, and some years later a second edition was called for, of which the above is a translation. It is a book intended for the general public rather than the scientific student, and in that respect will prove less satisfactory to the latter than, for instance, Prof. Waitz's 'Anthropologie.' Ratzel does not give references to authorities for his statements, thus avoiding notes and the discussion of small points, but leaving his reader without an aid to further researches. His style is clear and pleasant, and the translator has, as a rule, done his part of the task cleverly, and given an easy English rendering to the original. The illustrations are abundant, accurate and well printed, and aid materially in bringing the descriptions home to the mind.

This first volume includes two 'Books,' one on the principles of Ethnography and the second on 'The American-Pacific Group of

Races,' that is, the Polynesians, Australians and Malays.

It may be appropriate here to ask why the translator renders 'Völkerkunde' in the title of Book I. by 'Ethnography,' while the work itself he christens 'The History of Mankind,' which it is not in any sense of the phrase, nor is it so called in the original.

The author sets for himself the task of describing mankind 'as we find it to-day throughout the earth;' that is, he confines himself to the ethnography of the present age, and does not deal in history or archæology. His remoter aim is 'to demonstrate the cohesion of the human race.' In this particular field he belongs to the historic school, and where he finds similarities, *e. g.*, in religions of American, African and Australasian tribes, which he cannot explain, he 'predicts' (p. 40) that they 'will be found germs of survivals of Indian or Egyptian tradition.' This antique explanation (why did he not say Hebrew tradition ?) will no longer avail in the light of modern psychologic science applied to ethnography.

In his detailed descriptions the author has been careful to present an accurate perspective of the life of the ruder races. He aims to give them their just position in the scheme of the world, and safely steers between the rocks of indiscriminate praise and under-valuation. He is constantly on the alert to point out the connection between special forms of culture and the natural conditions which give it color and form. His work is one which will be hailed with pleasure by all interested in the diffusion of knowledge regarding man, and it may be recommended as much the best in the domain which it treats now accessible in English.

D. G. Brinton.

University of Pennsylvania.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES, OCTOBER 5, 1896.

At the meeting of the Academy, October 5, 1896, the following gentlemen were nominated as honorary members of the Academy, and on ballot were duly elected : Prof. James J. Thomson, Cavendish professor of physics in the University of Cambridge, England ; Prof. Felix Klein, professor of mathematics in the University of Göttingen, Germany ; Prof. Henri Moissan, of the University of Paris, France.

On the organization of the Section of Astronomy and Physics, Prof. J. K. Rees stated that the work of the Columbia College observatory upon the variation of latitude had been continued during the past summer in such a manner that forty pairs of stars were observed every two weeks. This is a part of the general programme to continue these observations for the next two or three years until the observatories contemplated by the National Geodetic Association should be established. Prof. Rees also referred to the work of Dr. Davis, of the Astronomical Department of Columbia, who is about to undertake the reduction of the Piazzi catalogue devoting himself especially to the reduction of declinations.

Dr. H. Jacoby reported on the proceedings of the meeting held at Paris to consider the astro-photographic star charts. He stated that the 36,000 plates to be used in the catalogue of stars down to the 11th magnitude have nearly all been made, and the work measuring these plates is well under way. The Postdam measurements are practically ready for publication. The Paris and Greenwich reports will be ready in from five to seven years. The limit of accuracy in all of this work is about $0''.2$ of arc. This catalogue is expected to contain about 2,000,000 stars.

Wm. Hallock,
Secretary of Section.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, SEPTEMBER 29, 1896.

Dr. S. G. Dixon communicated an experiment that tends to establish the spore formation in the Tubercle bacillus. A glass tube was made six inches in length, one-half inch in diameter, having two bulbous enlargements situated one and one-half inches apart. *Agar Agar* nidus was placed in these hanging enlargements and the tube plugged at either end with cotton. After thorough sterilization the tube was placed in the Dixon manipulating chamber, when the cotton was removed from one end and the *Agar Agar* in one of the culture mediums inoculated with a growth of the tubercle bacillus. Then the tube was carefully replugged and capped with rubber. It was held in a horizontal position and placed in a brood-oven where it remained for three weeks, at the end of which time a growth was apparent on the *Agar Agar* which had not been inoculated, thus demonstrating that something lighter than the bacillus itself had floated in an air-tight chamber at least one and one-half inches distant, warranting a belief in the existence of spores.

October 6th, Dr. Goldsmith called attention to the trap formations in Pennsylvania, more particularly to that near Pottstown, known as 'Ringing Rocks.' Referring to the contention as to whether they were of plutonic or volcanic origin, he said that he had been examining them for several years and was now convinced of their volcanic origin. In support of this view he described the general land configuration surrounding these formations, which he thought in some instances indicated the former existence of a crater, while in others the outflow had been through fissures. In further confirmation he exhibited a number of rock specimens and microscopic sections of the same. The subject was debated by Profs. Pilsbry and Frazer and Dr. Rand.

Theodore D. Rand presented specimens of mica schist from the River road, in Fairmount Park, Philadelphia. The nodules resemble very imperfect andalusite crystals, but appear on examination to be almost wholly quartz with a little kyanite or sillimanite, resembling closely those described by the late Dr. George H. Williams, in the 15th annual report of the United States Geological Survey as occurring on Sligo Branch (probably Fairfax county, Virginia,) and as suggesting metamorphism of included fragments.

Papers under the following titles have been recently presented for publication:

'Fossil bones of Birds and Mammals from Grotto Pietro Tamponi and Grive St. Alban.' By R. W. Shufeldt, M. D.

'Contributions to the Zoology of Tennessee, No. 4, Mollusks.' By Samuel N. Rhoads and Henry A. Pilsbry.

'Mammals collected by Dr. A. Donaldson Smith during his expedition to Lake Rudof.' By Samuel N. Rhoads.

'The Hymenoptera collected by Dr. A. Donaldson Smith in Northeast Africa.' By William J. Fox.

EDWARD J. NELSON,
Secretary.

THE TORREY BOTANICAL CLUB.

THE first fall meeting was held on Tuesday evening, October 13th, 33 persons being in attendance. Eight new members were elected. Dr. Britton reported that the field meetings during July and August had been usually well attended. Arrangements were made for reprinting several exhausted numbers of the *Bulletin*, so that complete sets can again be supplied. Specimens of the Russian thistle, collected on Captain's Island, off the Connecticut coast, were exhibited. The members interchanged accounts of their summer field experiences. Specimens of fleshy fruits were exhibited which had been preserved perfectly well since the early part of May in a 4 per cent. solution of formalin.

H. H. RUSBY,
Secretary.

SCIENTIFIC JOURNALS.

AMERICAN CHEMICAL JOURNAL, OCTOBER.

Trimetaphosphimic Acid and Its Decomposition Products: By H. N. STOKES. The author has defined a metaphosphimic acid as a metaphosphoric acid in which one-third of the oxygen is replaced by an equivalent number of imide groups. The complexity of these acids is so great that in most cases at least four forms are theoretically possible. Reference is made to the work of several investigators in the same field, and it is pointed out that the results obtained by Gladstone are capable of a different interpretation from that which he gave, and that the acid under investigation may have been trimetaphosphimic acid. The constitution of trimetaphosphimic acid depends on that of the chloronitride $P_3N_3Cl_6$. The author considers that the methods of formation and decomposition can be most readily explained on the assumption that the nucleus consists of a symmetrical ring of three phosphorus and three nitrogen atoms. Replacement of the chlorine by hydroxyl and a transformation into a tantomeric form would produce the trimetaphosphimic acid. It can be easily identified by its salts, several of which are quite characteristic. If a solution of the acid is decomposed by a strong mineral acid the final products are orthophosphoric acid and ammonia. If, however, the action is limited, a series of intermediate acids is formed. Methods were devised for obtaining these acids in pure condition and a number of their salts were made and studied.

On Certain Derivatives of Trichlordinitrobenzol: By C. Loring Jackson and W. R. Lamar. The results of an investigation of the behavior of various reagents with tribromdinitrobenzol have been published in this Journal. In the present paper the author compares those results with the ones obtained when trichlordinitrobenzol is used. With aniline the reaction in both cases is similar, the product formed being trianilidodinitrobenzol. When sodic ethylate is used, the replacement of two bromine or two chlorine atoms leads to the formation of similar compounds; but the replacement of the third does not follow the same rule, nor is the reaction with malonic acid ester similar in the two cases.

Camphoric Acid: By W. A. Noyes. Results obtained by this author have led him to reject the formula proposed for camphor by Bredt, which is the one most generally accepted, and that proposed recently by Tiemann. The evidence against the latter is found in the fact that the rate of esterification of two compounds, which should according to the view of Tiemann be the same, is very different. He has also subjected Armstrong's formula to a synthetic test and finds that his formula for camphor is not true. One of the products obtained in the course of this investigation, dihydro-cis-campholytic acid, has been studied by E. B. Harris, and the results are incorporated in this article.

On Diacid Anilides: By H. L. Wheeler. Diacid anilides may be divided into two classes, the first consisting of those which have identical acid groups, and the second of those with unlike acid groups. The second class have not been obtained by the same methods as the first; but the author of this paper has devised a method for their formation, which consists in treating silver or mercury acid anilides with an aliphatic acid chloride, when the action is similar to the one in which benzoylchloride is used. A number of these mixed diacid anilides were prepared and studied. When silver and mercury salts of the amides were used, imidoethers were formed and not diacidamides, as was expected.

Iodometic Determination of Selenious and Selenic Acids: By J. F. Norris and H. Fay. This method depends on the reaction between sodium thiosulphate and selenious acid in the presence of hydrochloric acid. If the selenious acid in the presence of hydrochloric acid is treated with an excess of sodium thiosulphate, and then titrated back with iodine, very satisfactory results can be obtained. The complete reaction which takes place here is as yet unknown. Selenic acid must be reduced by boiling with hydrochloric acid before the selenium can be determined. Mixtures of the two can be easily analyzed by first determining the selenious acid and then the total after reduction of the selenic acid.

J. Elliott Gilpin.

NEW BOOKS.

An American Text-Book of Physiology. Edited by William H. Howell. Philadelphia, W. B. Saunders. 1896. Pp. 1052.

Die Bedingungen der Fortpflanzung bei einigen Algen und Pilzen. Georg Klebs. Jena, Gustav Fischer. 1896. Pp. xviii+543.

Die Morphologie und Physiologie des pflanzlichen Zellkernes. A. Zimmermann. Jena, Gustav Fischer. 1896. Pp. viii+188.

On Certain Problems of Vertebrate Embryology. John Beard. Jena, Gustav Fischer. 1896. Pp. vi+77. M. 2.

Evolution of the Art of Music. C. Hubert Parry. New York, D. Appleton & Co. 1896. Pp. x+342.

Alterations of Personality. Alfred Binet. Translated by Helen Green Baldwin. New York, D. Appleton & Co. Pp. vii+356.

Number and its Algebra. Arthur Lefevre. Boston, D. C. Heath & Co. 1896. Pp. 230.

The Coming Ice Age. C. A. M. Taber. Boston, Geo. H. Ellis. 1896. Pp. 94.

Genius and Degeneration. William Hirsch. Translated from the second edition of the German work. New York, D. Appleton & Co. 1896. Pp. vi+333.

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

*BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

ADDRESS TO THE ZOOLOGICAL SECTION BY THE PRESIDENT OF THE SECTION.

A very brief study of the proceedings of this Section in bygone years will show that Presidents have exercised a very wide choice in the selection of subjects. At the last meeting of the Association in this city, in 1870, the Biological Section had as its President the late Prof. Rolleston, a man whose remarkable personality made a deep impression upon all who came under his influence, as I have the strongest reason for remembering, inasmuch as he was my first teacher in zoology, and I attended his lectures when but little over seventeen. His address was most characteristic, glancing over a great variety of subjects, literary as well as scientific, and abounding in quotations from several languages, living and dead. A very different style of address was that delivered by the distinguished zoologist who presided over the meeting. Prof. Huxley took as his subject 'The History of the Rise and Progress of a Single Biological Doctrine.'

Of these two types I selected the latter as my example, and especially desired to attempt the discussion, however inadequate, of some difficulty which confronts the zoologist at the very outset, when he begins to reason from the facts around him

* Liverpool, 1896.

—a difficulty which is equally obvious and of equal moment to the highly-trained investigator and the man who is keenly interested in the results obtained by others, but cannot himself lay claim to the position and authority of a skilled observer; to the naturalist, and to the one who follows some other branch of knowledge but is interested in the progress of a sister science.

Two such difficulties were alluded to by Lord Salisbury in his interesting presidential address to the British Association at Oxford in 1894, when he spoke of 'two of the strongest objections to the Darwinian explanation' of evolution—viz, the theory of natural selection—as appearing 'still to retain all their force.' The first of these objections was the insufficiency of the time during which the earth has been in a habitable state, as calculated by Lord Kelvin and Prof. Tait, 100 million years being conceded by the former, but only 10 million by the latter. Lord Salisbury quite rightly stated that for the evolution of the organic world as we know it by the slow process of natural selection at least many hundred million years are required; whereas, "if the mathematicians are right, the biologists cannot have what they demand. * * * The jelly-fish would have been dissipated in steam long before he had had a chance of displaying the advantageous variation which was to make him the ancestor of the human race."

The second objection was that "we cannot demonstrate the process of natural selection in detail; we cannot even, with more or less ease, imagine it." "In natural selection who is to supply the breeder's place?" "There would be nothing but mere chance to secure that the advantageously varied bridegroom at one end of the wood should meet the bride, who by a happy contingency had been advantageously varied in the same direction at the same time at the other end of the wood. It would be a mere chance if they ever knew of each other's existence; a still more unlikely chance that they should resist on both sides all temptations to a less advantageous alliance. But unless they did so the new breed would never even begin, let alone the question of its perpetuation after it had begun."

Prof. Huxley, in seconding the vote of thanks to the President, said that he could imagine that certain parts of the address might raise a very good discussion in one of the Sections, and I have little doubt that he referred to these criticisms and to this Section. When I had to face the duty of preparing this address I could find no subjects better than those provided by Lord Salisbury.

At first the second objection seemed to offer the more attractive subject. It was clear that the theory of natural selection as held by Darwin was misconceived by the speaker, and that the criticism was ill-aimed. Darwin and Wallace, from the very first, considered that the minute differences which separate individuals were of far more importance than the large single variations which occasionally arise—Lord Salisbury's advantageously varied bride and bridegroom at opposite ends of the wood. In fact, after Fleeming Jenkins' criticisms in the *North British Review* for June 1867, Darwin abandoned these large single variations altogether. Thus he wrote in a letter to Wallace (February 2, 1869): "I always thought individual differences more important; but I was blind, and thought single variations might be preserved much oftener than I now see is possible or probable. I mentioned this in my former note merely because I believed that you had come to a similar conclusion, and I like much to be in accord with you."* Hence we may infer that the other great discoverer of natural selection had come to the same conclusion at an even earlier date. But this fact re-

* *Life and Letters*, Vol. III.

moves the whole point from the criticism I have just quoted. According to the Darwin-Wallace theory of natural selection, individuals sufficiently advantageously varied to become the material for a fresh advance when an advance became necessary, and at other times sufficient to maintain the ground previously gained—such individuals existed not only at the opposite ends of the wood, but were common enough in every colony within its confines. The mere fact that an individual had been able to reach the condition of a possible bride or bridegroom would count for much. Few will dispute that such individuals "have already successfully run the gauntlet of by far the greatest dangers which beset the higher animal [and, it may be added, the lower animals also]—the dangers of youth. Natural selection has already pronounced a satisfactory verdict upon the vast majority of animals which have reached maturity."*

But the criticism retains much force when applied to another theory of evolution by the selection of large and conspicuous variations—a theory which certain writers have all along sought to add to or substitute for that of Darwin. Thus Huxley from the very first considered that Darwin had burdened himself unnecessarily in rejecting *per saltum* evolution so unreservedly.† And recently this view has been revived by Bateson's work on variation and by the writings of Francis Galton. I had at first intended to attempt a discussion of this view, together with Lord Salisbury's and other objections which may be urged against it; but the more the two were considered, the more pressing became the claims of the criticism alluded to at first—the argument that the history of our planet does not allow sufficient time for a process which all its advocates admit to be extremely slow in its operation. I select this subject because of its transcendent importance in relation to organic evolution, and because I hope to show that the naturalist has something of weight to contribute to the controversy which has been waged intermittently ever since Lord Kelvin's paper 'On Geological Time'* appeared in 1868. It has been urged by the great worker and teacher who occupied the Presidential Chair of this Association when it last met in this city that biologists have no right to take part in this discussion. In the Anniversary Address to the Geological Society in 1869 Huxley said: "Biology takes her time from geology. * * * If the geological clock is wrong, all the naturalist will have to do is to modify his notions of the rapidity of change accordingly." This contention is obviously true as regards the time which has elapsed since the earliest fossiliferous rocks were laid down. For the duration of the three great periods we must look to the geologist; but the question as to whether the whole of organic evolution is comprised within these limits, or, if not, what proportion of it is so contained, is a question for the naturalist. The naturalist alone can tell the geologist whether his estimate is sufficient, or whether it must be multiplied by a small or by some unknown but certainly high figure, in order to account for the evolution of the earliest forms of life known in the rocks. This, I submit, is a most important contribution to the discussion.

Before proceeding further it is right to point out that obviously these arguments will have no weight with those who do not believe that evolution is a reality. But although the causes of evolution are greatly debated, it may be assumed that there is

*Poulton, *Colours of Animals*, p. 308.

†See his letter to Darwin, November 23, 1859: *Life and Letters*, Vol. II.

* *Trans. Geol. Soc.* Glasgow, Vol. III. See also 'On the Age of the Sun's Heat,' Macmillan, March, 1862: reprinted as Appendix to Thomson and Tait, *Natural Philosophy*, Vol. I, part 2, second edition, and 'On the Secular Cooling of the Earth,' *Royal Society of Edinburgh*, 1862.

no perceptible difference of opinion as to evolution itself, and this common ground will bear the weight of all the zoological arguments we shall consider to-day.

It will be of interest to consider first how the matter presented itself to naturalists before the beginning of this controversy on the age of this habitable earth. I will content myself with quotations from three great writers on biological problems—men of extremely different types of mind, who yet agreed in their conclusions on this subject.

In the original edition of the 'Origin of Species' (1859), Darwin, arguing from the presence of trilobites, Nautilus, Lingula, etc., in the earliest fossiliferous rocks, comes to the following conclusion (pages 306, 307): "Consequently, if my theory be true, it is indisputable that before the lowest Silurian stratum was deposited long periods elapsed, as long as, or probably far longer than, the whole interval from the Silurian age to the present day; and that during these vast yet quite unknown periods of time the world swarmed with living creatures."

The depth of his conviction in the validity of this conclusion is seen in the fact that the passage remains substantially the same in later editions, in which, however, Cambrian is substituted for Silurian, while the words 'yet quite unknown' are omitted, as a concession, no doubt, to Lord Kelvin's calculations, which he then proceeds to discuss, admitting as possible a more rapid change in organic life, induced by more violent physical changes.*

We know, however, that such concessions troubled him much, and that he was really giving up what his judgment still approved. Thus he wrote to Wallace on April 14, 1869: "Thomson's views of the recent age of the world have been for some time one of my sorest troubles. * * *" And again, on July 12, 1871, alluding to Mivart's criticisms, he says: "I can say nothing more about missing links than what I have said. I should rely much on pre-Silurian times; but then comes Sir W. Thomson like an odious spectre."

* 6th ed., 1872, p. 286.

Huxley's demands for time in order to account for pre-Cambrian evolution, as he conceived it, were far more extensive. Although in 1869 he bade the naturalist stand aside and take no part in the controversy, he had nevertheless spoken as a naturalist in 1862, when, at the close of another Anniversary address to the same Society, he argued from the prevalence of persistent types "that any admissible hypothesis of progressive modification must be compatible with persistence without progression through indefinite periods;" and then maintained that "should such an hypothesis eventually be proved to be true * * * the conclusion will inevitably present itself that the Paleozoic, Mesozoic, Cainozoic faunæ and floræ, taken together, bear somewhat the same proportion to the whole series of living beings which have occupied this globe as the existing fauna and flora do to them."

Herbert Spencer, in his article on 'Illogical Geology' in the *Universal Review* for July, 1859,* uses these words: "Only the last chapter of the earth's history has come down to us. The many previous chapters, stretching back to a time immeasurably remote, have been burnt, and with them all the records of life we may presume they contained." Indeed, so brief and unimportant does Herbert Spencer consider this last chapter to have been that he is puzzled to account for 'such evidences of progression as exist;' and finally concludes that they are of no significance in relation to the doctrine of evolution, but probably represent the succession of forms by which a newly upheaved land would be peopled. He argues that the earliest immigrants would be

* Reprinted in his *Essays*, 1868, Vol. I., pp. 324–376.

the lower forms of animal and vegetable life, and that these would be followed by an irregular succession of higher and higher forms, which 'would thus simulate the succession presented by our own sedimentary series.'

We see, then, what these three great writers on evolution thought on this subject; they are all convinced that the time during which the geologists concluded that the fossiliferous rocks had been formed was utterly insufficient to account for organic evolution.

Our object to-day is first to consider the objections raised by physicists against the time demanded by the geologist, and still more against its multiplication by the student of organic evolution; secondly, to inquire whether the present state of paleontological and zoological knowledge increases or diminishes the weight of the threefold opinion quoted above—an opinion formed on far more slender evidence than that which is now available. And if we find this opinion sustained, it must be considered to have a very important bearing upon the controversy.

The arguments of the physicists are three:

First, the argument from the observed secular change in the length of the day, the most important element of which is due to tidal retardation. It has been known for a very long time that the tides are slowly increasing the length of our day. Huxley explains the reason with his usual lucidity: "That this must be so is obvious, if one considers, roughly, that the tides result from the pull which the sun and moon exert upon the sea, causing it to act as a sort of brake upon the solid earth."*

A liquid earth takes a shape which follows from its rate of revolution, and from which, therefore, its rate of revolution can be calculated.

The liquid earth consolidated in the form it last assumed, and this shape has persisted until now and informs us of the rate of revolution at the time of consolidation. Comparing this with the present rate, and knowing the amount of lengthening in a given time due to tidal friction, we can calculate the date of consolidation as certainly less than 1,000 million years ago.

This argument is fallacious, as many mathematicians have shown. The present shape tells us nothing of the length of the day at the date of consolidation; for the earth, even when solid, will alter its form when exposed for a long time to the action of great forces. As Professor Perry said in a letter to Professor Tait:* "I know that solid rock is not like cobbler's wax, but 1,000 million years is a very long time, and the forces are great." Furthermore, we know that the earth is always altering its shape and that whole coastlines are slowly rising or falling, and that this has been true, at any rate, during the formation of the stratified rocks.

This argument is dead and gone. We are, indeed, tempted to wonder that the physicist, who was looking about for arguments by which to revise what he conceived to be the hasty conclusions of the geologists as to the age of the earth, should have exposed himself to such an obvious retort in basing his own conclusions as to its age on the assumption that the earth, which we know to be always changing in shape, has been unable to alter its equatorial radius by a few miles under the action of tremendous forces constantly tending to alter it, and having 1,000 million years in which to do the work.

With this flaw in the case it is hardly necessary to insist on our great uncertainty as to the rate at which the tides are lengthening the day.

The spectacle presented by the geologist and biologist, deeply shocked at Lord Kel-

* Anniv. Address to Geol. Soc., 1869.

* *Nature*, January 3, 1895.

vin's extreme uniformitarianism in the domain of astronomy and cosmic physics, is altogether too comforting to be passed by without remark; but, in thus indulging in a friendly *tu quoque*, I am quite sure that I am speaking for every member of this Section in saying that we are in no way behind the members of Section A in our pride and admiration at the noble work which he has done for science, and we are glad to take this opportunity of congratulating him on the half century of work and teaching—both equally fruitful—which has reached its completion in the present year.

The second argument is based upon the cooling of the earth, and this is the one brought forward and explained by Lord Salisbury in his Presidential Address. It has been the argument on which, perhaps, the chief reliance has been placed, and of which the data—so it was believed—were the least open to doubt.

On the Sunday during the meeting of the British Association at Leeds (1890) I went for a walk with Prof. Perry and asked him to explain the physical reasons for limiting the age of the earth to a period which the students of other sciences considered to be very inadequate. He gave me an account of the data on which Lord Kelvin relied in constructing this second argument, and expressed the strong opinion that they were perfectly sound, while, as for the mathematics, it might be taken for granted, he said, that they were entirely correct. He did not attach much weight to the other arguments, which he regarded as merely offering support to the second.

This little piece of personal history is of interest, inasmuch as Prof. Perry has now provided us with a satisfactory answer to the line of reasoning which so fully satisfied him in 1890. And he was led to a critical examination of the subject by the attitude taken up by Lord Salisbury in 1894. Prof. Perry was not present at the meeting, but when he read the President's address, and saw how other conclusions were ruled out of court, how the only theory of evolution which commands anything approaching universal assent was set on one side because of certain assumptions as to the way in which the earth was believed to have cooled, he was seized with a desire to sift these assumptions and to inquire whether they would bear the weight of such far-reaching conclusions. Before giving the results of his examination, it is necessary to give a brief account of the argument on which so much has been built.

Lord Kelvin assumed that the earth is a homogeneous mass of rock similar to that with which we are familiar on the surface. Assuming, further, that the temperature increases, on the average, 1° F. for every 50 feet of depth near the surface everywhere, he concluded that the earth would have occupied not less than twenty, nor more than four hundred million, years in reaching its present condition from the time when it first began to consolidate and possessed a uniform temperature of 7,000° F.

If, in the statement of the argument, we substitute for the assumption of a homogeneous earth an earth which conducts heat better internally than it does towards the surface, Prof. Perry, whose calculations have been verified by Mr. O. Heaviside, finds that the time of cooling has to be lengthened to an extent which depends upon the value assigned to the internal conducting power. If, for instance, we assume that the deeper part of the earth conducts ten times as well as the outer part, Lord Kelvin's age would require to be multiplied by fifty-six. Even if the conductivity be the same throughout, the increase of density in the deeper part, by augmenting the capacity for heat of unit volume, implies a longer age than that conceded by Lord Kelvin. If the interior of the earth be fluid or contain fluid in a honeycomb structure, the rate at which heat can travel would be immensely increased by convection currents, and the age would have to be correspondingly lengthened. If, furthermore, such conditions, although not obtaining now, did obtain in past times, they will have operated in the same direction.

Prof. Tait, in his letter to Prof. Perry (published in *Nature* of January 3, 1895), takes the entirely indefensible position that the latter is bound to prove the higher internal conductivity. The obligation is all on the other side, and rests with those who have pressed their conclusions hard and carried them far. These conclusions have been, as Darwin found them, one of our 'sorest troubles;' but when it is admitted that there is just as much to be said for another set of assumptions leading to entirely different conclusions our troubles are at an end, and we cease to be terrified by an array of symbols, however unintelligible to us. It would seem that Prof. Tait, without, as far as I can learn, publishing any independent calculation of the age of the earth, has lent the weight of his authority to a period of 10 million years, or half of Lord Kelvin's minimum. But in making this suggestion he apparently feels neither interest nor responsibility in establishing the data of the calculations which he borrowed to obtain therefrom a very different result from that obtained by their author.

Prof. Perry's object was not to substitute a more correct age for that obtained by Lord Kelvin, but rather to show that the data from which the true age could be calculated are not really available. We obtain different results by making different assumptions, and there is no sufficient evidence for accepting one assumption rather than another. Nevertheless, there is some evidence which indicates that the interior of the earth in all probability conducts better than the surface. Its far higher density is consistent with the belief that it is rich in metals, free or combined. Prof. Schuster concludes that the internal electric conductivity must be considerably greater than the external. Geologists have argued from the amount of folding to which the crust has been subjected that cooling must have taken place to a greater depth than 120 miles, as assumed in Lord Kelvin's argument. Prof. Perry's assumption would involve cooling to a much greater depth.

Prof. Perry's conclusion that the age of the habitable earth is lengthened by increased conductivity is the very reverse of that to which we should be led by a superficial examination of the case. Prof. Tait, indeed, in the letter to which I have already alluded, has said: "Why, then, drag in mathematics at all, since it is absolutely obvious that the better conductor the interior in comparison with the skin, the longer ago must it have been when the whole was at 7,000° F., the state of the skin being as at present?" Prof. Perry, in reply, pointed out that one mathematician who had refuted the tidal retardation argument* had assumed that the conditions described by Prof. Tait would have involved a shorter period of time. And it is probable that Lord Kelvin thought the same; for he had assumed conditions which would give the result—so he believed at the time—most acceptable to the geologist and biologist. Prof. Perry's conclusion is very far from obvious, and without the mathematical reasoning would not be arrived at by the vast majority of thinking men.

The 'natural man' without mathematics would say, so far from this being 'absolutely obvious,' it is quite clear that increased conductivity, favoring escape of heat, would lead to more rapid cooling and would make Lord Kelvin's age even shorter.

The argument can, however, be put clearly without mathematics, and, with Prof. Perry's

*Rev. M. H. Close in *R. Dublin Soc.*, February 1878.

help, I am able to state it in a few words. Lord Kelvin's assumption of an earth resembling the surface rock in its relations to heat leads to the present condition of things, namely, a surface gradient of 1 ° F. for every 50 feet, in 100 million years, more or less. Deeper than 150 miles he imagines that there has been almost no cooling. If, however, we take one of the cases put by Prof. Perry, and assume that below a depth of four miles there is ten times the conductivity, we find that after a period of 10 billion years the gradient at the surface is still 1 ° F. for every 50 feet; but that we have to descend to a depth of 1,500 miles before we find the initial temperature of 7,000° F. undiminished by cooling. In fact, the earth, as a whole, has cooled far more quickly than under Lord Kelvin's conditions, the greater conductivity enabling a far larger amount of the internal heat to escape; but in escaping it has kept up the temperature gradient at the surface.

Lord Kelvin, replying to Prof. Perry's criticisms, quite admits that the age at which he had arrived by the use of this argument may be insufficient. Thus, he says, in his letter*: "I thought my range from 20 millions to 400 millions was probably wide enough, but it is quite possible that I should have put the superior limit a good deal higher, perhaps 4,000 instead of 400."

The third argument was suggested by Helmholtz, and depends on the life of the sun. If the energy of the sun is due only to the mutual gravitation of its parts, and if the sun is now of uniform density, "the amount of heat generated by his contraction to his present volume would have been sufficient to last 18 million years at his present rate of radiation."† Lord Kelvin rejects the assumption of uniform density, and is, in consequence of this change, able to offer a much higher upward limit of 500 million years.

*Nature, January 3, 1895.

†Newcomb's *Popular Astronomy*, p. 523.

This argument also implies the strictest uniformitarianism as regards the sun. We know that other suns may suddenly gain a great accession of energy, so that their radiation is immensely increased. We only detect such changes when they are large and sudden, but they prepare us to believe that smaller accessions may be much more frequent, and perhaps a normal occurrence in the evolution of a sun. Such accessions may have followed from the convergence of a stream of meteors. Again, it is possible that the radiation of the sun may have been diminished and his energy conserved by a solar atmosphere.

Newcomb has objected to these two possible modes by which the life of the sun may have been greatly lengthened, that a lessening of the sun's heat by under a quarter would cause all the water on the earth to freeze, while an increase of much over half would probably boil it all away. But such changes in the amount of radiation received would follow from a greater distance from the sun of $15\frac{1}{2}$ per cent., and a greater proximity to him of 18.4 per cent., respectively. Venus is inside the latter limit, and Mars outside the former, and yet it would be a very large assumption to conclude that all the water in the former is steam and all in the latter ice. Indeed, the existence of water and the melting of snow on Mars are considered to be thoroughly well authenticated. It is further possible that in a time of lessened solar radiation the earth may have possessed an atmosphere which would retain a larger proportion of the sun's heat; and the internal heat of the earth itself, great lakes of lava under a canopy of cloud, for example, may have played an important part in supplying warmth.

Again we have a greater age if there was more energy available than in Helmholtz's hypothesis. Lord Kelvin maintains that this is improbable because of the slow rotation of the sun, but Perry has given reasons for an opposite conclusion.

The collapse of the first argument of tidal retardation, and of the second of the cooling of the earth, warn us to beware of a conclusion founded on the assumption that the sun's energy depends, and has ever depended, on a single source of which we know the beginning and the end. It may be safely maintained that such a conclusion has not that degree of certainty which justifies the followers of one science in assuming that the conclusion of other sciences must be wrong, and in disregarding the evidence brought forward by workers in other lines of research.

We must freely admit that this third argument has not yet fully shared the fate of the two other lines of reasoning. Indeed, Prof. George Darwin, although attacking these latter, agrees with Lord Kelvin in regarding 500 million years as the maximum life of the sun.*

We may observe, too, that 500 million years is by no means to be despised; a great deal may happen in such a period of time. Although I should be very sorry to say that it is sufficient, it is a very different offer from Prof. Tait's 10 million.

In drawing up this account of the physical arguments, I owe almost everything to Prof. Perry for his articles in *Nature* (January 3 and April 18, 1895), and his kindness in explaining any difficulties that arose. I have thought it right to enter into these arguments in some detail and to consume a considerable proportion of our time in their discussion. This was imperatively necessary, because they claimed to stand as barriers across our path, and, so long as they were admitted to be impassable, any further progress was out of the question. What I hope has been an unbiassed examination has shown that, as barriers, they are more imposing than effective; and we are free to proceed and to look for the conclusions warranted by our own evidence. In this matter we are at one with the geologists; for, as has been already pointed out, we rely on them for an estimate of the time occupied by the deposition of the stratified rocks, while they rely on us for a conclusion as to how far this period is sufficient for the whole of organic evolution.

First, then, we must briefly consider the geological argument, and I cannot do better than take the case as put by Sir Archibald Geikie in his Presidential Address to this Association in Edinburgh in 1892.

Arguing from the amount of material removed from the land by denuding agencies, and carried down to the sea by rivers, he showed that the time required to reduce the height of the land by one foot varies, according to the activity of the agencies at work, from 730 years to 6,800 years. But this also supplies a measure of the rate of deposition of rock; for the same material is laid down elsewhere, and would, of course, add the same height of one foot to some other area equal in size to that from which it was removed.

The next datum to be obtained is the total thickness of the stratified rocks from the Cambrian system to the present day. "On a reasonable computation these stratified masses, where most fully developed, attain a united thickness of not less than 100,000 feet. If they were all laid down at the most rapid recorded rate of denudation they would require a period of 73 millions of years for their completion. If they were laid down at the slowest rate they would demand a period of not less than 680 millions."

The argument that geological agencies acted much more vigorously in past times he entirely refuted by pointing to the character of the deposits of which the stratified series is composed. "We can see no proof

* British Association Reports 1886, pp. 514–518.

whatever, nor even any evidence which suggests, that on the whole the rate of waste and sedimentation was more rapid during Mesozoic and Palæozoic time than it is to-day. Had there been any marked difference in this rate from ancient to modern times, it would be incredible that no clear proof of it should have been recorded in the crust of the earth."

It may, therefore, be inferred that the rate of deposition was no nearer the more rapid than the slower of the rates recorded above, and, if so, the stratified rocks would have been laid down in about 400 million years.

There are other arguments favoring the uniformity of conditions throughout the time during which the stratified rocks were laid down, in addition to those which are purely geological and depend upon the character of the rocks themselves. Although more biological than geological, these arguments are best considered here.

The geological agency to which attention is chiefly directed by those who desire to hurry up the phenomena of rock formation is that of the tides. But it seems certain that the tides were not sufficiently higher in Silurian times to prevent the deposition of certain beds of great thickness under conditions as tranquil as any of which we have evidence in the case of a formation extending over a large area. From the character of the organic remains it is known that these beds were laid down in the sea, and there are the strongest grounds for believing that they were accumulated along shores and in fairly shallow water. The remains of extremely delicate organisms are found in immense numbers and over a very large area. The recent discovery, in the Silurian system of America, of trilobites, with their long delicate antennæ perfectly preserved, proves that in one locality (Rome, New York State) the tranquillity of deposition was quite as profound as in any locality yet discovered on this side of the Atlantic.

There are, then, among the older Palæozoic rocks a set of deposits than which we can imagine none better calculated to test the force of the tides; and we find that they supply evidence for exceptional tranquility of conditions over a long period of time.

There is other evidence of the permanence, throughout the time during which the stratified rocks were deposited, of conditions not very dissimilar from those which obtain to-day. Thus the attachments of marine organisms, which are permanently rooted to the bottom or on the shores, did not differ in strength from those which we now find—an indication that the strains due to the movements of the sea did not greatly differ in the past.

We have evidence of a somewhat similar kind to prove uniformity in the movements of the air. The expanse of the wings of flying organisms certainly does not differ in a direction which indicates any greater violence in the atmospheric conditions. Before the birds had become dominant among the larger flying organisms their place was taken by the flying reptiles, the pterodactyls, and before the appearance of these we know that in Palæozoic times the insects were of immense size, a dragon-fly from the Carboniferous rocks of France being upwards of 2 feet in the expanse of its wings. As one group after another of widely dissimilar organisms gained control of the air, each was in turn enabled to increase to the size which was best suited to such an environment, but we find that the limits which obtain to-day were not widely different in the past. And this is evident, for the uniformity in the strains due to wind and storm no less than to those due to gravity. Furthermore, the condition of the earth's surface at present shows us how extremely sensitive the flying organism is to an increase in the former of these strains, when it occurs in proximity to the sea. Thus it is well known that an unusually large proportion of the Madeiran beetles are wingless, while those which require the power of flight possess it in a stronger degree than on continental areas. This evolution in two directions is readily explained by the destruction, by drowning, of the winged individuals of the species which can manage to live without the power of flight, and of the less strongly winged individuals of those which need it. Species of the latter kind cannot live at all in the far more stormy Kerguelen Land, and the whole of the insect fauna is wingless.

The size and strength of the trunks of fossil trees afford, as Prof. George Darwin has pointed out, evidence of uniformity in the strains due to the condition of the atmosphere.

We can trace the prints of raindrops at various geological horizons, and in some cases found in this country it is even said that the eastern side of the depressions is the more deeply pitted, proving that the rain drove from the west, as the great majority of our storms do to-day.

When, therefore, we are accused of uniformitarianism, as if it were an entirely unproved assumption, we can at any rate point to a large body of positive evidence which supports our contention, and the absence of any evidence against it. Furthermore, the data on which we rely are likely to increase largely, as the result of future work.

After this interpolation, chiefly of biological argument in support of the geologist, I cannot do better than bring the geological evidence to a close in the words which conclude Sir Archibald Geikie's address: "After careful reflection on the subject, I affirm that the geological record furnishes a mass of evidence which no arguments drawn from other departments of Nature can explain away, and which, it seems to me, cannot be satisfactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede."

In his letter to Prof. Perry,* Lord Kelvin says: "So far as underground heat alone is concerned, you are quite right that my estimate was 100 million, and please remark † that that is all Geikie wants; but I should be exceedingly frightened to meet him now with only 20 million in my mouth."

We have seen, however, that Geikie considered the rate of sedimentation to be, on the whole, uniform with that which now obtains, and this would demand a period of nearly 400 million years. He points out, furthermore, that the time must be greatly increased on account of the breaks and interruptions which occur in the series, so that we shall probably get as near an estimate as is possible from the data which are available by taking 450 million as the time during which the stratified rocks were formed. Before leaving this part of the subject, I cannot refrain from suggesting a line of enquiry which may very possibly furnish important data for checking the estimates at present formed by geologists, and which, if the mechanical difficulties can be overcome, is certain to lead to results of the greatest interest and importance. Ever since the epoch-making voyage of the 'Challenger' it has been known that the floor of the deep oceans outside the shallow shelf which fringes the continental areas is covered by a peculiar deposit formed entirely of meteoric and volcanic dust, the waste of floating pumice and the hard parts of animals living in the ocean. Of these latter only the most resistant can escape the powerful solvent agencies. Many observations prove that the accumulation of this deposit is extremely slow. One indication of this is especially convincing; the teeth of sharks and the most resistant part of the

* *Nature*, January 3, 1895.

† *P. L. and A.*, Vol. II., p. 87.

skeleton—the ear bones—of whales are so thickly spread over the surface that they are continually brought up in the dredge, while sometimes a single haul will yield a large number of them. Imagine the countless generations of sharks and whales which must have succeeded each other in order that these insignificant portions of them should be so thickly spread over that vast area which forms the ocean floor. We have no reason to suppose that sharks and whales die more frequently in the deep ocean than in the shallow fringing seas; in fact, many observations point in the opposite direction, for wounded and dying whales often enter shallow creeks and inlets, and not uncommonly become stranded. And yet these remains of sharks and whales, although well known in the stratified rocks which were laid down in comparatively shallow water and near coasts, are only found in certain beds, and then in far less abundance than in the oceanic deposit. We can only explain this difference by supposing that the latter accumulate with such almost infinite slowness as compared with the continental deposits that these remains form an important and conspicuous constituent of the one, while they are merely found here and there when looked for embedded in the other. The rate of accumulation of all other constituents is so slow as to leave a layer of teeth and ear-bones uncovered, or covered by so thin a deposit that the dredge can collect them freely. Dr. John Murray calculates that only a few inches of this deposit have accumulated since the Tertiary period. These most interesting facts prove furthermore that the great ocean basins and continental areas have occupied the same relative positions since the formation of the first stratified rocks; for no oceanic deposits are found anywhere in the latter. We know the sources of the oceanic deposit, and it might be possible to form an estimate, within wide limits, of its rate of accumulation. If it were possible to ascertain its thickness by means of a boring, some conclusions as to the time which has elapsed during the lifetime of certain species—perhaps even the lifetime of the oceans themselves—might be arrived at. Lower down the remains of earlier species would probably be found. The depth of this deposit and its character at deeper levels are questions of overwhelming interest; and perhaps even more so is the question as to what lies beneath. Long before the 'Challenger' had proved the persistence of oceanic and continental areas, Darwin, with extraordinary foresight, and opposed by all other naturalists and geologists, including his revered teacher, Lyell, had come to the same conclusion. His reasoning on the subject is so convincing that it is remarkable that he made so few converts, and this is all the more surprising since the arguments were published in the 'Origin of Species,' which in other respects produced so profound an effect. In speculating as to the rocks in which the remains of the ancestors of the earliest known fossils may still exist, he suggested that, although the existing relationship between the positions of our present oceans and continental areas is of immense antiquity, there is no reason for the belief that it has persisted for an indefinite period, but that at some time long antecedent to the earliest known fossiliferous rocks "continents may have existed where oceans are now spread out; and clear and open oceans may have existed where our continents now stand." Not the least interesting result would be the test of this hypothesis, which would probably be forthcoming as the result of boring into the floor of a deep ocean; for although, as Darwin pointed out, it is likely enough that such rocks would be highly metamorphosed, yet it might still be possible to ascertain whether they had at any time formed part of a continental deposit, and perhaps to discover much more than this. Such an undertaking might be carried out in conjunction with other investigations of the highest interest, such as the attempt to obtain a record of the swing of a pendulum at the bottom of the ocean.

E. B. POULTON.

(*To be Concluded.*)

SECTION H. ANTHROPOLOGY.

THE Liverpool session of the Anthropological Section will long be remembered as one of exceptional interest. The President, Mr. Arthur J. Evans, keeper of the Ashmolean Museum at Oxford, had long previously arranged for a discussion on the origin of the Mediterranean race and culture, and numerous distinguished archæologists and anthropologists had been invited to attend and join in the discussion, among others may be mentioned Prof. Sergi, M. Salomon Reinach, Dr. P. Topinard and Prof. D. G. Brinton, but these four were at the last unfortunately unable to be present. In the course of his able address the President touched on many points that were coming on for discussion during the meeting, and he thus, as it were, struck the keynote of the proceedings. Taking it as a whole the meeting was distinctly archæological in character, and it will probably be found that the giving of a distinctive character to a meeting will ensure a higher average of excellence in the papers than if the communications offered are left to chance. There is more likelihood of a number of distinguished men interested in a comparatively limited subject gathering to meet with one another by prearrangement, than the same number of equally competent men in various departments of Anthropology; but at the same time no department of Anthropology should be entirely unrepresented.

The range of the subjects dealt with at the meeting will be evident from the following summary, in which no attempt is made to retain the order in which the papers were read.

Mr. Seton Karr exhibited a selection of the paleolithic implements he discovered in Somaliland, these form a remarkable series taken in conjunction with the types from India and Western Europe, and suggest either the extension of an associated people or a migration. Recent numerous finds of flint implements in North Ireland appear to throw back the age of man in Ireland further than the typical Neolithic period which is the limit usually acknowledged, but it is not yet generally accepted that the striæ on some of these implements are really of glacial origin. Mr. W. J. Knowles brought forward evidence to show that at Whitepark Bay, County Antrim, Neolithic settlers carried away to sites among the sand hills, the weathered cores and flakes of palæolithic age from the raised beach and worked them up into fresh implements, which still show the older flaked surfaces; their newer surfaces, however, are still fresh. A lantern exhibition of photographs taken by Prof. W. A. Herdman, of the dolmens of Brittany, led to a discussion of their age. Most speakers dated them as being neolithic, but perhaps in some cases of later date, Prof. Boyd Dawkins, however, claimed them as belonging to the Bronze age. Mr. F. T. Elworthy recorded the very recent discovery of a cist burial in Somersetshire, of which he exhibited photographs. The man, judging from his skull, certainly belonged to the Roundbarrow or Bronze race, but the interment and the earthen vessel were more neolithic in character; perhaps he was a pioneer. The ancient forts or *brochs* of Scotland formed the subject of a paper by Miss Maclagan.

The occurrence of an European Copper age was more than once alluded to. Dr.

Munro denied its existence and regarded the copper implements as 'starved' bronze, owing to a temporary scarcity of tin. Prof. Flinders Petrie placed the first employment of copper tools in the Mediterranean basin at from 3,500 to 3,000 B. C. Dr. Montelius referred to the early copper implements of north and central Italy having the same form as the antecedent stone types, and Dr. J. H. Gladstone presented a series of analyses of implements which demonstrated a transition from pure copper, through copper hardened with sub-oxides of copper and natural alloys of copper with antimony and arsenic to tin bronze. When the latter was hit upon it quickly superseded the others.

The great debate on the Mykenæan civilization was opened in a brilliant, slashing speech by Prof. W. Ridgeway. The discovery of Mykenæan remains in various parts of the Greek world from Asia Minor and Cyprus to Sicily makes it desirable to re-examine the question of the origin of these remains. It is generally conceded that the choice lies between the Pelasgians and the Achæans. When Schliemann discovered the Mykenæan finds, scholars at once rushed to the conclusion that these belonged to the Achæan culture as sung by Homer. This involves many difficulties: (1) the age of Mykenæ is that of bronze, that of Homer's Achæans is distinctly of iron; (2) engraved gems are characteristic of Mykenæ, but such engraved gems, used either as signets or as ornaments, are unknown to Homer; (3) No fibulæ have been found in the Acropolis of Mykenæ, but Homer's Achæans used them to keep on their dress; (4) the Mykenæans had a peculiar shield, like the figure 8, they had no breastplate, no greaves of metal, and wore their hair in three locks behind; whilst the Achæans had round shields, bronze breastplates and greaves, and wore their hair flowing. To obviate such difficulties Reichel, followed by Leaf, would make wholesale excision of passages from the Homeric poems. The Greeks themselves thought that Mykenæ and Tiryus were built before the Achæans entered Peloponnese, and by the Pelasgians. The Greek historians declared that Attica was never inhabited by any other race than the Pelasgians, and Mykenæan remains have been found in abundance in Attica. The Mykenæan culture is that of the Bronze age and Pelasgian in origin. It was supplanted by the Iron age which was introduced by the Achæans into Greece. Prof. Petrie offered as an additional argument the continuity in Attica of artistic preeminence from Mykenæan times to the highest period of Greek art. Dr. Beddoe adduced craniological evidence in support of the Pelasgian origin of some of the most noted Greeks. Various speakers continued the discussion, some of whom combatted Prof. Ridgeway's conclusions, but the general impression was that he had established his main contentions, and he maintained that he was justified in laying stress on traditional history as this was so largely supported by archæological finds. The physical characters and migrations of the Mediterranean race according to Sergi were laid before the meeting by Mr. Myres.

The chronology of the Bronze Age in northern and central Italy formed the subject of a learned and beautifully illustrated paper by Dr. Montelius, the renowned Swedish archæologist. He distinguished four divisions of the Bronze Age dating from 2100 to 1100 B. C.; and in central Italy two Protetruscan Periods from 1100 to 900 B. C., and two Etruscan Periods from 900 to 700 B. C. Associated with this group of subjects was an erudite paper by Mr. J. L. Myres on Cypress and the trade routes of southeast Europe.

The starting-point of the Iron Age in Europe, formed the subject of a communication by Prof. Ridgeway. He stated that

Scandinavia cannot be its place of origin, for there the Iron Age began later than the Christian era. It is admitted that the Iron Age comes *per saltum* in Swiss lake dwellings, in Italy, Greece, France and Britain. Iron is found going with the Kelts into these various regions.

Hallstatt, in Austria, is the only place in Europe where articles of iron are found gradually replacing those of the same kind made in bronze. It has not been hitherto pointed out that within a very short distance of the Hallstatt cemetery lies one of the most famous iron mines of antiquity, that of Noreia. From this center iron spread into Italy, Switzerland, Gaul, Spain, Greece and eastern Germany. He suggested that the old bronze workers came across an outcrop of volcanic iron, such as that known in at least one place in Greenland. Man would thus find ready to hand masses of wrought iron, and there is no need to suppose that meteoric stones first supplied him with that metal. This view was discussed but it did not find much acceptance. Prof. Flinders Petrie referred to his recent discovery in Egypt of various iron tools of such a character that they must have been made by a people long acquainted with iron. They occurred in company with an Assyrian helmet. He put them down to about 670 B. C. This is the oldest datable iron find.

Various other papers bore upon the primitive civilization of Europe. The president, for example, read one on 'Pillar and Tree worship in Mykenæan Greece,' in which he showed the great part played by these objects in the religion of that epoch. On a gold ring from the early Mykenæan period (about 1500 B. C.), a dual cult of a male and female divinity in their pillar shape is illustrated, and an armed sun-god is being brought down on to his obelisk, or Bethel, by ritual incantation; other signets show pillars and trees enclosed in small shrines. The cult of the sacred fig tree and the early sanctity of the dove were alluded to. This ancient pillar and tree worship largely survived in the rustic cult of classical Greece.

Another important paper on ceremonies which date back to prehistoric times was read by Mr. G. L. Gomme as an appendix to the Report of the Ethnographic Survey of the United Kingdom. It was entitled 'On the Method of Determining the Value of Folklore as Ethnological Data.' He dealt with the traces of fire worship in the British Islands, and by a process of analysis and synthesis arrived at the conclusion that the fire, obtained in a sacred manner, was maintained within a group connected by common descent, whose welfare is dependent upon the performance of the ceremony and the continual possession of the fire. This is equated with the early tribal system of the Aryans. By connecting by lines all the places in a country where more or fewer of these customs occur, a diagram is obtained the contour of which forms what Mr. Gomme calls an 'ethnological test-figure.' He has previously suggested that water-worship customs are non-Aryan in origin, and therefore belongs to the pre-Celtic people of these islands, and it is noteworthy that the 'ethnological test-figure' produced from water customs differs radically from that produced by the fire customs.

Other interesting communications were a beautifully illustrated account of the Swedish boat-graves from 600 to 1000 A. D., by Dr. H. Stolpe. Mr. G. Coffey brought forward additional evidence in support of his view that the spirals and some other devices of the incised stones of New Grange, Dowth and Loughcrew, in Ireland, had been derived from Scandinavia, one important piece of evidence being the discovery of a second drawing of a boat similar to those of the well known rock-scribings of Sweden. Mr. R. A. S. Macalister carefully described an important prehistoric settlement in Kerry. These, as well as several other papers, were fully illustrated by lantern slides.

The centenary of the birth of A. Retzius, the pioneer of some of the modern methods of craniological research was suitably commemorated by Sir William Turner, Mr. Brabrook and the President. Mr. A. W. Moore and Dr. J. Beddoe described the anthropology of the Isle of Man, and Dr. Garson illustrated the mean bodily proportions of the members of the British Association from measurements which had been taken at numerous meetings. Dr. D. Hepburn gave a very elaborate comparison of the femur of *Pithecanthropus* with numerous femora of various races. He found, as Dr. Manouvrier had already done, that all the peculiarities could be matched in recent bones.

The elaborate report on the north-west tribes of Canada was read, and Prof. E. Adlum gave a very interesting account of the Coast Indians of British Columbia. Graf von Pfeil described from personal experience the Duk-duk, Eineth and Marawot ceremonies of the Bismarck Archipelago. Mr. C. H. Read, of the British Museum, strongly urged the formation of an Imperial Bureau of Ethnology analogous, but not necessarily similar to the splendid Bureau at Washington; this idea was warmly supported by several speakers. Prof. A. C. Haddon drew attention to the necessity for the immediate anthropological investigation of Oceanic Islands and other districts where the natives are disappearing before or becoming modified by the white man. Mr. S. H. Ray pointed out that British New Guinea was at the present moment a very favorable field for such research.

The problem of storehousing anthropological and archæological collections formed the subject of an animated discussion. Prof. Flinders Petrie proposed the erection in a country site, not too far from London, of long, low well-lighted stores, which would be capable of indefinite extension and where associated objects of any number or size could be kept together for reference. Some of the details of his scheme appeared impracticable to several speakers, but there was a general feeling that this is a question that must be faced sometime or other. No satisfactory scientific work can be done unless there are long series of specimens for comparison and we must also consider the needs of posterity.

The general interest in anthropology was increased by Prof. Flinders Petrie's evening lecture on 'Man before writing.' In Prof. W. H. Goodyear's lantern demonstration at one of the conversationes, the false perspective of numerous mediæval Italian churches was abundantly proved. A novel feature in connection with the meeting was a loan exhibition in which numerous objects referred to in the papers were exhibited.

A. C. Haddon.

Cambridge, England.

THE INTERNATIONAL PSYCHOLOGICAL CONGRESS.

The Third International Congress for Psychology was held at Munich, August 4–8. Of the 550 who registered as members, nearly 400 were present. Germany was naturally represented by the greatest number, but France and the other neighboring countries also sent large delegations. From England there were twelve, and from the United States there were twenty-six present.

The Congress began with an informal reception on August 3d, at the Café Luitpold, thus giving the members an opportunity of meeting each other before the sessions. The other social arrangements were numerous and varied, and made an interesting and pleasing commentary on the hospitality and the customs of the German people.

These included a reception in the Rathhaus, given by the city of Munich, at which Professors Richet (France), Baldwin (U. S. A.), Sidgwick (England), Tokarsky (Russia), Sergi (Italy), Flournoy (Switzerland), Heymans (Holland), Saliger (Austria), and Geijer (Scandanavia), representing their respective countries, brought greetings to the land whence had come much of the impetus to the present work in the science. Wednesday noon, the Congress was invited to partake of a 'Frühschoppen,' and to view the arrangements of the 'Brauerei zum Spaten;' the same evening, in honor of the Congress, there was a presentation of 'Don Giovanni' in the Royal theatre. The next noon the English and the American members lunched together, and in the evening there was a Congress dinner. A lawn party and an excursion on the Starnberger Sea, which had been arranged, were given up on account of the weather, and in place of the latter, on Friday evening, there was another informal reception, bringing the Congress to a close.

At the business meetings it was decided to hold the next Congress at Paris in 1900. The following officers were then elected: President, Prof. Th. Ribot; Vice-President, Prof. Ch. Richet; General Secretary, Prof. Pierre Janet; all from Paris. In addition to these officers, the following were appointed as members of the international committee of organization: Professors A. Binet (Paris), P. Flechsig (Leipzig), H. Ebbinghaus (Breslau), Th. Lipps (Munich), C. Stumpf (Berlin), H. Sidgwick (Cambridge, Eng.), G. F. Stout (Cambridge, Eng.), J. Sully (London), W. James (Cambridge, U. S. A.), J. M. Baldwin (Princeton), E. B. Titchener (Ithaca, N. Y.), E. Morselli (Genua), G. Sergi (Rome), S. Exner (Vienna), and G. Heymans (Groningen, Holland).

The work of the Congress was divided into general and sectional sessions. In the first general session the President, Prof. C. Stumpf (Berlin), after formally opening the Congress, read his presidential address and then presented the Minister of the Interior for Church and School Affairs of Bavaria, Count von Landmann, who welcomed the Congress to Germany and to Bavaria in the name of the government. The vice-mayor, Bürgermeister Brunner, next welcomed the Congress in the name of the city of Munich, and the rector of the University, Prof. von Baur, gave a welcome from the University. Then followed a paper by Prof. Charles Richet (Paris), 'On Pain,' and one by Prof. von Liszt (Halle), on 'Criminal Accountability.' At the second general session papers were read by Prof. P. Flechsig (Leipzig), 'The Association Centers in the Human Brain' (with anatomical demonstration); Prof. G. Sergi (Rome), 'Where is the Seat of the Emotions?' and Prof. W. Preyer (Wiesbaden), 'The Psychology of the Child.' The third general session included the following papers: Prof. F. Brentano (Vienna), 'Theory of Sensation;' Prof. Pierre Janet (Paris), 'The Hypnotic Influence and the Necessity of Caution in its Use;' Prof. H. Ebbinghaus (Breslau), 'A New Method for Testing Mental Capabilities and its Application to School Children;' Prof. Th. Lipps (Munich), 'The Idea of the Unconscious in Psychology.' The remainder of the papers presented were read in sectional meetings. The divisions into which the work was separated were as follows:

I. Anatomy and physiology of the brain and the sense organs. Psychology of the senses. Psycho-physics.

II. Psychology of the normal individual.

III. Pathological and criminal psychology.

IV. Psychology of sleep, dreams, hypnotism, and allied phenomena.

V. Comparative and educational psychology.

A short account of some of the papers follows. At the general sessions—

Prof. C. Stumpf (Berlin), in his presidential address, first reviewed briefly the two previous congresses, calling attention to the fact that this one was a congress for *psychology*, while the first one at Paris was a congress for *physiological psychology*, and the second one at London was a congress for *experimental psychology*. He then discussed the different theories of the relation of body and mind, and concluded with a short account of the advance in psychology since the time of Descartes and Spinoza, and a brief reference to some of the present problems.

Prof. Richet (Paris) treated 'Pain' from the biological standpoint. He showed that in general pain is caused by strong stimuli and by every cause which greatly modifies the state of the nerves. He finds in it, with its fundamental character of persistence in memory, one of the seasonable provisions that guards the individual from injury and from the shortening of life, and he considers it a powerful motive, particularly in man, pushing him unceasingly toward perfection.

Prof. von Liszt (Halle a. S.) considered the question of 'Criminal responsibility.' He thought that the questions of the freedom of the will and of mental capabilities would not settle responsibility, but rather the psychological considerations of the feelings and of the will.

Prof. P. Flechsig (Leipzig), in his paper 'On the association centers in the human brain,' told of his work (first announced two years ago), on the brains of the embryo and of the young, by which he found the gradual development, or ripening, as he called it, of the different portions of the cerebrum; first, the parts connected with movements and the senses, and then the connecting parts, the association fibres. A lantern demonstration with brain sections, showing the different stages of development, followed. The paper led to a long and heated discussion between the physiologists and pathologists and the psychologists in which, beside the reader of the paper, Lipps, Ebbinghaus, Stumpf, Forel and Dechterew took part.

Prof. G. Sergi (Rome) discussed the question 'Where is the seat of the emotions?' After reviewing the different theories of the emotions and the evidence in support of them, he turned to the question and brought forth evidence to show that the emotional center is not in the brain (cerebellum or cerebrum), but in the medulla oblongata, and he considered the seat of the emotions to be peripheral, and due to changes in the blood supply, to breathing and to nutritional changes.

Prof. W. Preyer (Wiesbaden) made an appeal in his paper, 'The Psychology of the child,' for the closer and more extended study of the psychic life of the child, which represents in itself the whole mental development of mankind.

Prof. F. Brentano (Vienna), in his discourse, treated of the theory of sensation, dealing particularly with the concept of intensity.

Prof. Ebbinghaus (Breslau) next told of some of the practical uses of experimental psychology. His paper, 'On a new method for testing mental ability and its application to school children,' was an account of some experiments he had made on school children, testing their ability to memorize, their accuracy, etc., under the varying school conditions, to discover the most favorable conditions for school work.

Prof. Pierre Janet (Paris) spoke of the influence of the hypnotizer over his subject, of the feelings sometimes aroused in the latter toward the former—love, hate, terror, veneration, jealousy—which feelings sometimes exist even when the subject is not in a somnambulic state. He considered the influence due mainly to weakness of will and to dependence on others, the subjects thus needing some one to decide for them.

Prof. Th. Lipps (Munich), the Vice-President, considered the subject 'The idea of the unconscious in psychology.' For a true science of the mind the speaker found it was necessary to consider the unconscious, and he held that a psychology which took account only of our conscious experiences would be an '*Unding.*'

The following papers were also announced for the general sessions, but were not read: G. Stanley Hall (Worcester, Mass.), 'A Genetic Study of Primitive Emotions;' G. F. Stout (Cambridge, Eng.), 'Unanalyzed Individuality as a Dominant Category in Savage Thought;' F. W. H. Myers (Cambridge, Eng.), 'The Psychology of Genius;' W. von Tschisch (Dorpat, Russia), 'Memory for Sense Perceptions; A. Binet (Paris), 'Individual Psychology.'

The following are short accounts of some of the papers read at the sectional sessions:

SECTION I.

Dr. A. Tokarsky (Moscow) considered the question of the shortest time of a simple reaction. He excluded only those experiments as premature which either actually preceded or coincided with the stimulus, and found then that the shortest reactions were from .005 to .01 second.

Prof. H. Ebbinghaus (Breslau), in his communication on the psycho-physical method of right and wrong cases, pointed out some errors in the use of the method and discussed the relation it bore to the method of mean error.

Prof. O. Külpe (Würzburg) communicated some preliminary results he had obtained on the influence of the attention on the intensity (brightness) of a sensation. He had experimented with visual stimuli and found in the diversion of attention by convergence and accommodation that one observer made an under-valuation, while two others over-valued the intensity. The paper led to a discussion between Münsterberg, Ebbinghaus, Stumpf, Exner, Lipps and the reader of the paper.

Prof. G. Martius (Bonn) announced some results on the influence of the intensity of light on the brightness of the color sensation. His experiments showed that the brightness of the color sensation bears a functional relation to the objective intensity of the light. Red, orange, yellow and purple decreased steadily as the intensity decreased; the other colors increased up to the value found by the method of minimum intensity.

W. S. Wadsworth (Philadelphia) gave an account of some experiments made with persons of defective color vision. He exhibited many charts showing effects of education, association, sex, temperament, etc. He referred to the difficulties experienced in making comparisons with results of previous investigators and, to obviate this in the future, suggested the appointment of an international committee to consider and decide upon a standard series of colors.

Dr. G. M. Stratton (Berkeley, Cal.) described some preliminary experiments he had made on 'vision without inversion of the retinal image.' The aim of the work was to test the assertions, made by the exponents of the 'projection' and of the 'eye movement' theories of upright vision, that the inversion of the retinal image is necessary for upright vision. The experiments were made using only one eye, but they showed a rapid reharmonizing of tactual and visual localization. The speaker concluded, therefore, that the experiment proved that the perception of the field as 'upright' is not dependent on the inversion of the retinal image.

Prof. R. Taverni (Catania, Sardinia) communicated some results on 'States in the other senses analogous to Daltonism.' Among the number of people examined by him during the past thirteen years he found 161 such abnormal people, of whom 108 were hearing defectives, 23 taste, 18 touch, and 12 smell. Of the whole number (161) only two were also color defectives. The proportion of men to women for the several defects were: hearing, 2:1; taste, 1:3; touch, 1:5; smell, 1:2. Among the number it was found that there were three times as many of the poorer classes as of those in better social condition.

Prof. W. Wendensky (St. Petersburg) reported some experiments to determine what influence the stimulation of a cortical center on one hemisphere of the brain had on the corresponding center of the opposite side. The results were very variable, but led to the conclusion that there was a functional relation between the hemispheres much closer than has been usually admitted.

Dr. E. Hering (Prague) propounded and attempted to answer the question 'In how far is the integrity of the centripital nerves a condition for voluntary action?' His conclusion was that if *all* centripital stimulation cease, voluntary acts would also cease, but if after centripital paralysis the excitability of the nerves still remained, then one could not say that acts might not be voluntary.

Dr. L. William Stern (Berlin) discussed the manner in which we perceive changes. These he found to be: (1) through momentary perception; (2) through prolonged perception, and (3) through the comparison of an event's separate phases.

SECTION II.

Prof. H. Flournoy (Geneva) reported experiments made on the association of figures. Observers were intructed to write as quickly as possible single numbers (those from one to nine), thinking of them only as single, and writing pêle mêle, not in the order of the figures (*e. g.*, 1. 2. 3. or 9. 8. 7). The results showed considerable individual differences both in the quantity and in the numbers written. A decided preference for the numbers 3, 5 and 7 was noted and also a seeming dislike for 2, 6 and particularly 1. The individuals were found to be constant in their preferences, etc., over a period of four years.

Prof. L. Edinger (Frankfort on the Main), in answer to the question "Can psychology derive benefit from the present state of brain anatomy?" considered that from anatomical study psychology had much to learn, and particularly was this the case for comparative psychology in experimenting on the psychic condition of animals.

Prof. J. Courtier (Paris) made some preliminary announcements on memory for music. He had used as subjects the professors and students at the conservatory of Paris and had also experimented with other musical people, singers, instrumentalists and composers.

Prof. V. Basch (Rennes) spoke of 'Method in æsthetics.' He considered it entirely unscientific to follow exclusively the logical, or metaphysical, or psychological lines when dealing with this subject, and concluded that any proper treatment must include the three, first psychological, then logical, and finally metaphysical.

A. T. Shand (London) discussed, in his paper, 'On the psychological hypotheses concerning the relation of the mind and the brain,' the two theories most commonly accepted, viz: those of 'parallelism,' and that of 'interaction.' He showed that the two are not mutually exclusive and that when taken together would make a better hypothesis than either separately. He attempted to reconcile and combine them.

Prof. C. Ueberhorst (Innsbruck) analyzed out the psychic factors in visual perception.

J. Philippe (Paris) gave the general results he had obtained in mental imagery. He showed there were three ways of studying the imagination: (1) considering the way in which our mental images are formed; (2) taking the contents of our imagination at different times, and (3) studying the way in which our mental images disappear or fade away. His experiments were made with the last method chiefly, and he considered only visual images. The visual images of objects seen or felt were noted immediately after, after a lapse of 15 days, after 30 days and after two months. It was found that details tended to disappear and that the typical form became more and more accentuated, making thus a general image of the object.

Prof. G. G. Gizzi (Rome) discussed 'Feeling and its Laws.' The laws he deduced were as follows: (1) The sensation and the feeling are directly proportional to the sensibility of the individual and the inversely to the mental distraction. (2) During the persistance of a stimulus the intensity of the sensation decreases while the intensity of the feeling increases, the increase or decrease being directly proportional to the culture and education of the individual and inversely proportional to the mental distraction.

Dr. W. Jerusalem (Vienna) discussed the origin of the number concept. He considered that our notion of number arose through the existence of similar objects in nature and from our function of judgment. Our arithmetical judgments, therefore, are general laws of physical occurrences and have an unconditioned and indubitable validity.

Dr. S. S. Epstein (Berlin) described some experiments on the influence of light stimulation on the blood supply. All colors were found to have a stimulating effect, red having the most and green the least.

SECTION III.

Prof. A. von Strümpell (Erlangen) gave an account of some interesting diseases of memory, with loss of mental images for periods of time past, some cases of word amnesia, etc.

Prof. Pierre Janet (Paris) announced some interesting results on 'the times for simple reactions in their relation to diseases of attention.' Different classes of insane people were tested, and the curves obtained showed the feebleness of attention in the melancholic, the oscillations in the neurasthenic and its rapid fatigue in the hysterical cases. The reactions, if continued beyond fifteen or twenty minutes, in some cases, particularly with paranoiacs and hysterical patients, become automatic, so that the reaction cannot always be taken as a sure guide of the state of attention.

Dr. O. Näcke (Leipzig), in his paper on 'Criminal Psychology,' defined the materials with which to work as follows: (1) Those generally classed as criminals (a heterogeneous mass). (2) Those mentally unsound, epileptic, imbecile, etc. (3) The lowest strata of society.

Dr. A. de Jong (The Hague) considered 'the psychology of false ideas of the insane.' He thought they were only secondary symptoms and as logical developments. Their character cannot determine the diagnosis of the case, he thought, but we must look rather to their developments.

Drs. G. C. Ferrari and Bernadini (San Maurizio, Italy) described some experiments to test the musical memory of idiots. Simple melodies were used and the idiots required to repeat immediately after, as well as possible, what they had just heard. 60 (39 men and 21 women) out of 100 (60 men, 21 women) could repeat the chord C.E.G.C., while 12 (7 men, 5 women) were found to have (for idiots) good memory for music.

SECTION IV.

Dr. E. Roemer (Heidelberg) described some experiments in progress on the relation between sleep and mental ability. The observer's memory was tested, and the accuracy and speed of work, the association time and time of discrimination, were taken at different times after awaking and after different periods of sleep.

Prof. J. M. Vold (Christiania) reported some experiments on visual images in dreams. Objects were looked at just before going to bed and dreams noted. It was found that very seldom was the entire appearance of the object (if a dream happened to be about it) changed, but that there was usually a curious change in color.

C. Lloyd Tuckey (London) gave the results of his use of hypnotism for the cure of chronic alcoholism. Of the 65 cases he had treated in eight years, 15 were permanently cured, and 7 greatly benefited.

Dr. Bonjour (Lausanne) gave an account of cases in which suggestion had been used as a means of curing disease. He used his illustrations to show the influence of the psychic over the material part of our nature, of the mind over the body.

Mrs. Sidgwick (Cambridge, Eng.) made a final report on 'the statistical enquiry into sensory hallucinations experienced while awake by persons in ordinary health.' She referred to the Proceedings of the Society for Psychical Research for the full report, but treated more fully of its bearing on the evidence for telepathy. As there were a number present who considered the results could be explained in a different manner, the paper received a full discus sion.

Prof. Sidgwick (Cambridge, Eng.) next considered, in his paper entitled 'Experiments in involuntary whispering and their bearing on alleged cases of thought transference,' the work of Lehmann and Hansen published in Wundt's *Philosophische Studien.* As neither of the authors were present, however, the speaker did not go into details, but showed briefly that, although the Danish investigators might draw the conclusions they did for the experiments made with the percipient and agent in the same room, their explanation would be slightly overdrawn for results obtained when the percipient and agent were in different rooms, and again when the matter communicated was not numbers but complex drawings.

Dr. T. Crocq (Brussels) discussed the conditions of sensibility and of the intellectual functions in hypnotized subjects. He found that without suggestion there was in general a diminution of sensibility to pain, and that the special senses—sight, smell, taste, even hearing—lose their functions unless suggestions to the contrary are given. Memory without suggestion is not exalted; with proper suggestion there may be amnesia, but this does not always occur. There is also a rest in thought until some suggestion comes to rouse the brain.

Dr. J. M. Bramwell (London) gave an account of experiments on the appreciation of time by somnambules. Suggestions were given for doing acts after lapses of varying times. The results showed the three possible things that could have happened, viz.: utter failure, partial success and total success. The same speaker also discussed the advantages and disadvantages of the use of hypnotism in medical and surgical treatment, mentioning cases in which it had been used with success.

Dr. H. Stadelmann (Saal a. Saale) told of the value of suggestion in the cure of disease, particularly with mental disorders.

Dr. A. Voisin (Paris) also discussed the the application of hypnotic suggestion to the treatment of mental maladies. His success in its use was great in those cases characterized by fixed ideas, hallucinations, perversions, and moral insanity.

SECTION V.

Dr. M. Friedmann (Mannheim) considered the problem of the development of judgments in primitive peoples.

Dr. H. Gutzmann (Berlin) discussed the relation between the speech of the savage and the child's speech. He showed that the child's learning to speak was an exact parallel to the development of speech among primitive peoples.

Dr. A. Marro (Turin) spoke of the psychoses of puberty. He divided these into three classes: (1) Psychosis of first reflection; (2) Psychosis, presenting the character of *hébéphrénie*, and (3) psychosis from organic, either congenital or acquired, causes.

J. Friedrich (Würzburg) described some experiments to determine the effect of continued work and of work with occasional periods of recreation on the accuracy of the work of school children.

J. W. David (Warschaw, Russia) announced some results on the development of school children.

S. I. Franz and Dr. H. Griffing (New York) communicated some results on the conditions of fatigue in reading. The experiments were to determine what kind of type, paper and illumination were least fatiguing to the eye. The most important condition was found to be large type, but for the most economical use of the eyes good paper and good illumination are necessary.

M. Vaschide and G. S. Ferrari (San Maurizio) reported the results of some experiments on the memory for lines. Lines of from 2 to 40 mm. long were used and it was found that the shortest ones were more accurately reproduced. Distraction, strange to say, favored the memory, the best results being obtained under these conditions. Alcohol had a varying effect, causing the smaller lines to appear greater and the larger ones smaller.

Dr. J. Cohn (Berlin) gave the results of experiments on individual memory differences. The acoustic type of people were found to be better memorizers than the others, but this may be due to the fact that the experiments were more favorable to them than to other types.

Dr. A. de Jong (The Hague) discussed the value of hypnotism and suggestion as educational helps, and concluded that the use of hypnotic suggestion would be of great use to teachers, particularly for cases of perverse character, etc.

During the Congress there was a demonstration of Röntgen rays, showing the beating of the heart, by Dr. M. Boy, of Berlin; a demonstration of psychological apparatus by Dr. Schumann, of Berlin, and by a number of German mechanicians.

Finally, any general account of the Congress would seem incomplete without a word of commendation for the General Secretary, Dr. Frhr. von Schrenk-Notzing, to whose energy and work much of the success of the general gatherings is due.

Shepherd Ivory Franz.
Columbia University.

THE PRINCETON SESQUICENTENNIAL.

There are probably no other institutions so enduring as those devoted to the advancement of education and learning. Governments come and go, while universities maintain their continuity. The College at Princeton has a long and honorable history and it was fitting that the hundred and fiftieth anniversary of its foundation should have been celebrated with unusual magnificence. Our readers are already fully informed of the nature of the ceremonies by the detailed accounts published in the daily papers. It is, however, fitting that we should record in this Journal the events of scientific significance.

Dignity was given to the celebration by a series of lectures during the preceding week. As we have already noted, the sciences were admirably represented; mathematics by Prof. Felix Klein, of Göttingen; physics by Prof. J. J. Thomson, of Cambridge, and zoology by Prof. A. A. W. Hubrecht, of Utrecht. Lectures in philology, literature and philosophy, were given by Prof. Karl Brugmann, of Leipzig; Prof. Edward Dowden, of Dublin, and Prof. Andrew Seth, of Edinburgh. Many American men of science and scholars were present at Princeton during the week to attend the lectures and the meeting of the American Mathematical Society on Saturday.

The ceremonies last week extended over three days. On Tuesday morning the President of the University, Dr. Patton, preached a special sermon, and in the afternoon official receptions were given to the delegates. On Wednesday Prof. Woodrow Wilson made an oration choosing as his theme 'Princeton in the National Service,' and Rev. Dr. Henry van Dyke read a poem entitled 'The Builders.' On Thursday President Patton made the formal announcement of the change in the insitution's title from *The College of New Jersey* to *Princeton University*, and announced the gifts that had been contributed in honor of the Sesquicentennial. These amount to more than $1,300,000. The two largest sums, $600,000 for the library building and $250,000 for a purpose not yet announced, were given by donors whose names are still withheld. The library building is already in course of erection and will be one of the finest university buildings in America. Several fellowships have also been founded, and it is expected that the graduate departments will be otherwise enlarged.

President Cleveland made an address in which he dwelt on the importance of the universities and of educated men in their relation to the national life.

The degree of LL. D. was conferred on 36 of the delegates, including the Presidents of Johns Hopkins, Columbia, Pennsylvania and other universities and the following men of science:

A. A. W. Hubrecht, professor of zoology in the University of Utrecht, Utrecht, Holland.

Felix Klein, professor of mathematics in the University of Göttingen, Göttingen, Germany.

Henri Moissan, professor of chemistry in the University of Paris, and member of the Academy of Sciences, Paris.

Edward Baynall Poulton, Hope professor of zoology in the University of Oxford, Oxford, England.

Andrew Seth, professor of logic and metaphysics in the University of Edinburgh, Scotland.

Joseph John Thomson, Cavendish professor of physics in the University of Cambridge, Cambridge, England.

J. Willard Gibbs, professor of mathematical physics in Yale University, New Haven, Conn.

George Lincoln Goodale, Fisher professor of natural history and director of the botanical garden in Harvard University, Cambridge, Mass.

Hon. William T. Harris, United States Commissioner of Education, Washington, D. C.

George William Hill, President of the American Mathematical Society, West Nyack, N. Y.

Professor Herman von Hilprecht, professor of Assyrian and comparative Semitic philology and curator of Babylonian antiquities in the University of Pennsylvania, Philadelphia, Pa.

William James, professor of psychology in Harvard University, Cambridge, Mass.

George T. Ladd, Clark professor of moral philosophy and metaphysics in Yale University, New Haven, Conn.

S. P. Langley, secretary of the Smithsonian Institution, Washington, D. C.

Joseph LeConte, professor of geology and natural history in the University of California, and president of the American Geological Society, Berkeley, California.

John W. Mallet, professor of chemistry in the University of Virginia, Charlottesville, Virginia.

Silas Weir Mitchell, Philadelphia, Pa.

Simon Newcomb, mathematical astronomer, Nautical Almanac, Navy Department, Washington, D. C.

Ira Remsen, professor of chemistry and director of the chemical laboratory in the Johns Hopkins University, Baltimore, Md.

Henry A. Rowland, professor of physics and director of the physical laboratory in the Johns Hopkins University, Baltimore, Md.

The degrees of Doctor of Divinity and of Doctor of Letters were also conferred on a number of delegates, and the degree of Doctor of Music on Prof. E. A. MacDowell, of Columbia University. The LL. D. was conferred, *in absentatia*, on Lord Kelvin, professor of natural philosophy in the University of Glasgow, Scotland, and Otto Struve, formerly director of the observatory of Pulkowa, Russia, and a congratulatory cablegram from Lord Kelvin was read.

In the evening a dinner was given to about three hundred guests. There were eight toasts: 'Theology,' responded to by G. P. Fisher; 'Philosophy,' by Andrew Seth; 'Jurisprudence,' by William B. Hornblower; 'Mathematics,' by F. Klein; 'The Physical Sciences,' by Ira Remsen; 'The Natural Sciences,' by A. A. W. Hubrecht; 'History,' by Goldwin Smith, and 'Literature,' by Edward Dowden.

The pagentry of the celebration was carried out with unusual impressiveness. There were processions, concerts and athletic contests, taken part in by hundreds of alumni, students and invited guests. Princeton University may be congratulated on the enthusiasm of its friends as well as on the admirable arrangements which made the celebration notable as an educational, literary and scientific event.

CURRENT NOTES ON ANTHROPOLOGY.

THE BLACK RACE OF SUSA.

ONE of the most interesting questions in the ethnography of ancient Babylonia is the presence there of a black race. They seem to be referred to in various inscriptions of the first and second millenium B. C. as 'black heads;' and some of the human figures carved in relief are negroid, especially those from ancient Susiana.

Many writers, as Conder, Schurtz and de Quatrefages, have maintained that they were the vestiges of a primitive black race which in prehistoric times occupied most of southern Asia.

It has been generally stated that the only negroid people now west of the Indus are the Brahus, in the Khanate of Celat, whose language allies them to the Dravidas. Dr. Daniloff, however, recently made a communication to the Anthropological Society of St. Petersburg on the ethnography of Persia, in which he mentioned these 'Susians' as still forming an independent group, located among the mountains north of Shiraz. Many of them seek employment at a distance, and they are not rare in Teheran. It would be most interesting to study them carefully, and to obtain the relics of their peculiar language, if it still exists.

THE EARLIEST RELICS OF MAN IN FRANCE.

THE '*Revue Mensuelle*' of the Paris School of Anthropology for September contains a careful article by M. d'Ault du Mesnil on the palæolithic deposits of Abbeville. It is the most exact stratigraphic and palæontologic examination of this celebrated site which has yet appeared, and is the result of several years close study of the excavations.

There can be no doubt but that the oldest and rudest forms of implements date back to a period when the *Elephas antiquus* and *Elephas meridionalis* were abundant in that area. The artificially chipped stones from that ancient layer are large, almond-shaped, and often dressed on one side only. As the deposit is traced upward, the improvement in the artefacts is apparent and their number increases. The primitive forms continue to be present, that is, the tribes did not abandon the older models, but at each epoch new and higher forms and more careful technique appear. The relative age of these deposits can be fixed by the abundant remains of the fauna associated with them.

Whatever doubt may have persisted in the minds of some about the Abbeville relics must disappear after a close reading of this article.

THE MAN IN THE MOON.

In the *Correspondenz-Blatt* for July, of the German Anthropological Society, R. Behla has a curious study on the notions of various peoples as to what we see in the moon. These notions are strangely divergent. In most European nations there is a fancy that in the full moon there are the features of a human face, and hence the tales about 'the man in the moon.'

On the other hand, very widely throughout Asia, in both Aryan and Mongolian folklore, not a human being, but a hare, or rabbit, is believed to be seen, sitting on his haunches, in the orb of the moon. This also recurs among the Mexican Aztecs, though in South America again, among some Brazilian tribes, the man in the moon reappears.

In English and the Romance languages the moon is regarded as feminine, as was also the case among the Semites; but in German it is a masculine noun. This is usually the case among savage tribes, and often with them the sun is female, the wife or sister of the moon, and his inferior.

Behla adds some words on the importance of a more thorough comparative study of superstitions regarding the moon than we have at present. D. G. Brinton.

University of Pennsylvania.

CURRENT NOTES ON METEOROLOGY.

ATMOSPHERIC ELECTRICITY AND TELEPHONES.

An interesting paper by Trabert, on the crackling of the telephone on the Sonnblick, appears in the Fourth Report of the Sonnblick Verein. The Sonnblick, it may be stated, is one of the best known mountain observatories in the world, by reason of its height (10,154 ft.), and especially by reason of the valuable results which have been derived by Hann and others from the observations there made. For six years five observations a day have been made of the intensity of the crackling in the telephone at the summit. It appears from these data that in December the minimum crackling is at noon, with the maximum at 9 p. m., and a secondary maximum at 7 a. m., while in June there is a steady increase in the intensity of the noise from 7 a. m. to 9 p. m., without a noon minimum. The other months of winter and summer follow respectively the same rule as December and June, while the intermediate months, as expected, present the intermediate conditions. Further, the noise is greater in summer than in winter. Regarding the explanation of these phenomena, the author finds it chiefly in the presence of atmospheric electricity in the clouds over the Sonnblick, for there is a very striking correspondence between the crackling and the cloudiness on the summit, not only in the diurnal period, but in the annual as well. The days on which there is the greatest intensity of crackling are almost invariably distinguished by cloudiness, rain, snow or thunderstorms. The part played by earth currents must not be overlooked, for on one cloudless anticyclonic day there was a very well marked crackling, which could not be explained as being due to atmospheric electricity.

WEATHER FORECASTS SEVERAL DAYS IN ADVANCE.

An elementary discussion of the controls of the weather of central Europe, with suggestions as to weather forecasts for several days in advance, has recently been issued by Dr. van Bebber. It is entitled *Die Beurtheilung des Wetters auf mehrere Tage im Voraus* (Stuttgart, Enke, 1896). Five principal weather types are considered, depending chiefly on the position of the areas of high pressure. The weather conditions which these types usually bring are described, and the increased or decreased frequency of the types at different seasons is noted. The position of the cyclonic tracks and their dependence on the general (seasonal) distribution of pressure and of temperature over Europe and the Atlantic Ocean are seen to be controlling factors in the production of the different weather types.

THE FIRST DAILY WEATHER MAP.

ONE of the important dates in meteorology, about which there has been a good deal of dispute lately, is that which marks the issue of the first daily weather map. The credit of having been the first to publish such a map has been generally given to Le Verrier, who, on September 16, 1863, began the issue of a daily weather map in Paris. It is a fact, however, that twelve years before that, in 1851, a weather map based on observations made on the day of its publication was issued and sold in the Great Exhibition in England. The data for the map were collected by telegraph, and its publication was continued from August 8 to October 11, 1851, Sundays excepted. This was without doubt the first daily weather map. The September number of *Symons' Meteorological Magazine* contains a reproduction, about one-quarter the size of the original, of the Great Exhibition map of August 8, 1851.

R. DEC. WARD.

HARVARD UNIVERSITY.

NOTES ON INORGANIC CHEMISTRY.

A NEW element appears to have been discovered in monazite, to which the discoverer, P. Barrière gives the name *Lucium.* It is closely akin to the rare earths, perhaps most resembling erbium, though with quite different spectral rays. Its atomic weight is calculated as 104. The elementary nature of the substance is reported to have been confirmed by Schützenberger, Cleve, Fresenius and Boisbaudran. The only thing which seems to render the discovery questionable is that Barrière proposes to use the substance for the production of incandescent gas light in competition with the Welsbach burner and without infringing upon the patents which practically cover the use of all the rare earths now known.

IN a recent number of the Comptes Rendue, Moissan has summed up his researches on metallic carbids. In the electrical furnace no compounds with carbon could be formed with gold, bismuth or tin. Silver and the platinum metals take up carbon, but all separates out as graphite on cooling. No crystallized iron carbid could be formed. Copper takes up a trace of carbon only, but it materially effects its properties. The metals of the alkalies and alkaline earths form crystalline carbids which are decomposed by cold water with the evolution of acetylene. The carbids of aluminum and glucinum with water give off methane; the carbid of cerium, acetylene and methane; the carbid of manganese, methane and hydrogen; the carbid of uranium, methane, hydrogen and ethylene. The latter also gives off liquid and solid hydrocarbons in considerable quantity, as do in smaller quantities, the carbids of cerium and lanthanum. The carbids of molybdenum, tungsten and chromium fuse only at high temperature and are not acted on by water in the cold. In addition the carbids of silicon (carborundum), titanium, zirconium and vanadium, formed only at very high temperature are known. The fact of the formation of different hydrocarbons by the action of water upon the metallic carbids may have a decided bearing on the formation of petroleum and natural gas, and other hydrocarbons occurring in nature.

ROSSEL has followed up the researches in which Moissan found that the carbon of iron which had been saturated at 3000° and cooled under great pressure, crystallized out in small diamonds. Examining very hard steel, formed under similar conditions, Rossel finds a considerable quantity of crystallized carbon, which resembles Moissan's diamonds. Some of these crystals are more than half a millimeter in diameter.

J. L. H.

ASTRONOMICAL NOTES.

The *Astronomische Nachrichten* of October 5 contains an extended article by Dr. Paul Harzer upon the influence of gravity on the circles of astronomical instruments. This subject, which was treated by Bessel in the last paper he ever wrote, seems to possess theoretical rather than practical interest.

The Academy of Sciences of St. Petersburg has published a careful investigation of the errors of a micrometric apparatus constructed for the Academy by the Messrs. Repsold. The apparatus is intended for the accurate measurement of astronomical photographs, and its investigation has been carried out at the Poulcova observatory by Messrs. Renz and Kostinsky.

The Washburn Observatory has issued Vol. X., Part I of its publications. It contains Prof. Comstock's observations of double stars made between the years 1892 and 1896.

H. J.

SCIENTIFIC NOTES AND NEWS.

The great physiologist, Dr. Moritz Schiff, professor at Geneva, died on October 6th.

Dr. M. W. Drobisch, professor of philosophy in the University of Leipzig, died on September 30th, at the advanced age of 94 years. Drobisch was one of the most eminent of Herbart's followers, and had made contributions to mathematics as well as to philosophy.

François Felix Tisserand, director of the Paris Observatory, professor of astronomy in the Paris faculty of sciences, and member of the Institute, died from apoplexy at Paris on October 20th. Tisserand was born January 15, 1845. He was assistant in the Paris Observatory and was appointed director of the Observatory of Toulouse and professor in the faculty of sciences in that city in 1873. He was appointed first professor of mechanics at Paris, and later professor of astronomy. He was made director of the Paris Observatory in 1892, in the place of the late Admiral Monchez.

The Australian geologist, Baron Heinrich Freiherr von Foullon-Norbeeck, was killed on August 10th by natives on the island of Guadalcanara, one of the Solomon group. He had landed with a party from the German warship *Albatross*, to explore the mountains of the island, when the party was attacked and Foullon-Norbeeck, as well as three sailors and a guide, were killed. He was born in 1850, and was at the time of his death chief geologist of the geological bureau at Vienna.

Dr. Theodore Marbe, professor of zoology at Buda-Pesth, died on September 5th at the age of 80 years. He was known especially for histological researches on muscles and nerves, but had also made contributions to zoology, and had formed in the University at Buda-Pesth a laboratory of zoology and a museum of comparative anatomy.

Baron Sir Ferdinand von Müller, the eminent botanist, died at Melborne on October 9th. From the London *Times* we take the following facts: Müller was born at Rostock in Germany, in June, 1825. He obtained a training in pharmacy and in his leisure time devoted himself to the study of botany and chemistry. In 1846–47 he studied at the University of Kiel, where he took the degree of Ph.D. For several years he investigated the botany of Schleswig and Holstein. In 1847, in order to counteract a hereditary tendency to phthisis, he emigrated to Australia, and at once entered upon those labors for the exploration and development of the continent which have only ceased with his death. From 1848 to 1852 he traveled over 4,000 miles, mainly for botanical purposes. In 1852 he was appointed government botanist to the colony of Victoria. In 1855–56 he accompanied as botanist the expedition under the command of A. C. Gregory for the exploration of north and central Australia, and was one of the four to reach Termination Lake, in central Australia. Some 6,000 miles of previously unknown land was traversed, and abundant collections made of the various forms of vegetation. On Müller's return to Melbourne he was appointed director of the Botanical Garden of that city. His travels in Australia for botanical purposes, on foot and on horseback, covered some 25,000 miles. He was a voluminous author, and his writings are mostly of a strictly scientific character. The titles of over a hundred papers by Müller are given in the Royal Society's List. His 'Fragmenta Phytographiæ Australiæ' covers a dozen volumes. He coöperated with the late Mr. Bentham in compiling the 'Flora Australiensis,' which extends to several volumes. He is also the author of works on the 'Plants of Victoria,' on eucalyptus and on other botanical subjects.

Dr. Max Müller, son of the great physiologist Johannes Müller, himself an eminent surgeon and the author of important contributions to the science, died at Cologne on September 3d.

Dr. C. E. Brown-Sequard, the only son of the late eminent man of science, and himself engaged in scientific work, has died at Atlanta, Ga., at the age of 30 years.

The Fourteenth Congress of the American Ornithologists' Union will convene in Cambridge, Mass., on Monday, November 9th, 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 10th, at 10 a. m., and continuing for three days. Information regarding the Congress can be had by addressing the Secretary, Mr. John H. Sage, Portland, Conn.

The German Botanical Society met at Frankfort-on-Main on September 22d. The French Association of Surgeons met at Paris on October 19th.

According to *Nature* Dr. H. O. Forbes, in an inaugural address delivered before the Biological Society of Liverpool on Friday last, urged the amalgamation of all the local societies interested in biological science. He suggested that such a conjoint society meeting in some central place and to be called, perhaps, the Biological Institute of Liverpool, or the Liverpool Institute of Natural Science, or if all the scientific societies could be induced to unite, the Royal Society of Liverpool, as was the suggestion, some ten years ago, of Prof. Herdman, might be instituted on the model of the New Zealand Institute. Such a combined society in Liverpool would command wider recognition, and contribute more to the advancement of science, than is at present possible with disjointed forces. Dr. Forbes also expressed the hope that two other scientific institutions of the highest educational value, urgently required in a city like Liverpool—a zoological garden and a resuscitated botanical garden under a trained botanist, both conducted in a thoroughly scientific manner—might be accomplished facts before the end of this century.

M. Henri Moissan gave, on the evening of October 27th, at the College of Physicians and Surgeons, New York, a lecture, with experiments, on his researches with the electric furnace, by invitation of the New York Academy of Sciences, the New York Section of the American Chemical Society, the American Institute of Electrical Engineers, the College of Pharmacy of the City of New York, and the New York Section of the Society of Chemical Industry. On the evening of October 28th a banquet was given in New York in honor of M. Moissan.

Dr. Heinrich Kayser, professor of physics in the University of Bonn, has just returned to Germany, after having spent six weeks in America, making studies in astrophysics and spectroscopy.

Hon. Bertrand Russell, fellow of Trinity College, Cambridge, has arrived in America, and will deliver a course of lectures on *Non-Euclidean Geometry*, at Bryn Mawr College and at Johns Hopkins University.

Mr. Charles D. Walcott, director of the United States Geological Survey, is at present on the Pacific coast, where he is making an inspection of the work accomplished during the summer and arranging for the future conduct of the surveys.

Prof. Phillips, of the mathematical department of Yale University, will revise the series of mathematical text-books of the late Prof. Loomis.

Dr. E. R. L. Gould, professor of statistics in the University of Chicago, has prepared, at the request of Mayor Strong, a plan for a bureau of statistics for Greater New York. The commission will be asked to include it in the new city charter.

Dr. Herbert S. Jennings has been appointed to the Smithsonian Table at the Naples Zoological Station for three months. Prof. Francis H. Herrick will occupy the table during the month of November.

At the recent meeting of the British Association Mr. R. T. Glazebrook read the report of the Committee on Electrical Standards, which has had under consideration a thermal unit. The Committee in question issued circulars to authorities on the measurement of heat in other countries, and received many written opinions on the matter. Most of the writers wish to see some multiple of the erg adopted as the theoretical unit, but there are differences of opinion as to the multiple to be chosen. There is a fairly general agreement that as a practical unit the heat required to raise one gramme of water 1 deg. Centigrade must be taken, but views differ as to the initial temperature of the water. The weight of opinion is also in favor of the hydrogen thermometer being used for temperature measurements. The committee learn that a committee of the French Physical Society have the question at present under consideration, and suggest an international discussion on the subject.

The German Hygienic Association offers a prize of $1,200 for a research essay on the efficiency of electric heaters.

The Bender Hygienic Laboratory, of the Albany Medical College, was dedicated on October 27th. The building was formally presented to the Board of Trustees by Mr. H. H. Bender in the name of the doner, Mr. Matthew W. Bender, and addresses were made by Dr. George E. Gorham and Prof. A. Jacobi.

The Baltimore Naturalists' Field Club, which is composed of instructors and advanced students of the biological department of Johns Hopkins University, has elected Dr. C. P. Sigerfoos as President. Dr. F. S. Conant is chairman of the zoological section, Dr. J. E. Humphrey of the botanical section, and Dr. R. M. Bagg of the geological section. The Club holds field excursions on Tuesday afternoons during the autumn and spring.

The proposed mathematical club at the University of Pennsylvania has now been organized. Prof. Doolittle has been elected President; Prof. Goodspeed, Vice-President, and Prof. Crawley, Secretary. The club will meet once a month.

The Yerkes Observatory is now nearing completion, and about half of the faculty of the astronomical department of the University of Chicago will hereafter be in residence there.

The Dominion government is making a thorough survey of the currents in the Gulf of St. Lawrence. During the present season the steamship *Lansdowne*, of the marine department, has been engaged in studying the eastern arm of the gulf from Anticosti to Belle Isle, and in the almanacs of the present year tide-tables are given from the records obtained.

Mr. Lucas reports the capture of a specimen of the Ribbon Seal, *Histriophoca equestris*, in Bering sea. The individual, a young female, was taken by one of the sealing schooners about 84 miles due west of St. Paul Island, a very southern locality for this species, especially in August, when the capture was made.

Prof. L. H. Bailey has prepared a report for the Commissioner of Agriculture regarding the State appropriation, amounting to $32,000, for extending university instruction in horticulture. The work consists of the issue of bulletins for the benefit of farmers, of experiments on model farms, intended for imitation in the district, and the holding of district schools. Prof. Bailey wishes to extend further the work so that nature study may be taught in all normal schools and introduced in district schools. He recommends the establishment of a State bureau for correspondence and instruction, and wishes the teachers in the schools to cooperate with the farmers in the study and improvement of agricultural methods.

Dr. Woodhead read a paper at the Liverpool meeting of the British Association on the 'Organization of Bacteriological Research in Connection with Public Health,' which was regarded as of special interest. He said that while continental laboratories were supported by the State, in England they received practically no government support, and very little from the community, usually depending on the generosity of single individuals. As a result they were undermanned, and a large amount of public health work from which the community would profit remained undone. Each municipality should endow a laboratory, in which, besides original research, work required by the medical officer of health and the sanitary authorities could be done. The scheme he submitted presented very few difficulties. In the discussion that followed Prof. Haycraft mentioned that a commencement had already been made in South Wales. Dr. Hope thought it might soon be in operation in Liverpool, and Prof. Delepine described the arrangements already in existence in Manchester.

A PRIZE of £50, to be called the *Welby Prize*, is offered for the best treatise upon the following subject: The causes of the present obscurity and confusion in psychological and philosophical terminology, and the directions in which we may hope for an efficient practical remedy. Competition is open to those who, previously to October 1, 1896, have passed the examinations qualifying for a degree at some European or American university. The donor of the prize desires that general regard be had to the classification of the various modes in which a word or other sign may be said to possess 'meaning,' and to corresponding differences in the conveyance or interpretation of 'meaning.' The Committee of Award will consider the practical utility of the work submitted to them as of primary importance. The essays, which may be written in English, French or German, must be typewritten and extend at least to 25,000 words. They should be headed by a motto and accompanied by a sealed envelope containing the name of the writer. Manuscript from America should be sent to Prof. E. B. Titchener, Cornell University, Ithaca, N. Y., and must reach him not later than October 1, 1897. Other members of the committee are Prof. James Sully, London; Mr. G. F. Stout, Aberdeen, and Prof. O. Külpe, Würzburg.

UNIVERSITY AND EDUCATIONAL NEWS.

A DESPATCH from San Francisco says that the University of California is to be made richer by $4,000,000 by donations from various persons, chief among whom is Mrs. Phœbe Hearst, widow of Senator Hearst, of California. This amount is not to be given all at one time, but will be paid as soon as the State is prepared to make proper use of the money. The State must spend $500,000 on buildings, and when this is done the gifts will be paid. These facts became known at the meeting of the Board of Regents of the University when Mrs. Hearst sent a note to the board donating $15,000 to be used in securing plans for new buildings. Mrs. Hearst stated that she would erect two buildings at her own expense, one of which would be a memorial to her late husband. The names of others who will give funds are withheld.

FROM notices in the daily papers it appears that the registration at several universities is as follows: Yale, 2,515, an increase of 100 over last year; Columbia, 1,760, an increase of 130; Cornell, 1,720, an increase of 109; Chicago, 1,126, an increase of 17; Massachusetts Institute of Technology, 1,184, an increase of 12.

THE corner stone of Brinckerhoff Hall and Millbank Hall, of Barnard College, were laid on October 24th. The corner stone of Brinckerhoff Hall was laid by the Dean of the College, representing Mrs. Van Wyck Brinckerhoff, and the corner stone of Millbank Hall was laid by Miss Eleanor Millbank Anderson. Addresses were made by President Low, of Columbia University; by Mr. Silas B. Brownell and by Bishop Potter.

THE corner stone of the Hall of History of the American University, at Washington, was laid on October 21st. An address was made by Bishop John F. Hurst, Chancellor, and by other prominent leaders in the Methodist Church. The building is to be built of white marble in Ionic style, and is the first of the six buildings that have been planned.

THE board of directors of the Catholic University at Washington have chosen as nominees for the office of rector of the University, Rev. Father T. J. Conaty, rector of the Sacred Heart parish of Worcester, Mass.; Rev. Father Daniel Riordan, pastor of St. Elizabeth's parish, Chicago, and Rev. Father Joseph F. Mooney, vicar-general of the diocese of New York, and from these the Pope will select the rector, who will probably be the first recommendation of the board. The board of directors decided that the term of rector should be limited to six years.

The will of the late P. B. O'Brien, of New Orleans who died a few days ago, leaves $150,000 to the Catholic University at Washington to endow three chairs.

DISCUSSION AND CORRESPONDENCE.

HALSTED ON THE STRAIGHT.

Having returned from Russia so recently as not yet to be abreast of our current scientific literature, it is to the courtesy of the editor of Science that I owe my knowledge of the appearance in that journal of an important note by Prof. Fiske, headed 'The Straight Line as a Minimum Length.'

This note is right in maintaining that for the comparison of non-congruent lines, *e. g.*, the straight and circle, an assumption in addition to those of Euclid is essential. The strange thing about it is that in stating what Prof. Halsted 'appears to believe,' Prof. Fiske credits me with ignorance of the very principle which I of all the geometers have set forth most strenuously. To attract particular attention to it, I, in my Elementary Synthetic Geometry put it in the following somewhat bizarre form :

"In accordance with our definition of equivalent magnitudes, as such as can be cut into pieces congruent in pairs, no arc can be equivalent to a sect [piece of a straight]."

For the sake of comparison we make the following assumptions :

1. No arc is less than its chord.

2. No minor arc is greater than the sum of two tangents from the same point to its extremities.

By these paradoxal assumptions we attribute length to the curve, and can, *e. g.*, evaluate the circle in terms of its diameter to any desired degree of approximation."

George Bruce Halsted.

THE CURVE-TRACING TOP.

Editor of Science: In your issue of October 9th, Mr. Warring refers to the very interesting and instructive article by Prof. Barus on the curve-tracing top or 'gyrograph,' which article appeared in Science on September 25, 1896. Mr. Warring suggests as an improvement in the apparatus that, instead of a lead pencil and paper arrangement, a smoked glass be used, the plate to be afterwards flowed with thin varnish. I would suggest, as a further modification, a very simple process which I have found of great convenience and service in a number of self-registering and tracing devices. Long ago I discarded the use of smoked glass in favor of glass plates coated with a thin layer of printer's ink. The ink can be applied with an ordinary hand-press roller, and can be distributed with almost perfect uniformity. The plate so prepared should receive the tracing while the ink is wet; then by exposure to the air the ink dries and the record is comparatively permanent. Such a plate may be used as an ordinary photographic negative in making blue prints or silver paper copies.

Jas. E. Talmage.

University of Utah,
Salt Lake City, Utah.

GEOLOGY IN THE COLLEGES OF THE UNITED STATES.

In the discussion and correspondence of October 2d, Mr. F. W. Simonds, of the University of Texas, discusses Prof. T. C. Hopkins' report on this subject. It seems to me that Prof. Simonds treats altogether too severely those smaller colleges which still give courses in his judgment inadequate. It is scant justice to class all those who do not furnish contributions to geological literature as amateurs. It does not follow that a teacher who is occupied with details of administration to the exclusion of authorship is not quite as good a teacher as another who may contribute many papers.

The contention that geology is a subject of as great disciplinary value as the other sciences no one will dispute.

The situation in the smaller colleges is something like this: Many of them are unable to develop all lines of scientific work in a disciplinary form. They have quite generally followed a plan which has so good a warrant as the example of the Johns Hopkins University. The biological work was there developed along zoological lines while the botanical remained in a condition perhaps to be termed inadequate. It certainly seems better to place some lines of instructions upon a fairly adequate basis than to make all inadequate by trying to cover them all. If geology cannot be taught as a matter of discipline without sacrificing biological, chemical or physical instruction, should it be excluded altogether? I cannot think so, geology has a value as information and may be so imparted as not to give the student any undue sense of having learned all that can be learned. That it is so treated in many of our colleges and that the results are good I wish to bear most emphatic testimony. Few institutions can feel that they are accomplishing all that they would like to do. It is, however, true that in many a small college teachers of real power and inspiration are sacrificing the opportunity to make themselves known and recognized in their sciences in order that they may make their instruction more adequate. That they are succeeding is clearly evidenced by the steady stream of men who are passing from their institutions in the graduate courses of the universities.

L. W. CHANEY, JR.

CARLETON COLLEGE,
NORTHFIELD, MINN.

SCIENTIFIC LITERATURE.

Life Histories of North American Birds, from the Parrots to the Grackles, with special reference to their breeding habits and eggs. By CHARLES BENDIRE, Captain and Brevet Major U. S. A. (Retired). Smithsonian Contributions to Knowledge. Large 4to, pp. 518, col. pls. 7. Dated 1895; published September, 1896.

Probably no work on American birds since Audubon's Ornithological Biographies has been looked for with greater eagerness than the second volume of Bendire's 'Life Histories of North American Birds.' The first volume was a surprise, both to ornithologists and to the public. A good book was expected, but no one was prepared for the great mass of new information it contained or for the high technical knowledge shown in its preparation. The colored plates of eggs were the finest ever produced, and the demand for the work was so great that, although sold at the relatively high price of $7.50, the edition was soon exhausted. Naturally, the appearance of the second volume has been anxiously awaited by all classes of bird lovers from the technical ornithologist to the popular observer. On running over its handsome pages one is impressed by the fact that it is even better than the first, and that the plates also, if possible, are superior.

The scope of the work is comprehensive. All of the birds of the American Continent occurring north of Mexico are included. The first volume contained 416 large quarto pages and 12 colored plates, and treated of the Grouse, Pigeons, Hawks and Owls—146 species and subspecies in all. The present volume comprises 518 pages and 7 colored plates of eggs. It treats of the Parrots, Cuckoos, Anis, Roadrunner, Trogon, Kingfishers, Woodpeckers, Nighthawks, Poor Wills, Swifts, Hummingbirds, Flycatchers, Larks, Magpies, Jays, Crows, Orioles and Blackbirds—in all about 200 species and subspecies. The classification and nomenclature of the A. O. U. Check List are followed and references are given to the first name of the species and to the combination adopted. Following this brief synonomy is a complete concordance to the numbers the species bears in each of the five check lists from Baird's original list of 1855 to the American Ornithologists' Union list of 1895. The geographic range of the species is then summarized in a brief paragraph and is afterward given in greater detail, along with the dates of arrival at different points in its migratory range, the relative abundance of the species in different localities, and the local names by which it is known. Much attention is given to food and breeding habits, the accounts of which are graphically written and, as a rule, form the greater part of the biographies. Except in the very few instances in which the eggs are unknown, the history closes with a description of the nest and eggs, with average, maximum and minimum measurements (both in millimeters and inches).

The greater part of Major Bendire's life has been spent in the West, where, as a military officer, he has been stationed at remote outposts from the Mississippi Valley to the Pacific Coast, and from Arizona to Oregon. During his army life he took part in various Indian wars and had command of various exploring expeditions, traveling thousands of miles on horseback over the deserts and mountains of the far west. He thus had very exceptional opportunities for the study of birds in the field. On his retirement from the army he came east, at the solicitation of Prof. Baird, and was made Honorary Curator of the Department of Oology in the United States National Museum, which position he still holds. When he came he brought with him the largest and most valuable collection of birds' eggs ever gathered by one person in America, a collection numbering about 15,000 eggs.

Professor Baird, knowing the extent and value of Major Bendire's field notes, asked him to write a work on our birds, with special reference to their breeding habits, but unhappily did not live long enough to see even its beginning.

Since coming east Major Bendire has spent several summers in the field, chiefly in the Adirondack region in northern New York, thus supplementing his knowledge of the habits of western birds by studies of our eastern species. He is a keen observer and his wide field experience has made him personally familiar with nearly all the species of which he writes. In addition to his own notes he has secured from others a large mass of unpublished manuscript prepared expressly for the present work. The quantity of this original contributed matter is surprising and is vastly greater than that brought together by any author since the time of Audubon.

The work does not require comparison with any other, because no other covers the same ground. It is not in any sense a technical treatise and does not contain descriptions of the birds themselves, though in the case of closely related geographic races the points of difference are often clearly stated. On the other hand, unlike the works of Audubon and Wilson, it contains little in the way of personal narrative, although now and then the pages are enlivened by an anecdote or entertaining bit of personal experience. So far as the geographic distribution, food habits and breeding habits go, it is not too much to say that the work fairly represents the state of knowledge on these subjects at time of going to press. The proofs of the second volume were read more than a year ago (in June 1895) and the book is dated 1895, but through unfortunate delays in the Government printing office, it did not appear till September of the present year (1896). The reprehensible practice of some of the departments of Government of permitting their publications to bear a date a year or more anterior to the actual date of publication, cannot be too strongly condemned.

Bendire's 'Life Histories' is the only book ever published that contains reliable 'down to date' accounts of the food habits and breeding ranges of our birds, with descriptions of their nests and eggs. Special attention has been given to the geographic distribution of the various species, but the ranges are defined by means of political and geographical boundaries without reference to the faunal areas. The work as a whole is indispensable to students of North American birds and will long remain the standard authority on the subjects of which it treats. Both the author and the Smithsonian Institution are to be congratulated on the excellence of the colored plates, which were drawn by John L. Ridgway and reproduced by Ketterlinus.

C. H. M.

Economic Entomology for the Farmer and Fruit Grower, and for Use as a Text-book in Agricultural Schools and Colleges. By John B. Smith, Sc. D. J. B. Lippincott Company, Philadelphia. 1896.

Dr. Smith's experience as a teacher of economic entomology and as an investigator in this field has eminently fitted him for the authorship of this volume, just received from the press. Entomologists have been very fortunate during the past two years in witnessing the publication first of Comstock's admirable 'Manual for the Study of Insects,' second, Dr. Sharp's excellent consideration of the class 'Insecta' in Volume V. of the Cambridge Natural History and lastly of the volume now before us. Dr. Smith, in writing specifically for the farmer and fruit grower, and for the students in agricultural colleges and schools has covered a restricted ground and it goes without saying that he has done it well. In fact, it is difficult to see how it could be bettered. The volume is compact, abundantly illustrated, and contains nothing that is unnecessary. At the same time, it may almost be said that it omits nothing that is necessary, when we consider its especial objects. To cover the whole subject in a volume of less than 500 pages, using, at the same time, nearly 500 text figures, necessitates the most careful selection of material, yet so excellently has this been done and so happily has the text been prepared that there is on the one hand no appearance of forced condensation and on the other no semblance of superficiality. The illustrations for the most part have been borrowed, from which it results that there is great lack of uniformity in their excellence, some of them being extremely good and others very poor. The author evidently endorses the idea that a poor illustration, if not absolutely incorrect, is better than none. Nevertheless, it seems to us that such figures as those of *Agallia sanguinolenta*, *Anasa tristis*, *Necrophorus Americanus*, *Silpha Americana*, *Edema albifrons*, *Cacoecia rosaceana*, *Bibio albipennis*, *Ceraphron triticum* and perhaps a dozen others, should have been redrawn for a work of so many other excellencies. The author has made use of photography in some of his illustrations, but it must strike every one in glancing at his plate of bees, for example, that this method of illustration is only of value where great pains have been taken with the prior mounting and preparation of the subject.

These slight blemishes, however, detract little from the value of the book, which will undoubtedly soon be in the hands of every teacher of economic entomology in the country, and, let us hope, of very many of the rapidly growing class of scientific farmers and fruit growers.

L. O. HOWARD.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCE; BIOLOGICAL SECTION, OCTOBER 12, 1896.

DR. BASHFORD DEAN and Mr. G. N. Calkins presented preliminary reports upon the results attained at the Columbia University Zoological Laboratory at Port Townsend, Washington. The expedition spent about six weeks in exploring and collecting, and brought home large collections from exceptionally favorable collecting grounds. Dr. Dean spent some time at Monterey, Cal., and brought home collections of eggs and embryos of *Chimaera* and *Bdellostoma*.

Dr. J. L. Wortman made a preliminary report upon the American Museum Expedition to the Puerco and Wasatch beds. He reported finding a connecting link between the close of the Cretaceous and the beginning of the Tertiary. He gave an interesting account of the massive ruins of the so-called cliff dwellers in the region visited by him. In the Big Horn basin the expedition had remarkable success, as well as in the Wind River basin.

Prof. Osborn stated that with the collections made this summer the American Museum could now announce that their Eocene collection was complete, containing all mammals now known in the Eocene; that their collection from the Wasatch bed was the finest in existence and that from the Wind River basin was complete; the Bridger was represented by all but two or three types, and fine collections have been made in the Uinta.

Mr. W. J. Hornaday made a report of a tour of inspection of foreign zoological gardens, made under the auspices of the New York Zoological Society. He visited fifteen gardens in England and on the Continent, studying the features of excellence in each.

Prof. Bristol gave a brief account of the progress at the Marine Biological Laboratory at Wood's Holl, Mass., during the past summer.

Prof. Osborn offered the following resolution on the death of Prof. G. Brown Goode, after paying a tribute to his memory:

Resolved, That the members of the Biological Section of the New York Academy of Sciences desire to express their deep sense of loss in the death of Prof. G. Brown Goode, of the U. S. National Museum. In common with all naturalists in this country, we have admired his intelligent and highly successful administration of the National Museum, as well as his prompt and ready response to the requests and needs of similar institutions throughout the country.

In face of the arduous and exacting duties of his directorship he has held a leading position among American zoologists and we are indebted to him for a series of invaluable investigations, especially upon the fishes.

Those of us who had the good fortune to know Prof. Goode personally recall his singular charm of character, his genial interest in the work of others, his true scientific spirit. We have thus lost one of our ablest fellow-workers and one of the truest and best of men.

The resolution was adopted unanimously by a rising vote. CHARLES L. BRISTOL,
Secretary.

ANNUAL MEETING OF THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE annual meeting of the New York Section of the American Chemical Society was held at the College of the City of New York on Friday, October 9th, at 8:15 p. m.

The following officers were elected: Dr. Wm. McMurtrie, chairman; Dr. Durand Woodman, secretary and treasurer; Dr. Charles A. Doremus, Prof. A. A. Breneman, Dr. Albert C. Hale, members of the executive committee; Dr. Wm. McMurtrie, Dr. Chas. F. McKenna, Dr. Chas. A. Doremus, delegates to the Scientific Alliance of New York.

Papers were read and discussed as follows: On 'Some Disputed Points about the Light of Carbon,' by Woodbridge H. Birchmore. On 'The Conversion of Cows' Milk into a Substitute for Human Milk,' by Henry A. Bunker.

Committees were appointed to cooperate with other scientific bodies in New York for the purpose of securing a lecture from Prof. Henri Moissan before his return to France, and to arrange the programs for the meetings of the Section during the year.

The prospects of the Chemical Club were reported as very encouraging.

DURAND WOODMAN,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis, held October 19, 1896, Mr. Trelease exhibited living flowers of *Catasetum Gnomus*, demonstrating the extreme irritability of their tentacles and the precision with which the pollinia become attached to any object touching either tentacle. Mr. J. B. S. Norton presented a list of the Ustilagineæ of Kansas, together with the result of germinations of about one-half of the entire number. Three persons were elected to active membership.

WILLIAM TRELEASE,
Recording Secretary.

SCIENTIFIC JOURNALS.

THE AMERICAN GEOLOGIST, OCTOBER.

Dinicthys Prentis-Clarki: E. W. CLAYPOLE. A new species of this interesting genus of Devonian fishes is described.

The Fort Union Formation: WALTER HARVEY WEED. The conclusion long ago expressed by Newberry now seems to be definitely settled, viz., that the Fort Union beds are lower Tertiary and entirely distinct from the Laramie proper which is upper Cretaceous. The series in Montana is as follows; beginning with the lower Laramie (= Cretaceous), Livingston (transition), Fort Union (Eocene).

N. H. Winchell and U. S. Grant describe a volcanic ash from the north shore of Lake Superior. The existence of such deposits in this region has generally been doubted. No craters or vents have as yet been located.

A very complete synopsis of the geological papers presented at the Buffalo meetings of the Geological Society and the American Association is given by Warren Upham.

The 'Augen' Gneiss area, Pegmatite veins and Diorite dikes at Bedford, N. Y., are described at length by Luquer and Ries. The 'augen' are considered as the result of metamorphism by pressure of granitic or aplitic rocks, together with a granulation of the minerals from shearing, the unsheared portions of the rock remaining as 'augen.' The pegmatite veins and diorite dikes are of later origin as their component minerals are in their normal condition without signs of dynamic action.

James M. Safford notices a 'New and important source of Phosphate rock in Tennessee.' It differs conspicuously from any other deposit in the State in not being an original rock deposit, but one which has been produced by the leaching out of limestones rich in phosphates. This has raised the percentage of calcium phosphate to from 60 to 80 per cent. The age of these deposits is determined to be Trenton and their thickness ranges from three to eight feet.

SCIENCE

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G. Brown Goode

SCIENCE

FRIDAY, NOVEMBER 6, 1896.

CONTENTS:

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

GEORGE BROWN GOODE.

THE grievous loss to the scientific world of Dr. George Brown Goode has already been recorded in SCIENCE. At the request of the editor I now add a notice of some of the prominent features of his biography and an estimate of his scientific works.

For the biographical portion (I.) I am indebted to Dr. Marcus Benjamin.

I.

In the untimely death of Dr. G. Brown Goode, American science mourns the loss of one of its most distinguished representatives. No more, and equally no less, can be said of the man whose best years seemed as yet unlived, when he was suddenly stricken with pneumonia and died a victim of that cruel disease at his home on Lanier Heights, in Washington City, on Sunday evening, September 6.

George Brown Goode was born in New-Albany, Ind., on February 13, 1851. His ancestry was colonial and he traced with pride his paternal line to John Goode, of Varina Parish, in Virginia, who was a soldier under Bacon in 1676, in the first armed uprising of Americans against the oppressions of royal authority. On his mother's side he was descended from the Crane family of New Jersey, of which Stephen Crane was one of the most conspicuous representatives of that colony in the events that led to the war of the Revolution.

As a boy he moved with his parents from Indiana and settled in New York. He early showed a fondness for natural history and it was his pride to recall how this boyish fancy was confirmed by his reading the reports of the Smithsonian Institution, a set of which formed part of the family library. As he grew older he was prepared for college and in time entered Wesleyan University, in Middletown, Conn., where he was graduated in 1870, being one of the youngest members of his class. During his college career his predilection for natural history studies was marked, and he was recognized as 'a man exceptionally promising for work' in that direction. During the first part of the college year of 1870–71, he was entered as a graduate student in Harvard University and there came under the influence of the elder Agassiz. Meanwhile, Orange Judd Hall, a building devoted to natural sciences, was erected in Middletown through the munificence of the gentleman whose name it bears, and young Goode was promptly called by the faculty of his *alma mater* to arrange and display the natural history collections of the university in such a shape as to make them worthy the name of a museum. As the work proceeded it became manifest that he had found his vocation and in the task of arranging the museum of Wesleyan University he began to display that remarkable ability for museum administration, that has since found so worthy a field in the National Museum in Washington.

His scientific studies, however, were not neglected and he sought to increase his knowledge by becoming acquainted with the workings of the United States Fish Commission. He met Prof. Baird, in the summer of 1873, in Portland, Me., during the meeting there of the American Association for the Advancement of Science. It proved a fortunate meeting for both men. The elder naturalist was at once impressed by the enthusiasm of the younger man and invited him to become an assistant in the service of the commission. Regularly thereafter from 1873 until 1880 Goode was a member of one of the summer parties and later served in other capacities until, on the death of Prof. Baird, he was at once called to the place of Fish Commissioner, which high office, notwithstanding the many other duties pressing on him, he consented to fill without salary until the law could be amended so as to make the office independent of the National Museum.

In connection with the Fish Commission it is proper to mention the active part that he took in behalf of the United States at the Halifax Commission, which had to do with settling the fishery relations between this country and Canada. Nor should the fact that he had charge of the work for the Fishery Division of the tenth census be omitted.

The ability displayed by Goode during his first season with the Fish Commission soon led to closer ties between himself and Prof. Baird, for the latter invited him to join the scientific staff of the National Museum. In 1873 he became regularly connected with that institution, and for a time received as his only compensation specimens of natural history which he in turn presented to the Museum in Middletown, where he retained his connection until 1877. From assistant curator in the National Museum he was advanced to the office of assistant director, and in 1887 he was made, on the recommendation of Secretary Baird, assistant secretary of the Smithsonian Institution in charge of the National Museum, which office he continued to fill until his death. The genius that he first showed in the arrangement of the collections in Wesleyan University broadened and developed as he grew older until it was universally conceded that he had no superior in the world among museum administrators. His writings on this subject are accepted authorities, and include the well-known monograph ‘Museums of the Future’ (1890) and ‘Principles of Museum Administrations’ (1895) to which should be added his annual reports as assistant secretary during the years of his incumbency of that post.

The ability for museum administration with which he was so liberally gifted, led naturally to his active participation in what has come to be known among government officials as ‘Exposition work.’ Prof. Baird intrusted him with the installation of the Smithsonian exhibits at the Centennial Exhibition held in Philadelphia in 1876, and he served as U. S. Commissioner to the Fisheries Exhibitions that were held in Berlin in 1880 and in London in 1883. The minor expositions held in New Orleans, in Cincinnati, in Louisville, and more recently in Atlanta, contained his name on the Government Boards, and he was prominent in the management of the Government Exhibit at the World's Columbian Exposition held in Chicago during 1893, for which he also prepared a ‘Plan of Classification’ that formed the basis of the arrangement subsequently adopted by the officials for the installation of the exhibits. He had also to do with the Columbian Historical Exposition held in Madrid, Spain, during the winter months of 1892-93, and, after the death of the Commissioner General, acted in that capacity. His services in that connection gained for him the Order of Isabella the Catholic with the grade of Commander.

In this hasty summary of his life, only the more important of his many interests can be referred to; at least, mention must be made of his great fondness for matters pertaining to American history. His study of genealogy began when he was but a boy and led to his publication of the record of his family under the title of ‘Our Virginia Cousins.’ Soon after leaving college he was made one of the editors of the *Alumni Record*, of Wesleyan University, which is among the best of the ‘college books.’ He was one of the founders of the American Historical Association and contributed to its proceedings in 1890 his valuable paper on ‘The Origin of the National Scientific and Educational Institutions of the United States.’ He was also a member of the newly organized Southern Historical Society. Much of his leisure during the past two summers was given up to the preparation of the material that is to be used in the ‘Half Century Book of the Smithsonian Institution,’ which was his project, and which, when published, will be a monument to his knowledge of science in this country during the half century of the existence of the Smithsonian Institution.

Dr. Goode was one of the founders of the District of Columbia Society of the Sons of the American Revolution, becoming from the beginning one of its officers and since 1894 its president. He was a vice-president of the Society of the Sons of the Revolution and a lieutenant-governor of the Society of Colonial Wars.

In scientific societies he was equally conspicuous. In Washington he was a founder in several, and was a past president of the Philosophical Society and of the Biological Society, to both of which he contributed, on retiring, addresses that treated of the history of American science. Other societies both in this country and abroad were honored in having his name on their rolls. Among these were the Zoological Society of London and the National Academy of Sciences in the United States, to which he was elected in 1888. He was elected a member of the American Association for the Advancement of Science in 1873, and at its meeting held in Buffalo during August of this year he was chosen a vice-president for the section on zoology.

The honorary degree of LL. D. was

conferred upon him by Wesleyan University and the degree of Ph. D. by Indiana University.

Incidental mention has been made of some of his larger works, but a complete bibliography of his papers would include hundreds of titles, so indefatigable had he been in the too few years of his busy life. He has gone, but his influence will remain so long as the National Museum shall exist, and his memory will ever be cherished by all who had learned to love and respect him.

II.

Dr. Goode's first contribution to science was published in 1871 in his twenty-first year and incorporated in a note of the editors of the *American Naturalist* (v. 489); it merely recorded the occurrence of 'The bill fish in fresh water' in the Connecticut river.

His first memoir giving any indication of his range of reading and ability in the systematization of facts was published two years later (1873) "On the question 'do snakes swallow their young' "*. Through an advertisement in *The American Agriculturist*, a weekly journal with a large circulation in rural districts, he obtained numerous answers to the question and thus was enabled to supplement the records previously published by original accounts. The result of a critical survey of the data at command compelled him to admit that there was a good foundation in fact for the popular belief, and that certain viviparous snakes do really admit their young, who instinctively seek refuge in the interior of their mother when danger threatens and are liberated when it has passed.†

A 'Catalogue of the Fishes of the Bermudas,'* published in 1876, furnished additional evidence of knowledge of the literature of his subject and ability to use it to advantage in the discussion of mooted questions and it also evinced his power of observation.

In the same year, 1876, appeared another work which, to a still greater degree, rendered manifest those same mental characteristics. The work was only a catalogue, but perhaps from no other publication can some intellectual qualities be so readily and correctly gauged by a competent judge as an elaborate catalogue. Powers of analysis and synthesis, and the ability to weigh the relative values of the material at hand, may make a 'mere catalogue' a valuable epitome of a collection and of a science. Such a production was the 'Classification of the Collection to illustrate the Animal Resources of the United States,'† a work of 126 pages; three years later this catalogue served as the basis for and was elaborated and expanded into a large 'Catalogue of the Collection to illustrate the Animal Resources and the Fisher-

*On the Question, "Do Snakes swallow their Young?" In Proc. Amer. Assoc. Advan. Sci. 1873 (1874), pp. 176–185. Also separately, repaged, 12 pp.

†Mr. H. Tootal Broadhurst has collected a number of original observations in a recently published pamphlet confirming the allegation that mother snakes may receive their young within their mouths. Mr. Broadhurst was apparently unacquainted with Dr. Goode's article; his own is entitled, 'Do the Young of Vipers take Refuge Down the Throat of the Mother in cases of Sudden Surprise or Danger?' (Dumfries, July, 1895. 8vo, 29 pp.)

*Catalogue of the Fishes of the Bermudas, Based chiefly on the collectings of the United States National Museum. . . Washington: Government Printing Office. 1876. [8° pp. (2) 1–82.—Bulletin United States National Museum. No. 5.]

†International Exhibition, 1876. Board in Behalf of United States Executive Departments. Classification of the Collection to illustrate the Animal Resources of the United States. A list of substances derived from the animal kingdom, with synopsis of the useful and injurious animals and a classification of the methods of capture and utilization. . . Washington: Government Printing Office. 1876. [8° pp. 126.—A second edition with supplementary title as Bulletin No. 6, United States National Museum.]

ies of the United States,'* a volume of 351 pages. These catalogues were for the tentative and adopted arrangement of material exhibited by the Smithsonian Institution and the United States Fish Commission at the 'International Exhibition, 1876.'

It was the ability that was manifested in these catalogues and the work incidental to their preparation that especially arrested the attention of Prof. Baird and marked the author as one well adapted for the direction of a great museum. For signal success in such direction special qualifications are requisite. Only some of them are a mind well trained in analytical as well as synthetic methods, an artistic sense, critical ability, and multifarious knowledge, but above all the knowledge of men and how to deal with them. Perhaps no one has ever combined, in more harmonious proportions, such qualifications than G. Brown Goode. In him the National Museum of the United States and the world at large have lost one of the greatest of museum administrators.

As a naturalist, the attention of Dr. Goode was especially directed to and even concentrated on the fishes. His memoirs, contributed mostly to the Proceedings of the United States National Museum, were numerous and chiefly descriptive of new species. (For many of these he had, as a collaborator, Dr. Tarleton Bean, then the curator of fishes of the United States National Museum.) Some of the memoirs, however, dealt with special groups, as the Menhaden (1879), Ostraciontidae (1880), Carangidae (1881), the Sword-fishes (1881), and the Eel (1882). His monograph of the Menhaden (*Brevoortia tyrannus*), contributed originally to the Report of the United States Commissioner of Fisheries* and then published as a separate work†—a large volume of nearly 550 pages and with 30 plates—is a model of critical treatment of information collected from all quarters. But his most important contributions were published as official Government reports and were the results of investigations especially undertaken for such reports. Especially noteworthy were the volumes comprising the results of the census of 1880.

The 1880 census was planned and carried out on an unusual scale. For the Fisheries, the U. S. Commission of Fish and Fisheries cooperated and Dr. Goode had general charge of the entire work. The assistants and special agents were consequently selected with judgment and the results were very valuable. The huge mass of statistics was digested and condensed in seven large quarto volumes representing five sections separately devoted to special branches of the subject.‡ Dr. Goode's cares were mainly

* International Exhibition, 1876. Catalogue of the Collection to illustrate the Animal Resources and the Fisheries of the United States, exhibited at Philadelphia in 1876 by the Smithsonian Institution and the United States Fish Commission, and forming a part of the United States National Museum. . . Washington: Government Printing Office. 1879. [8° pp. 351. (1)—*Bulletin United States National Museum, No. 14.*]

* The Natural and Economical History of the American Menhaden. In Report United States Commission of Fish and Fisheries, Part v., 1879, Appendix A, pp. 1–529, Pl. i–xxxi (xxx cancelled.—Pp. 194–267 by Prof. W. O. Atwater.

† American Fisheries—A history of the Menhaden by G. Brown Goode, with an account of the Agricultural Uses of Fish by W. O. Atwater. . . And an introduction, bringing the subject down to date. Thirty plates.—New York: Orange Judd Company. 1880. [8° pp. x, (i), iii–xii, 1–529 (1); 31 pl.—pl. 30 "cancelled."]

An edition, with a special introduction of the foregoing.

‡ The Fisheries and Fishery Industry of the United States. Prepared through the coöperation of the Commissioner of Fisheries and the Superintendent of the Tenth Census. By George Brown Goode, assistant director of the United States National Museum, and a staff of associates.—Washington: Government Printing Office. 1884 [—1887. 5 sections in 7 volumes.] "Section I, Natural History of Aquatic Animals" was mainly prepared by Doctor Goode.

concentrated on the first section, treating of the 'Natural History of Aquatic Animals,' which was discussed in over 900 pages of text and illustrated by 277 plates. This work was by far the most complete survey of the economical fishes of the country that had ever appeared and has since been the most prized; it led to another.

After the appearance of the Census volumes, Dr. Goode was urged to prepare a work for popular use. His consent to do so was followed by a volume, entitled 'American Fishes, a popular treatise upon the game and food fishes of North America,'* published by the Standard Book Company of New York. Inasmuch as none of the previous popular works on the American fishes had emanated from men of scientific eminence, it scarcely need be added that the new work had no rival in the field, so far as accurate information and details of habits were involved.

A short time previously Dr. Goode had also prepared the text to accompany a series of twenty large folio colored portraits by an eminent artist—Mr. S. A. Kilbourne—of the principal 'Game Fishes of the United States.'†

Never had investigations of the deep sea been conducted with such assiduity and skill as during the last two decades. The chief honors of the explorations were carried off by the British and American Governments. As the fishes obtained by the vessels of the United States Fish Commission were brought in, they were examined by Dr. Goode (generally in company with Dr. Bean) and duly described. At length Doctors Goode and Bean combined together data respecting all the known forms occurring in the abyssmal depths of the ocean and also those of the open sea, and published a resumé of the entire subject in two large volumes entitled 'Oceanic Ichthyology.'* This was a fitting crown to the work on which they had been engaged so long and the actual publication only preceded Dr. Goode's death by about a fortnight.

But the published volumes did not represent all the work of Dr. Goode on the abyssalian fishes. He had almost completed an elaborate memoir on the distribution of those fishes and, contrary to the conclusions of former laborers in the same field, had recognized for them a number of different faunal areas. It is to be hoped that this may yet be given to the world.

Morphological and descriptive ichthyology were not cultivated to the exclusion of what is regarded as more practical features. In connection with his official duties as an officer of the United States Fish Commission he studied the subject of pisciculture in all its details. Among his many contributions to the subject are one on 'The First decade of the United States Commission, its plan of work and accomplished results, scientific and economical' (1880), another treating of the 'Epochs in the History of Fish Culture' (1881) and two encyclopædic articles—'The Fisheries of the World' (1882), and the one entitled 'Pisciculture,' in the Encyclopædia Britannica (1885).

* American Fishes. A popular treatise upon the Game and Food Fishes of North America, with especial reference to habits and methods of capture. By G. Brown Goode. With numerous illustrations. New York; Standard Book Company. 1888. [8°, xvi+496 pp., col. frontispiece.]

† Game Fishes of the United States. By S. A. Kilbourne. Text by G. Brown Goode.—New York: Published by Charles Scribner's Sons. 1879–1881. [Folio, 46 pp., 20 plates and map.—Published in ten parts, each with 2 plates, lithographs in water color, and four page folio of text.]

* Smithsonian Institution. United States National Museum. Special Bulletin. Oceanic Ichthyology. A treatise on the Deep-Sea and Pelagic Fishes of the World, based chiefly upon the collections made by the steamers Blake, Albatross, and Fish Hawk in the Northwestern Atlantic, with an Atlas containing 417 figures, by George Brown Goode, Ph.D., LL.D., and Tarleton H. Bean, M.D., M.S. Washington: Government Printing Office. 1895. 2 vols., 4°; I., xxxv+26*, 553 pp.; II., xxiii+26* pp., 123 pl.

Although Dr. Goode's zoological publications were principally ichthyological, it was not because of narrowed sympathies or knowledge. As a naturalist he had acquaintance with several classes of the animal kingdom and especially with the vertebrates. He even published several minor contributions on herpetology, the voices of crustaceans, and other subjects.

Anthropology naturally secured a due proportion of his regards and, indeed, his catalogues truly embraced the outlines of a system of the science. As a worker in that field he has been considered recently by Dr. Mason in *The American Anthropologist*, IX., 353, 354.

The flowering plants also enlisted much of his attention and his excursions into the fields and woods were enlivened by a knowledge of the objects he met with.

Dr. Goode's bent of mind was to the historical investigation of a subject and historical matters enlisted much of his attention. Two addresses on the progress of the biological sciences in the United States, given by him as the retiring president of the Biological Society of Washington, well exemplified his diligence in the collection of data and his skill in presenting them, and it is to be hoped that they may be republished in a more available form.

These addresses entitled 'The beginnings of Natural History in America' were delivered in 1886 and 1887 and were published in the third and fourth volumes of the Proceedings of the Biological Society of Washington. The pages of the old chroniclers of American affairs, scarcely ever consulted by naturalists, had been ransacked and the items of interest culled for these choice addresses.

The addresses were subsequently supplemented by an essay on 'The Origin of the National Scientific and Educational Institutions of the United States' (1890), contributed to the American Historical Association.

Bibliography was also a favorite subject with Dr. Goode and he derived much pleasure from the inquiries which that word indicates. He completed exhaustive enumerations of the works of two of the most prominent writers on American vertebrates, and these were published by the Smithsonian Institution as Bulletins of the United States National Museum and as numbers of a series of 'Bibliographies of American Naturalists.' The first was devoted to Spencer Fullerton Baird (1883), and the fifth to Charles Girard (1891), frequently colaborers in olden times. Another (not yet published, but entirely printed) records the numerous memoirs of Philip Lutley Sclater, the distinguished ornithologist of England, who survives his biographer.

A gigantic work in the same line had been projected by him and most of the materials collected; it was no less than a complete bibliography of Ichthyology, including the names of all genera and species published as new. Whether this can be completed by another hand remains to be seen. While the work is a great desideration, very few would be willing to undertake it or even arrange the material already collected for publication. In no way may Ichthyology, at least, more feel the loss of Goode than in the loss of the complete bibliography.

The same inclination that led to historical investigation conducted him further into genealogy. As a result of some of his studies in that line, a large volume on the genealogy of the Goode family appeared in 1892 as a private publication with the title 'Virginia Cousins*.' It was printed for

* Virginia Cousins. A study of the Ancestry and Posterity of John Goode, of Whitby, a Virginia colonist of the seventeenth century, with notes upon related families, a key to Southern Genealogy, and a history of the English surname, Gode, Goad, Goode or Good, from 1148 to 1887.—Richmond, Virginia: J. W. Randolph & English. 1887. [4to, xxxvi+526 pp., 54 plates.]

the author in Washington. Its nearly 600 pages and 54 plates involved the information collected during a quarter century. Much historical and biographical information of general interest is to be found in the monograph and the most approved methods are manifest in the treatment and presentation of his theme.

The author's interest did not cease with the publication of the work; it rather increased, and he received so many new contributions and so much additional information that he felt obliged to prepare for a second edition. The new material had already been intercalated with the corrected old, and the second edition was nearly ready for the press when death interposed.

Doctor Goode was blessed with a poetical vein and loved to dip into the offerings of poets, old and new. Frequent quotations are to be found in his works and many apt ones are given at the heads of the chapters of the 'Game fishes of the United States' and the "American fishes."

His disposition was a bright and sunny one and he ingratiated himself in the affections of his friends in a marked degree. He had a hearty way of meeting intimates, and a caressing cast of the arm over the shoulder of such an one often followed sympathetic intercourse.* But in spite of his gentleness, firmness and vigor in action became manifest when occasion called for them. A tribute to those qualities from his chief who is better prepared to speak than myself will fittingly supplement this notice.

Theo. Gill.

Smithsonian Institution.

It has been suggested that I should say something about my dear personal friend and official intimate, Dr. G. Brown Goode, but since Dr. Gill, who is so much better fitted for the task than I, has consented to speak of his scientific career, I prefer to leave that side of Dr. Goode's life-work in such competent hands.

I do not want the occasion to pass, however, without saying briefly that I have never known a more perfectly true, sincere and loyal character than Dr. Goode's; or a man who with a better judgment of other men, or greater ability in moulding their purposes, to his own, used these powers to such uniformly disinterested ends, so that he could maintain the discipline of a great establishment like the National Museum, while retaining the personal affection of every subordinate. He was not only possessed of the exact scientific training which found expression in the ways which Dr. Gill has noted, and as a specialist in museum administration, but was an adept in many other branches of knowledge. His historical powers in grouping incidents and events were akin to genius. His genealogical writings showed wide and accurate research, while his literary faculty displayed itself with singular charm in some of his minor writings.

But how futile these words seem to be in describing a man, of whom perhaps the best, after all, to be said, is that he was not only trusted, but beloved by all with an affection that men rarely win from one another.

S. P. Langley.

Smithsonian Institution.

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*BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

ADDRESS TO THE ZOOLOGICAL SECTION BY THE PRESIDENT OF THE SECTION.

(*Concluded.*)

We now come to the strictly biological part of our subject—to the inquiry as to

* Several portraits have been published. The first appeared in *Harper's Weekly* in 1887 and was a fine wood engraving and excellent likeness of him at the time—on the whole (in my opinion) the most satisfactory that has been made. Imprints of the engraving were furnished by the Harpers for the 'Virginia Cousins' and inserted opposite p. 288.

*Liverpool, 1896.

how much of the whole scheme of organic evolution has been worked out in the time during which the fossiliferous rocks were formed, and how far, therefore, the time required by the geologist is sufficient.

It is first necessary to consider Lord Kelvin's suggestion that life may have reached the earth on a meteorite. Accepting this view, it might be argued that the evolution which took place elsewhere may have been merely completed, in a comparatively brief space of time, on our earth.

We know nothing of the origin of life here or elsewhere, and our only attitude towards this or any other hypothesis on the subject is that of the anxious inquirer for some particle of evidence. But a few brief considerations will show that no escape from the demands for time can be gained in this way.

Our argument does not deal with the time required for the origin of life, or for the development of the lowest beings with which we are acquainted, from the first formed beings of which we know nothing. Both these processes may have required an immensity of time; but as we know nothing whatever about them and have as yet no prospect of acquiring any information, we are compelled to confine ourselves to as much of the process of evolution as we can infer from the structure of living and fossil forms—that is, as regards animals, to the development of the simplest into the most complex Protozoa, the evolution of the Metazoa from the Protozoa, and the branching of the former into its numerous Phyla, with all their classes, orders, families, genera and species. But we shall find that this is quite enough to necessitate a very large increase in the time estimated by the geologist.

The Protozoa, simple and complex, still exist upon the earth in countless species, together with the Metazoan Phyla. Descendants of forms which in their day constituted the beginning of that scheme of evolution which I have defined above—descendants, furthermore, of a large proportion of those forms which, age after age, constituted the shifting phases of its onward progress—still exist, and in a sufficiently unmodified condition to enable us to reconstruct, at any rate in mere outline, the history of the past. Innumerable details and many phases of supreme importance are still hidden from us, some of them, perhaps, never to be recovered. But this frank admission, and the eager and premature attempts to expound too much, to go further than the evidence permits, must not be allowed to throw an undeserved suspicion upon conclusions which are sound and well supported, upon the firm conviction of every zoologist that the general trend of evolution has been, as I have stated it, that each of the Metazoan Phyla originated, directly or indirectly, in the Protozoa.

The meteorite theory, if used to shorten the time required for evolution, would, however, require that the process of evolution went backward on a scale as vast as that on which it went forward, that certain descendants of some central type, coming to the earth on a meteorite, gradually lost their Metazoan complexity and developed backward into the Protozoa, throwing off the lower Metazoan Phyla on the way, while certain other descendants evolved all the higher Metazoan groups. Such a process would shorten the period of evolution by half, but it need hardly be said that all available evidence is entirely against it.

The only other assumption by means of which the meteorite hypothesis would serve to shorten the time is even more wild and improbable. Thus it might be supposed that the evolution which we believe to have taken place on this earth really took place elsewhere—at any rate as regards all its main lines—and that samples of all the various phases, including the earliest and simplest, reached us by a regular meteoric service, which was established at some time after the completion of the scheme of organic evolution. Hence the evidences which we study would point to an evolution which occurred in some unknown world with an age which even Prof. Tait has no desire to limit.

If these wild assumptions be rejected, there remains the supposition that, if life was brought by a meteorite, it was life no higher than that of the simplest Protozoon—a supposition which leaves our argument intact. The alternative supposition, that one or more of the Metazoan Phyla were introduced in this way while the others were evolved from the terrestrial Protozoa, is hardly worth consideration. In the first place, some evidence of a part in a common scheme of evolution is to be found in every Phylum. In the second place, the gain would be small; the arbitrary assumption would only affect the evidence of the time required for evolution derived from the particular Phylum or Phyla of supposed meteoric origin.

The meteoric hypothesis, then, can only affect our argument by making the most improbable assumptions, for which, moreover, not a particle of evidence can be brought forward.

We are therefore free to follow the biological evidence fearlessly. It is necessary, in the first place, to expand somewhat the brief outline of the past history of the animal kingdom, which has already been given. Since the appearance of the 'Origin of Species,' the zoologist, in making his classifications has attempted, as far as possible, to set forth a genealogical arrangement. Our purpose will be served by an account of the main outlines of a recent classification, which has been framed with a due consideration for all sides of zoological research, new and old, and which has met with general approval. Prof. Lankester divides the animal kingdom into two grades, the higher of which, the Enterozoa (Metazoa), were derived from the lower, the Plastidozoa (Protozoa). Each of these grades is again divided into two sub-grades, and each of these is again divided into Phyla, corresponding more or less to the older Sub-Kingdoms. Beginning from below, the most primitive animals in existence are found in the seven Phyla of the lower Protozoan sub-grade, the Gymnomyxa. Of these unfortunately only two, the Reticularia (Foraminifera) and Radiolaria, possess a structure which renders possible their preservation in the rocks. The lowest and simplest of these Gymnomyxa represent the starting point of that scheme of organic evolution which we are considering to-day. The higher order of Protozoan life, the sub-grade Corticata, contains three Phyla, no one of which is available in the fossil state. They are, however, of great interest and importance to us as showing that the Protozoan type assumes a far higher organization on its way to evolve the more advanced grade of animal life. The first formed of these latter are contained in the two Phyla of the sub-grade Cœlentera, the Porifera or Sponges, and the Nematophora or Corals, Sea Anemones, Hydrozoa and allied groups. Both of these Phyla are plentifully represented in the fossil state. It is considered certain that the latter of these, the Nematophora, gave rise to the higher sub-grade, the Cœlomata, or animals with a cœlom, or body-cavity, surrounding the digestive tract. This latter includes all the remaining species of animal in nine Phyla, five of which are found fossil—the Echinoderma, Gephyrea, Mollusca, Appendiculata and Vertebrata.

Before proceeding further, I wish to lay emphasis on the immense evolutionary history which must have been passed through before the ancestor of one of the higher of these nine Phyla came into being. Let us consider one or two examples, since the establishment of this position is of the utmost importance for our argument. First consider the past history of the Vertebrata—of the common ancestor of our Balanoglossus, Tunicates, Amphioxus, Lampreys, Fishes, Dipnoi, Amphibia, Reptiles, Birds and Mammals. Although zoologists differ very widely in their opinions as to the affinities of this ancestral form, they all agree in maintaining that it did not arise direct from the Nematophora in the lower sub-grade of Metazoa, but that it was the product of a long history within the Cœlomate sub-grade. The question as to which of the other Cœlomate Phyla it was associated with will form the subject of one of our discussions at this meeting; and I will, therefore, say no more upon this period of its evolution, except to point out that the very question itself, 'the ancestry of Vertebrates,' only means a relatively small part of the evolutionary history of the Vertebrate ancestor within the Cœlomate group. For when we have decided the question of the other Cœlomate Phylum or Phyla to which the ancestral Vertebrate belonged, there remains, of course, the history of that Phylum or those Phyla earlier than the point at which the Vertebrate diverged, right back to the origin of the Cœlomata; while, beyond and below, the wide gulf between this and the Cœlentera had to be crossed, and then, probably after a long history as a Cœlenterate, the widest and most significant of all the morphological intervals—that between the lowest Metazoon and the highest Protozoon—was traversed. But this was by no means all. There remains the history within the higher Protozoan sub-grade, in the interval from this to the lower, and within the lower sub-grade itself, until we finally retrace our steps to the lowest and simplest forms. It is impossible to suppose that all this history of change can have been otherwise than immensely prolonged; for it will be shown below that the only evidence which is available supports the belief that the changes during these earlier phases were at least as slow as those which occurred later.

If we take the history of another of the higher Phyla, the Appendiculata, we find that the evidence points in the same direction. The common ancestor of our Rotifera, earthworms, leeches, Peripatus, centipedes, insects, Crustacea, spiders and scorpions, and forms allied to all these, is generally admitted to have been Chætopod-like, and probably arose in relation to the beginnings of certain other Cœlomate Phyla, such as the Gephyrea and perhaps Mollusca. At the origin of the Cœlomate sub-grade the common ancestor of all Cœlomate Phyla is reached, and its evolution has been already traced in the case of the Vertebrata.

What is likely to be the relation between the time required for the evolution of the ancestor of a Cœlomate Phylum and that required for the evolution, which subsequently occurred, within the Phylum itself? The answer to this question depends mainly upon the rate of evolution in the lower parts of the animal kingdom as compared with that in the higher. Contrary, perhaps, to anticipation, we find that all evidences of rapid evolution are confined to the most advanced of the smaller groups within the highest Phyla, and especially to the higher Classes of Vertebrata. Such evidence as we have strongly indicates the most remarkable persistence of the lower animal types. Thus in the Class Imperforata of the Reticularia (Foraminifera) one of our existing genera (*Saccamina*) occurs in the Carboniferous strata, another (*Trochammina*) in the Permian, while a single new genus (*Receptaculites*) occurs in the Silurian and Devonian. The evidence from the Class Perforata is much stronger, the existing genera *Nodosaria*, *Dentalina*, *Textularia*, *Grammostomum*, *Valvulina* and *Nummulina* all occurring in the Carboniferous, together with the new genera *Archœdiscus* (?) and *Fusulina*.

I omit reference to the much-disputed Eozoon from the Laurentian rocks far below the horizon, which, for the purpose of this address, I am considering as the lowest fossiliferous stratum. We are looking forward to the new light which will be thrown upon this form in the communication of its veteran defender, Sir William Dawson, whom we are all glad to welcome.

Passing the Radiolaria, with delicate skeletons less suited for fossilization, and largely pelagic and, therefore, less likely to reach the strata laid down along the fringes of the continental areas, the next Phylum which is found in a fossil state is that of the Porifera, including the sponges, and divided into two classes, the Calcispongiæ and Silicospongiæ. Although the fossilization of sponges is in many cases very incomplete, distinctly recognizable traces can be made out in a large number of strata. From these we know that representatives of all the groups of both classes (except the Halisarcidæ, which have no hard parts) occurred in the Silurian, Devonian and Carboniferous systems. The whole Phylum is an example of long persistence with extremely little change. And the same is true of the Nematophora; new groups, indeed, come in, sometimes extremely rich in species, such as the Palæozoic Rugose corals and Graptolites; but they existed side by side with representatives of existing groups, and they are not in themselves primitive or ancestral. A study of the immensely numerous fossil corals reveals no advance in organization, while researches into the structure of existing Alcyonaria and Hydrocorallina have led to the interpretation of certain Palæozoic forms which were previously obscure, and the conclusion that they find their place close beside the living species.

All available evidence points to the extreme slowness of progressive evolutionary changes in the Cœlenterate Phyla, although the Protozoa, if we may judge by the Reticularia (Foraminifera), are even more conservative.

When we consider, later on, the five Cœlomate Phyla which occur fossil, we shall find that the progressive changes were slower and, indeed, hardly appreciable in the two lower and less complex Phyla, viz: the Echinoderma and Gephyrea, as compared with the Mollusca, Appendiculata and Vertebrata.

Within these latter Phyla we have evidence for the evolution of higher groups presenting a more or less marked advance in organization. And not only is the rate of development more rapid in the highest Phyla of the animal kingdom, but it appears to be most rapid when dealing with the highest animal tissue, the central nervous system. The chief, and doubtless the most significant, difference between the early Tertiary mammals and those which succeeded them, between the Secondary and Tertiary reptiles, between man and the mammals most nearly allied to him, is a difference in the size of the brain. In all these cases an enormous increase in this, the dominant tissue of the body, has taken place in a time which, geologically speaking, is very brief.

When treating, later on, of the evolution which has taken place within the Phyla, further details upon this subject will be given, although in this, as in other cases, the time at our disposal demands that the exposition of evidence must largely yield to an exposition of the conclusions which follow from its study. And undoubtedly a study of all the available evidence points to the conclusion that in the lower grade, sub-grades and Phyla of the animal kingdom evolution has been extremely slow as compared with that in the higher. We do not know the reason. It may be that this remarkable persistence through the stratified series of deposits is due to an innate fixity of constitution which has rigidly limited the power of variation; or, more probably, perhaps, that the lower members of the animal kingdom were, as they are now, more closely confined to particular environments, with particular sets of conditions, with which they had to cope, and, this being successfully accomplished, natural selection has done little more than keep up a standard of organization which was sufficient for their needs; while the higher and more aggressive forms ranging over many environments, and always prone to encounter new sets of conditions, were compelled to undergo responsive changes or to succumb. But whatever be the cause, the fact remains, and is of great importance for our argument. When the ancestor of one of the higher Phyla was associated with the lower Phyla of the Cœlomate sub-grade, when further back it passed through a Cœlenterate, a higher Protozoan, and finally a lower Protozoan phase, we are led to believe that its evolution was probably very slow as compared with the rate which it subsequently attained. But this conclusion is of the utmost importance; for the history contained in the stratified rocks nowhere reveals to us the origin of a Phylum. And this is not mere negative evidence, but positive evidence of the most unmistakable character. All the five Cœlomate Phyla which occur fossil appear low down in the Palæozoic rocks, in the Silurian or Cambrian strata, and they are represented by forms which are very far from being primitive, or, if primitive, are persistent types. such as Chiton, which are now living, Thus Vertebrata are represented by fishes, both sharks and ganoids; the Appendiculata by cockroaches, scorpions, Limulids, Trilobites and many Crustacea; the Mollusca by Nautilus and numerous allied genera, by Dentalium, Chiton, Pteropods, and many Gastropods and Lamellibranchs; the Gephyrea by very numerous Brachiopods and many Polyzoa; the Echinoderma by Crinoids, Cystoids, Blastoids, Asteroids, Ophiuroids and Echinoids. It is just conceivable, although, as I believe, most improbable, that the Vertebrate Phylum originated at the time when the earliest known fossiliferous rocks were laid down. It must be remembered, however, that an enormous morphological interval separates the fishes which appear in the Silurian strata from the lower branches, grades and classes of the Phylum in which Balanoglossus, the Ascidians, Amphioxus and the Lampreys are placed. The earliest Vertebrates to appear are, in fact, very advanced members of the Phylum, and, from the point of view of anatomy, much nearer to man than to Amphioxus. If, however, we grant the improbable contention that so highly organized an animal as a shark could be evolved from the ancestral Vertebrate in the period which intervened between the earliest Cambrian strata and the Upper Silurian, it is quite impossible to urge the same with regard to the other Phyla. It has been shown above that when these appear in the Cambrian and Silurian they are flourishing in full force, while their numerous specialized forms are a positive proof of a long antecedent history within the limits of the Phylum.

If, however, we assume for the moment that the Phyla began in the Cambrian, the geologist's estimate must still be increased considerably, and perhaps doubled, in order to account for the evolution of the higher Phyla from forms as low as many which are now known upon the earth; unless, indeed, it is supposed, against the whole weight of all such evidence as is available, that the evolutionary history in these early times was comparatively rapid.

To recapitulate, if we represent the history of animal evolution by the form of a tree, we find that the following growth took place in some age antecedent to the earliest fossil records, before the establishment of the higher Phyla of the animal kingdom. The main trunk representing the lower Protozoa divided, originating the higher Protozoa ; the latter portion again divided, probably in a threefold manner, originating the two lowest Metazoan Phyla, constituting the Cœlentera. The branch representing the higher of these Phyla, the Nematophora, divided, originating the lower Cœlomate Phyla, which again branched and originated the higher Phyla. And, as has been shown above, the relatively ancestral line, at every stage of this complex history, after originating some higher line, itself continued down to the present day, throughout the whole series of fossiliferous rocks, with but little change in its general characters, and practically nothing in the way of progressive evolution. Evidences of marked advance are to be found alone in the most advanced groups of the latest highest products—the Phyla formed by the last of these divisions.

It may be asked how is it possible for the zoologist to feel so confident as to the past history of the various animal groups. I have already explained that he does not feel this confidence as regards the details of the history, but as to its general lines. The evidence which leads to this conviction is based upon the fact that animal structure and mode of development can be, and have been, handed down from generation to generation from a period far more remote than that which is represented by the earliest fossils ; that fundamental facts in structure and development may remain changeless amid endless changes of a more general character ; that especially favorable conditions have preserved ancestral forms comparatively unchanged. Working upon this material, comparative anatomy and embryology can reconstruct for us the general aspects of a history which took place long before the Cambrian rocks were deposited. This line of reasoning may appear very speculative and unsound, and it may easily become so when pressed too far. But applied with due caution and reserve, it may be trusted to supply us with an immense amount of valuable information which cannot be obtained in any other way. Furthermore, it is capable of standing the very true and searching test supplied by the verification of predictions made on its authority. Many facts taken together lead the zoologist to believe that A was descended from C through B ; but if this be true, B should possess certain characters which are not known to belong to it. Under the inspiration of hypothesis a more searching investigation is made, and the characters are found. Again, that relatively small amount of the whole scheme of animal evolution which is contained in the fossiliferous rocks has furnished abundant confirmation of the validity of the zoologist's method. The comparative anatomy of the higher Vertebrate Classes leads the zoologist to believe that the toothless beak and the fused caudal vertebræ of a bird were not ancestral characters, but were at some time derived from a condition more conformable to the general plan of vertebrate construction, and especially to that of reptiles. Numerous secondary fossils prove to us that the birds of that time possessed teeth and separate caudal vertebræ, culminating in the long lizard-like tail of Archæopteryx.

Prediction and confirmation of this kind, both zoological and paleontological, have been going on ever since the historic point of view was adopted by the naturalist as the outcome of Darwin's teaching, and the zoologist may safely claim that his method, confirmed by paleontology so far as evidence is available, may be extended beyond the period in which such evidence is to be found.

And now our last endeavor must be to obtain some conception of the amount of evolution which has taken place within the higher Phyla of the animal kingdom during the period in which the fossiliferous rocks were deposited. The evidence must necessarily be considered very briefly, and we shall be compelled to omit the Vertebrata altogether.

The Phylum Appendiculata is divided by Lankester into three branches, the first containing the Rotifera, the second the Chætopoda, the third the Arthropoda. Of these the second is the oldest and gave rise to the other two, or at any rate to the Arthropoda, with which we are alone concerned, inasmuch as the fossil records of the others are insufficient. The Arthropoda contain seven classes, divided into two grades, according to the presence or absence of antennæ—the Ceratophora, containing the Peripatoidea, the Myriapoda and the Hexapoda (or insects); the Acerata, containing the Crustacea, Arachnida, and two other classes (the Pantopoda and Tardigrada) which we need not consider. The first class of the antenna-bearing group contains the single genus Peripatus—one of the most interesting and ancestral of animals, as proved by its structure and development and by its immense geographical range. Ever since the researches of Moseley and Balfour, extended more recently by those of Sedgwick, it has been recognized as one of the most beautiful of the connecting links to be found amongst animals, uniting the antenna-bearing Arthropods, of which it is the oldest member, with the Chætopods. Peripatus is a magnificent example of the far-reaching conclusions of zoology, and of its superiority to paleontology as a guide in unravelling the tangled history of animal evolution. Peripatus is alive to-day, and can be studied in all the details of its structure and development; it is infinitely more ancestral, and tells of a far more remote past than any fossil Arthropod, although such fossils are well known in all the older of the Palæozoic rocks. And yet Peripatus is not known as a fossil. Peripatus has come down, with but little change, from a time, on a moderate estimate, at least twice as remote as the earliest known Cambrian fossil. The agencies which, it is believed, have crushed and heated the Archæan rocks so as to obliterate the traces of life which they contained were powerless to efface this ancient type, for, although the passing generations may have escaped record, the likeness of each was stamped on that which succeeded it, and has continued down to the present day. It is, of course, a perfectly trite and obvious conclusion, but not the less one to be wondered at, that the force of heredity should thus far outlast the ebb and flow of terrestrial change throughout the vast period over which the geologist is our guide.

If, however, the older Palæozoic rocks tell us nothing of the origin of the antenna-bearing Arthropods, what do they tell us of the history of the Myriapod and Hexapod Classes?

The Myriapods are well represented in Palæozoic strata, two species being found in the Devonian and no less than thirty-two in the Carboniferous. Although placed in an Order (Archipolypoda) separate from those of living Myriapods, these species are by no means primitive and do not supply any information as to the steps by which the Class arose. The imperfection of the record is well seen in the traces of this Class; for between the Carboniferous rocks and the Oligocene there are no remains of undoubted Myriapods.

We now come to the consideration of insects, of which an adequate discussion would occupy a great deal too much of your time. An immense number of species are found in the Palæozoic rocks, and these are considered by Scudder, the great authority on fossil insects, to form an Order, the Palæodictyoptera, distinct from any of the existing Orders. The latter, he believes, were evolved from the former in Mesozoic times. These views do not appear to derive support from the wonderful discoveries of M. Brongniart* in the Upper Carboniferous of Commentry in the Department of Allier, in central France. Concerning this marvellous assemblage of species, arranged by their discoverer in 46 genera and 101 species, Scudder truly says:

"Our knowledge of Palæozoic insects will have been increased three or fourfold at a single stroke * * * No former contribution in this field can in any way compare with it, nor even all former contributions taken together." †

When we remember that the group of fossil insects, of which so much can be affirmed by so great an authority as Scudder, lived at one time and in a single locality, we cannot escape the conclusion that the insect fauna of the habitable earth during the whole Palæozic period was of immense importance and variety. Our knowledge of this single group of species is largely due to the accident that coal-mining in Commentry is carried on in the open air.

Now, these abundant remains of insects, so far from upholding the view that the existing orders had not been developed in Palæozic times, are all arranged by Brongniart in four out of the nine Orders into which insects are usually divided, viz: the Orthoptera, Neuroptera, Thysanoptera and Homoptera. The importance of the discovery is well seen in the Neuroptera, the whole known Palæozoic fauna of this order being divided into 45 genera and 99 species, of which 33 and 72 respectively have been found at Commentry.

Although the Carboniferous insects of Commentry are placed in new families, some of them come wonderfully near those into which existing insects are classified, and obviously form the precursors of these. This is true of the Blattidæ, Phasmidæ, Acridiidæ and Locustidæ among the Orthoptera, the Perlidæ among the Neuroptera, and the Fulgoridæ among the Homoptera. The differences which separate these existing families from their Carboniferous ancestors are most interesting and instructive. Thus the Carboniferous cockroaches possessed ovipositors and probably laid their eggs one at a time, while ours are either viviparous or lay their eggs in a capsule. The Protophasmidæ resemble living species in the form of the head, antennæ, legs and body; but while our species are either wingless or, with exception of the female Phyllidæ, have the anterior pair reduced to tegmina, useless for flight, those of Palæozoic times possessed four well-developed wings. The forms representing locusts and grasshoppers (Palæacridiidæ) possessed long slender antennæ like the green grasshoppers (Locustidæ), from which the Acridiidæ are now distinguished by their short antennæ. The divergence and specialization which is thus shown is amazingly small in amount. In the vast period between the Upper Carboniferous rocks and the present day the cockroaches have gained a rather different wing venation, and have succeeded in laying their eggs in a manner rather more specialized than that of insects in general; the stick insects and leaf insects have lost or reduced their wings, the grasshoppers have shortened their antennæ. These, however,

*Charles Brongniart.—'Recherches pour servir á l'Histoire des Insectes fossiles des temps primaires, précédées d'une Etude sur la nervation des ailes des Insectes.' 1894.

†S. H. Scudder, *Am. Journ. Sci.* Vol. XLVII., February, 1894. Art. viii.

are the insects which most closely resemble the existing species; let us turn to the forms which exhibit the greatest differences. Many species have retained in the adult state characters which are now confined to the larval stage of existence, such as the presence of tracheal gills on the sides of the abdomen. In some the two membranes of the wing were not firmly fixed together, so that the blood could circulate freely between them. On the other hand, they are not very firmly fixed together in existing insects. Another important point was the condition of the three thoracic segments, which were quite distinct and separate, instead of being fused as they are now in the imago stage. The external difference probably also extended to the nervous system, so that the thoracic ganglia were separate instead of concentrated. The most interesting distinction, however, was the possession by many species of a pair of prothoracic appendages much resembling miniature wings, and which especially suggest the appearance assumed by the anterior pair (tegmina) in existing Phasmidæ. There is some evidence in favor of the view that they were articulated, and they exhibit what appears to be a trace of venation. Brongniart concludes that, in still earlier strata, insects with six wings will be discovered, or rather insects with six of the tracheal gills sufficiently developed to serve as parachutes. Of these, the two posterior pair developed into wings as we know them, while the anterior pair degenerated, some of the Carboniferous insects presenting us with a stage in which degeneration had taken place but was not complete.

One very important character was, as I have already pointed out, the enormous size reached by insects in this distant period. This was true of the whole known fauna as compared with existing species, but it was especially the case with the Protodonata, some of these giant dragon-flies measuring over two feet in the expanse of the wings.

As regards the habits of life and metamorphoses, Brongniart concludes that some species of Protoephemeridæ, Protopelidæ, etc., obtained their food in an aquatic larval stage and did not require it when mature. He concludes that the Protodonata fed on other animals, like our dragon-flies; that the Palæacridiidæ were herbivorous like our locusts and grasshoppers, the Protolocustidæ herbivorous and animal feeders like our green grasshoppers, the Palæoblattidæ omnivorous like our cockroaches. The Homoptera, too, had elongated sucking mouth-parts like the existing species. It is known that in Carboniferous times there was a lake with rivers entering it, at Commentry. From their great resemblance to living forms of known habits, it is probable that the majority of these insects lived near the water and their larvæ in it.

When we look at this most important piece of research as a whole, we cannot fail to be struck with the small advance in insect structure which has taken place since Carboniferous times. All the great questions of metamorphosis, and of the structures peculiar to insects, appear to have been very much in the position in which they are to-day. It is, indeed, probable enough that the Orders which zoologists have always recognized as comparatively modern and specialized, such as the Lepidoptera, Coleoptera and Hymenoptera, had not come into existence. But as regards the emergence of the Class from a single primitive group, as regards its approximation towards the Myriapods, which lived at the same time, and of both towards their ancestor Peripatus, we learn absolutely nothing. All we can say is that there is evidence for the evolution of the most modern and specialized members of the Class, and some slight evolution in the rest. Such evolution is of importance as giving us some vague conception of the rate at which the process travels in this division of the Arthropoda. If we look upon development as a series of paths which, by successively uniting, at length meet in a common point, then some conception of the position of that distant center may be gained by measuring the angle of divergence and finding the number of unions which occur in a given length. In this case the amount of approximation and union shown in the interval between the Carboniferous period and the present day is relatively so small that it would require to be multiplied many times before we could expect the lines to meet in the common point, the ancestor of insects, to say nothing of the far more distant past in which the Tracheate Arthropods met in an ancestor presenting many resemblances to Peripatus. But it must not be forgotten that all this vast undefined period is required for the history of one of the two grades of one of the three branches of the whole Phylum.

Turning now to the brief consideration of the second grade of Arthropods, distinguished from the first grade by the absence of antennæ, the Trilobites are probably the nearest approach to an ancestral form met with in the fossil state. Now that the possession of true antennæ is certain, it is reasonable to suppose that the Trilobites represent an early class of the Aceratous branch which had not yet become Aceratous. They are thus of the deepest interest in helping us to understand the origin of the antennaless branch, not by the ancestral absence, but by the loss of true antennæ which formerly existed in the group. But the Trilobites did not themselves originate the other classes, at any rate during Palæozoic times. They represent a large and dominant class, presenting more of the characters of the common ancestor than the other classes; but the latter had diverged and had become distinct long before the earliest fossiliferous rocks; for we find well-marked representatives of the Crustacea in Cambrian, and of the Arachnida in Silurian strata. The Trilobites, moreover, appear in the Cambrian with many distinct and very different forms, contained in upwards of forty genera, so that we are clearly very far from the origin of the group.

Of the lower group of Crustacea, the Entomostraca, the Cirripedes are represented by two genera in the Silurian, the Ostracodes by four genera in the Cambrian and over twenty in the Silurian; of these latter two genera, Cythere and Bairdia, continue right through the fossiliferous series and exist at the present day. Remains of Phyllopods are more scanty, but can be traced in the Devonian and Carboniferous rocks. The early appearance of the Cirripedes is of special interest, inasmuch as the fixed condition of these forms in the mature state is certainly not primitive, and yet, nevertheless, appears in the earliest representatives.

The higher group, Malacostraca, are represented by many genera of Phyllocarida in the Silurian and Devonian, and two in the Cambrian. These also afford a good example of the imperfection of the record, inasmuch as no traces of the group are to be found between the Carboniferous and our existing fauna in which it is represented by the genus Nebalia. The Phyllocarida are recognized as the ancestors of the higher Malcostraca, and yet these latter already existed—in small numbers, it is true—side by side with the Phyllocarida in the Devonian. The evolution of the one into the other must have been much earlier. Here, as in the Arthropoda, we have evidence of progressive evolution among the highest groups of the class, as we see in the comparatively late development of the Brachyura as compared with the Macrura. We find no trace of the origin of the class, or of the larger groups into which it is divided, or, indeed, of the older among the small groupings into families and genera.*

Of the Arachnida, although some of the most wonderful examples of persistent types are to be found in this class, but little can be said. Merely to state the bare fact that three kinds of scorpions are found in the Silurian, two Pedipalpi, eight scorpions, and two spiders in the Carboniferous, is sufficient to show that the period computed by geologists must be immensely extended to account for the development of this class alone, inasmuch as it existed in a highly specialized condition almost at the beginning of the fossiliferous series ; while, as regards so extraordinarily complex an animal as a scorpion, nothing apparent in the way of progressive development has happened since. Prof. Lankester has, however, pointed out to me that the Silurian scorpions possessed heavier limbs than those of existing species, and this is a point in favor of their having been aquatic, like their near relation, Limulus. If so, it is probable that they possessed external gills, not yet inverted to form the lung-book. The Merostomata are, of course, a Palæozoic group, and reach their highest known development at their first appearance in the Silurian; since then they have done nothing but disappear gradually, leaving the single genus Limulus, unmodified since its first appearance in the Trias, to represent them. It is impossible to find clearer evidence of the decline rather than the rise of a group. No progressive development, but a gradual or rapid extinction, and consequent reduction in the number of genera and species, is a summary of the record of the fossiliferous rocks as regards this group and many others, such as the Trilobites, the Brachiopods and the Nautilidæ. All these groups begin with many forms in the oldest fossiliferous rocks, and three of them have left genera practically unchanged from their first appearance to the present day. What must have been the time required to carry through the vast amount of structural change implied in the origin of these persistent types and the groups to which they belong—a period so extended that the interval between the oldest Palæozoic rocks and the present day supplies no measureable unit?

But I am digressing from the Appendiculate Phylum. We have seen that the fossil record is unusually complete as regards two classes in each grade of the Arthropod branch, but that these classes were well developed and flourishing in Palæozoic times. The only evidence of progressive evolution is in the development of the highest orders and families of the classes. Of the origin of the classes nothing is told, and we can hardly escape the conclusion that for the development of the Arthropod branches from a common Chætopod-like ancestor, and for the further development of the classes of each branch, a period many times the length of the fossiliferous series is required, judging from the insignificant amount of development which has taken place during the formation of this series.

It is impossible to consider the other Cœlomate Phyla as I have done the Appendiculata. I can only briefly state the conclusions to which we are led.

As regards the Molluscan Phylum, the evidence is perhaps even stronger than in the Appendiculata. Representatives of the whole of the classes are, it is believed, found in the Cambrian or Lower Silurian. The Pteropods are generally admitted to be a recent modification of the Gastropods, and yet, if the fossils described in the genera Conularia, Hyolithes, Pterotheca, etc., are true Pteropods, as they are supposed to be, they occur in the Cambrian and Silurian strata, while the group of Gastropods

* For an account of the evolution of the Crustacea see the Presidential Addresses to the Geological Society of London in 1895 and 1896 by Dr. Henry Woodward.

from which they almost certainly arose, the Bullidæ, are not known before the Trias. Furthermore, the forms which are clearly the oldest of the Pteropods—Limacina and Spirialis—are not known before the beginning of the Tertiary Period. Either there is a mistake in the identification of the Palæozoic fossils as Pteropods, or the record is even more incomplete than usual, and the most specialized of all Molluscan groups had been formed before the date of the earliest fossiliferous rocks. If this should hereafter be disproved, there can be no doubt about the early appearance of the Molluscan classes, and that it is the irony of an incomplete record which places the Cephalopods and Gastropods in the Cambrian and the far more ancestral Chiton no lower than the Silurian. Throughout the fossiliferous series the older families of Gastropods and Lamellibranchs are followed by numerous other families, which were doubtless derived from them; new and higher groups of Cephalopods were developed, and, with the older groups, either persisted until the present time or became extinct. But in all this splitting up of the classes into groups of not widely different morphological value, there is very little progressive modification, and, taking such changes in such a period as our unit for the determination of the time which was necessary for the origin of the classes from a form like Chiton, we are led to the same conclusion as that which followed from the consideration of the Appendiculata, viz: that the fossiliferous series would have to be multiplied several times in order to provide it.

Of the Phylum Gephyrea, I will only mention the Brachiopods, which are found in immense profusion in the early Palæozoic rocks and which have occupied the subsequent time in becoming less dominant and important. So far from helping us to clear up the mystery which surrounds the origin of the class, the earliest forms are quite as specialized as those living now, and, some of them (Lingula, Discina) even generically identical. The demand for time to originate the group is quite as grasping as that of the others we have been considering.

All the classes of Echinoderma, except the Holothurians, which do not possess a structure favorable for fossilization, are found early in the Palæozoic rocks, and many of them in the Cambrian. Although these early forms are very different from those which succeeded them in the later geological periods, they do not possess a structure which can be recognized as in any way primitive or ancestral. The Echinoderma are the most distinct and separate of all the Cœlomate Phyla, and they were apparently equally distinct and separate at the beginning of the fossiliferous series.

In concluding this imperfect attempt to deal with a very vast subject in a very short time, I will remind you that we were led to conclude that the evolution of the ancestor of each of the higher animal Phyla, probably occupied a very long period, perhaps as long as that required for the evolution which subsequently occurred within the Phylum. But the consideration of the higher Phyla which occur fossil, except the Vertebrata, leads to the irresistible conclusion that the whole period in which the fossiliferous rocks were laid down must be multiplied several times for this later history alone. The period thus obtained requires to be again increased, and perhaps doubled, for the earlier history.

In the preparation of the latter part of this address I have largely consulted Zittel's great work. I wish also to express my thanks to my friend, Prof. Lankester, whom I have consulted on many of the details, as well as the general plan which has been adopted.

E. B. Poulton.

Oxford.

PLANS FOR THE PROPOSED ZOOLOGICAL PARK IN NEW YORK.

Last spring the plans of the New York Zoological Society reached a point where it became necessary to take up the many questions involved in the design and construction of buildings and other enclosures for animals, and also their arrangement in the proposed Zoological Park. The Executive Committee realized the necessity of a thorough examination and study of the best zoological gardens of Europe.

Accordingly, Mr. William T. Hornaday, the Director, was instructed to visit all the large gardens of Europe, examine them carefully, and bring back photographs and designs of their most valuable and interesting features. He left New York in June, and visited the zoological gardens of the following cities, in the order named: London, Antwerp, Rotterdam, The Hague, Amsterdam, Hanover, Hamburg, Berlin, Dresden, Leipsic, Frankfort, Cologne and Paris. Altogether fifteen gardens were inspected, and their best features were photographed, sketched and studied throughout. Without an exception, the Directors, Superintendents and Inspectors of the gardens visited were very cordial. Every fact asked for was cheerfully furnished, without the slightest hesitation or reservation. Not only were good features pointed out as being worthy of special attention, but some officers very kindly indicated the mistakes that had been made in their gardens in the early days when everything had to be determined by experiment, thus showing what to avoid.

In London, Dr. P. L. Sclater, the executive head of the London Zoological Society, gave all the information and facilities for photographing that were desired in the Society's gardens, and Mr. Clarence Bartlett, Assistant Superintendent, explained the entire working machinery of this truly magnificent zoological institution.

At Antwerp the visitor is fairly amazed at the perfection of all the larger buildings for animals and the extreme beauty and attractiveness of nearly every feature of that scientific establishment. Director L'hoest and his Assistant, M. J. De Winter, were untiring in their willingness to afford all the information desired, and to show everything not open to general view. Only two and one-half hours distant is found the beautiful garden at Rotterdam, known to but few Americans, where Dr. Von Bemmelin pointed out with pardonable pride the newest lion house, in Europe, and the first great flying cage ever constructed for the larger wading birds. An equally short distance farther on, at Amsterdam, is found a very rich colleclection, installed amid charming surroundings, in which the health and 'condition' of every bird and quadruped seems absolutely perfect. In the absence of Director Kerbert, Inspector Castens devoted hours of time to answering the question, "How do you keep everything in such fine condition?"

At Hanover, Dr. Ernest Schäff fully explained the plan of foundation and management of his zoological *forest*, and supplied a plan of the new and admirably constructed Antelope House. At Berlin was found another royal establishment, with the larger mammalia housed in ornate and costly buildings. The garden occupies part of imperial grounds and it is one of which the citizens of Berlin may well be proud. Dr. Ludwig Heck, its director, became much interested in the New York plan, and his cooperation was heartily extended. At Hamburg another very fine garden was inspected, in which all the shade is the result of artificial planting. It thus affords a fine opportunity to observe what can be accomplished if sufficient time is allowed. The shade trees are now very beautiful, and at once impress the expert visitor as being remarkably well distributed to serve their purpose of shading both the out-door animals and the walks. Two days were spent with Herr Carl Hagenbeck, who has at Hamburg a *Thierpark* of his own, quite as large as the Central Park Menagerie of New York. Probably no man living has given more study to the problems of zoological garden construction and the care of animals in captivity, and Mr. Hornaday found him not only willing but eager to explain the mistakes to avoid, as well as the latest developments in the care of animals.

The director of the very interesting garden at Cologne, Dr. Wunderlich, was quite as ready with helpful information as his colleagues of other cities, and some of the features of his establishment were found to possess exceptional interest. The Frankfort garden contains much that is new and admirable. Prof. Milne Edwards, Director of the Paris *Jardin des Plantes*, also extended every facility for study and examination of this the oldest garden of Europe. Regarding the status of a garden which, like this, is free to the entire public, the experiences and observations of Prof. Milne Edwards were both interesting and valuable. He expressed the opinion that no zoological garden should be kept open every day in the week, principally because it is not best for the collections.

The store of photographs, sketches, notes and plans collected during this tour are now being utilized in the preliminary plans for the New York Park. It is proposed to determine the location and general design of every building and enclosure before the project is finally submitted to the city authorities in January, 1897. The site selected by the Society is the southern portion of Bronx Park, about a quarter of a mile south of the Botanical Garden. According to the Charter granted to the Society by the New York Legislature in 1895, the approval of this selection rests with the Mayor and Commissioners of the Sinking Fund.

CURRENT NOTES ON PHYSIOGRAPHY.

GLACIAL SAND PLAINS ABOUT NARRAGANSETT BAY.

The geographical significance of glacial action is well exhibited in an account of the 'Retreat of the ice sheet in the Narragansett bay region,' by J. B. Woodworth (*Amer. Geol.*, XVIII., 1896, 150–168). Sand Plains, stretching east and west, repeatedly succeed one another on a north-south line. Each plain was formed rapidly by streams flowing out from the margin of the slowly retreating ice sheet into standing water; whether the standing water was an arm of the sea, then about fifty feet higher than now, or a local water body, is not determined. Each plain has the gently sloping surface, the lobate front and the peculiarly stratified structure of a delta; but at the head the plain falls off northward in a steep slope, associated with kames, and descending to a lowland area that is often boulder-strewn and marked by gravel mounds or occupied by swampy basins drained by sluggish streams; here the ice sheet stood while the plain was forming. This lowland is compared to the 'fosse,' a marked feature on Nantucket, between the head of the great sand plain on the south and the moranic till mounds on the north. The same might be said of the similar fosse on Martha's Vineyard.

A small but well defined boulder moraine in southwest Rhode Island is described by Woodworth and Marbut (Chicago Journ. Geol., IV., 1896, 691–703).

TOPOGRAPHIC TERMS OF SPANISH AMERICA.

The richness of some languages and the poverty of others in terms descriptive of topographic form has often been remarked. The New Englander never invented a generic name for the numerous drumlins that he early selected for clearing; they were to him simply 'hills.' The Spanish race is more appreciative and a number of Spanish-American topographic terms are now brought together by R. T. Hill, who illustrates their value by using them in a few sample descriptions (*Nat. Geogr. Mag.*, VII., 1896, 291–302): "An appropriate generic term should be provided for every possible form of the earth's surface, so that when referred to it may be as readily recognized as are the parts of a building in an architectural description."

It is to be noted that the terms quoted by Hill are purely empirical, connoting in their original usage no explanation, although Hill now gives them certain physiographic limitations. They are thus like *delta*, *atoll* and *drumlin*, and are quite unlike *anarregmatic* and *heteroptygmatic*, invented by Löwl; *anaclinal* and *cataclinal*, proposed by Powell, and *beheadland* and *inface*, of other authors. The precise definition of the Spanish-American terms by an expert familiar with the ground is a valuable contribution to exact geography; but it is questionable whether a wholesale introduction of foreign words from a single language (if this be contemplated) is desirable in reports on our western country, where such terms may have a certain currency. Instead of adopting Spanish-American words, let us imitate their methods and evolve our own words; or let us be more cosmopolitan and take appropriate words from many languages. For the Spanish *teta*, the Scotch have *pap;* for *huerfano*, there is the French *témoin*, if our own *outlier* does not suffice; for *caleta*, we could import *beck* or *gill*, from north England; for *plaza*, there is the Hindu *khadar*, or the Scotch *strath*, and so with many others. The chief advantage of foreign words is that they are to us meaningless, except in their special use. This advantage is indeed shared by terms like *symptygmatic*, *diaclinal* and *obsequent;* yet such terms are for some reason hardly used by others than their inventors. After all, terms will grow rapidly enough if we have term-users, studious observers of the face of the earth. Without these the richest terminology is of no avail.

MATURE AND IMMATURE GEOGRAPHY.

THE current style of geographical description is essentially immature, in that it differs from the geography of school years in quantity rather than in quality. There is no reproach in designating the geography appropriate to school children as 'childish,' but it is a reproach to the science of geography to find so great a quantity of material not beyond childish quality in geographical journals intended for mature readers. The general phrasing is, of course, more mature than that adapted to school use, but the geographical terms are hardly increased beyond the small stock gathered from elementary text-books, and the relation of earth and man often has to be inferred by the reader from the diverse and disconnected facts reported by the writer. Mountains and valleys, plains and plateaus, rivers and lakes; high and low, broad and narrow, imposing and tame, fertile and barren—these are fair samples of the nouns and adjectives used by explorers in describing the varied features of the land. Manifest relations, such as the avoidance of rugged mountains and the occupation of fertile valleys, the location of trails over passes, the migration of wandering tribes with the seasons, are commonly enough stated explicitly, as they might be in an elementary school book; but the more advanced discussion of the relation of earth and man is seldom consciously undertaken.

It is plain that the advance of geography to a mature stage, appropriate to the age of adult students, explorers and readers, requires serious preparatory discipline in various directions: First, in the systematic, scientific study of land and water forms, so that new examples of known kinds may be easily recognized and briefly named, and so that examples of novel, undescribed kinds may be attentively studied when discovered. Second, in the equally thorough study of the manifold types of weather and climate, so that they may be similarly treated. Third, in the equally thorough study of the various relations between earth and man—anthropogeography; or, if desired, between earth and all forms of life —biogeography; for then only can the human or organic element be stated in its geographical relations, and not simply in its anthropological or biological relations. A person who is untrained in these directions may, of course, follow known paths as a traveller, or break new paths as an explorer; but it is questionable whether he should be called a geographer.

GLACIAL ACTION AND SHIFTING DIVIDES IN THE SCHWARZWALD.

G. STEINMANN has recently discussed the glacial phenomena of the Schwarzwald (Die Spuren der letzen Eiszeit im hohen Schwarzwalde. Freiburg Univ. Festprogr., 1896). From ice fields above 700 m., many valley glaciers descended to 400 m. Glaciated surfaces, smoothed valleys, cirques, rock basins, terminal moraines and valley gravels are all described in evidence of ice action. The author is led to ascribe the diversion of former headwaters from the Wutach (Danube system) to the Höllenthal (Rhine system) by ice-barring. Map and profiles give clear illustration of the inferred process, which Steinmann naturally prefers to the cataclysmic explanation suggested by Fromherz half a century ago. But the width (about 1 k.) of the Höllenthal accross the old divide seems too great to have been gained in post-glacial time. Furthermore, no consideration is given to the normal process of shifting divides by the more rapid gnawing at the steeper headwater (Höllenthal). This slow process is undoubtedly responsible for the repeated examples of shifted divides between Rhine and Danube headwaters farther northeast in the Swabian Alp, where the 'cuesta,' as Hill might call it, or the 'Stufenlandschaft,' as Penck would say, becomes dominant. It therefore seems probable that normal shifting may find some application in the Schwarzwald also.

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CURRENT NOTES ON ANTHROPOLOGY.

THE INDIAN QUESTION.

IN practical sociology no question has so long worried the American philanthropists as 'What to do with the Indians.' Even the archæologists—who are popularly supposed to agree with General Crook, that the only good Indian is a dead Indian—have taken it up, and in the last number of the Proceedings of the American Antiquarian Society is an article on the subject by Mr. J. Evarts Greene.

He makes the revolutionary suggestion that our government should scrupulously keep its promises to the Indians (!) and then proclaim them minors, keep their property and spend it for them as we see fit.

This latter item we will all gladly undertake; but the former is so totally without precedent that it sounds anarchistic! Are we, because of some short-sighted promise of our fathers, to allow the savage to impede the glorious march of civilization in this great western world? Never!

In the discussion President G. Stanley Hall rather timidly advanced the suggestion that if the Indian is met 'in a sympathetic way' he might develop his own civilization. As if our noble and active youth had time to 'sympathize' with the 'gray barbarian,' when the manifest destiny of the youth is to amass a fortune and live abroad!

Independence and land in severalty form the only honorable platform, and, as we grant that to white, yellow and black citizens, why draw the line at the color red? Secular education, and not mere Sunday-schooling, will teach them to use this independence aright.

ANTHROPOLOGY OF FRENCH POLYNESIA.

WE scarcely ever hear about the French possessions in Polynesia. The tri-color in fact floats over a number of coral islets and pocket archipelagoes in the benign climes of the Pacific sea. The most important spots are Tahiti and the Marquesas group. The anthropology of these islands is discussed by Dr. Gros, of the French navy, in the Bulletins of the Anthropological Society, Paris, of this year.

After giving a number of measurements he discusses several questions of general interest. Is the native population decreasing, and why? It is decreasing, not very rapidly, and owing mainly to mortality from epidemics, which this brown race has little power to resist. They are, moreover, great drunkards, and this predisposes them to disease.

Are they capable of culture development? Decidedly so, thinks Dr. Gros. Before the arrival of the whites they had made steady and considerable progress, and when given an opportunity readily acquire and use modern education. The teacher is the person needed in Polynesia. Divorces are frequent and social morality low. Much of this is owing to the example and influence of Europeans. The race is rapidly becoming of mixed blood from crossing with foreigners of different nationalities who visit the islands.

THE LATE DR. A. H. POST.

IT would be difficult to name any writer in this generation whose conception of the science of Ethnology was so profound and noble as that of the late Dr. A. H. Post, of Bremen. He understood that science in its broadest connotation, and clearly recognized in it that branch of learning which in the not distant future will modify all others, changing their direction and altering their contents. He saw that ethnology is bound completely to subvert the present popular *Weltanschauung*, and substitute for it another with scarcely any points of contact.

Post's especial field was that branch of Ethnology which deals with the ideas of rights and equities, the treaties and duties of man to man, in other words, jurisprudence in its largest meaning. On this he wrote a number of articles and treatises, the most important being his 'Grundriss der ethnologischen Jurisprudenz,' published but a few months before his death. This is a work which combines extraordinary minuteness of detail with equally extraordinary grasp of principles, and sets forth the elements of Ethnology as a (one might almost say, *the*) universal science through one of its branches.

Dr. Post's friend and admirer, Dr. Th. Achelis, has just published an appreciative tribute to the departed thinker. It sets forth briefly the aim and spirit of his work and should be taken to heart by all who have learned to know this great, new growth of man's intelligence (A. H. Post und die vergleichende Rechtswissenschaft. Hamburg, 1896).

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NOTES ON INORGANIC CHEMISTRY.

A PAPER was recently read before the Royal Society of New South Wales by Prof. Liversidge, of the University of Sydney, on the amount of gold and silver in sea water. Heretofore it has been considered that the amount of gold present is about four grains per ton. The experiments of Prof. Liversidge show that for Australian waters this figure is too large, the amount being from one-half to one grain of gold per ton of sea water. Even this would be in round numbers about 200 tons of gold per cubic mile, and if the volume of the ocean be considered 300,000,000 cubic miles, a total amount of gold in sea water of sixty billion tons. Yet this amount is probably insignificant in comparison with the amount of gold disseminated in crystalline and sedimentary rocks apart from gold in veins and other deposits. Experiments seem to indicate that sea water contains about the same amount of silver and gold.

Prof. F. P. Venable's work on 'The Development of the Periodic Law' has just appeared from the press of the Chemical Publishing Company. It is a book of over three hundred pages, dealing exhaustively with subjects from the days of Dalton and Prout down to the present year, and covering a phase of chemical history hitherto vacant.

On October 1st appeared the initial number of a new periodical in chemical technology, the *Chemische Rundschau: Zeitschrift für die gesammte chemische Industrie.* It is a quarto of twenty-four pages, to appear semi-monthly, at sixteen Marks per year. Its editor is Dr. Franz Peters, assistant at the Technische Hochschule at Charlottenburg, and it is published in Berlin. The first number contains several pages of original matter, a rather larger number devoted to abstracts, and quite full trade notes, together with book reviews, society proceedings and patent lists.

The idea suggested by Prof. Ramsay in connection with his work on Helium, that it is possible that all atoms of the same chemical element do not possess exactly the same weight, and which was also suggested by Prof. Crookes in connection with his work upon the rare earths, is by no means new. Before Stas entered upon his great work on atomic weights he raised the question as to whether these weights were unchangeable, but after experiment decided it in the affirmative (Stas: Untersuchung über die Gesetze der chemischen Proportionen, etc. Deutsch von L. Aronstein, Leipzig, 1867, p. 3). Again in 1883, working on the analysis of Caucasian petroleum, Schützenberger was unable to explain certain quantitative anomalies in the amount of carbon dioxid obtained, and Butlerow proposed as a most probable cause a variation in weight of the carbon atom (Bull. Soc. Chim., 39: 258, 263). This question has also been discussed on theoretical grounds by Marignac, Kremers and Cooke. Prof. Ramsay's promised experiments on the fractional diffusion of oxygen and nitrogen through clay septa will be awaited with interest as a valuable contribution to the subject.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

A BUILDING FOR THE SCIENTIFIC SOCIETIES OF NEW YORK.

Mr. Charles F. Cox, Treasurer of the New York Academy of Sciences, has addressed a letter to the editor of the *Evening Post* appealing to a man of wealth or a group of men to provide a suitable building for the societies composing the Scientific Alliance of New York.

The counsel of the Alliance was last year incorporated under a charter which gives it power to receive gifts and bequests and to hold real estate for the benefit of the organizations which it represents. The combined membership of these societies is now over 1,000. Nearly all of them issue valuable publications; several of them own important libraries and growing collections of specimens, and all are actively engaged in original research as well as the popular presentation of scientific topics.

The societies suffer from lack of a suitable building similar to that of Burlington House, London, but in New York this can only be provided by the enlightened liberality of private citizens. The proposed building should be located in the center of the city, and should be large enough to contain: a lecture-hall having a seating capacity of not less than 1,200, in which free popular lectures could be given frequently; a library with shelf-room for not less 100,000 volumes, in which should be formed a model collection of works of reference in every department of science; a meeting-room to accommodate say 250 persons, in which the ordinary sessions of the several societies would be held; a smaller room for each of the constituent organizations, in which its private records and papers might be kept and where its committee meetings could be held and other detail work performed; and finally a few small laboratories and a photographic room for the common use of all members.

SPECIALISM AT THE BRITISH ASSOCIATION.

THE forthcoming number of *Natural Science* will contain a timely protest against the presentation of trivial papers, or of technical papers that should be printed rather than read, at meetings of the British Association. The editorial article continues: "Of course, the wise man does not go to hear these papers; he knows that many of them are read for the sake of self-advertisement, and that any which are of value will soon be accessible through the ordinary channels of publication. For all that, it seems well to protest, if only in the hope that our words may reach the Canadian cousins who are preparing so splendid a welcome for the Association next year. These papers not merely clog the work of the sections, but have an effect directly contrary to the main object of the Association. Some, perhaps, read by local naturalists, or descriptive of local phenomena, to which the attention of visitors should be directed, are not to be discouraged, but the rest both frighten away the people whom the Association wishes to attract, and, what we feel to be of more importance, tend to split the scientific visitors themselves still further among sections. The Association should rise above the specialism of most of our learned societies; it should offer a field where the zoologist might confer with the botanist, where both might exchange experiences with the geologist, and where all three might pick up something of use to them from the physicist and chemist, who in their turn need not go the poorer away. Let there be more discussions on matters of general interest, and let them be thrown open to even more sections. Why, for instance, should the discussion of Neo-Lamarckism have been confined to zoologists? Surely some of the physical problems that were hinted at in the discussion on the cell might have been laid before the physicists."

GENERAL.

FOLLOWING on the death of Ferdinand Baron von Müller the death is announced of Dr. Henry Trimen, who occupied a position in Ceylon somewhat similar to that held by Müller in Australia. Trimen died on October 16th, at Peradeniya, at the age of fifty-two. Before leaving England he had been curator of the anatomical museum of King's College and senior assistant of the botanical department of the British Museum. He edited the *Journal of Botany* from 1872 to 1879. In 1880 he was appointed director of the Royal Botanic Garden at Ceylon. He made numerous contributions to our knowledge of the flora of the island, and introduced into cultivation many useful products from foreign countries.

DR. GEORGE HARLEY, a distinguished English physician and versatile writer, died in London on October 27th.

PROF. L. L. DYCHE, of the University of Kansas, has returned from Alaska, where he has explored Cook's Inlet and the Knik river, and has obtained many valuable zoological specimens.

A SERIOUS explosion occurred in Paris on October 17th. A tube containing acetylene exploded and the building used by M. Raoul Pictet, the well known chemist, for the manufacture of acetylene was entirely destroyed.

IT is announced in *Nature* that the following have been nominated by the Council of the London Mathematical Society for election as the Council and officers for the ensuing session: President, Prof. Elliott, F. R. S.; Vice-Presidents, Major Macmahon, R. A., F. R. S., M. Jenkins and Dr. Hobson, F. R. S.; Treasurer, Dr. J. Larmor, F. R. S.; Secretaries, R. Tucker and A. E. H. Love, F. R. S.; other members, Lieut.-Col. Cunningham, R. E., H. T. Gerrans, Dr. Glaisher, F. R. S., Prof. Greenhill, F. R. S., Prof. Hill, F. R. S., Prof. Hudson, A. B. Kempe, F. R. S., F. S. Macaulay and D. B. Mair. At the annual general meeting of the Society, which will be held on November 12th, Major Macmahon will take as the subject of his valedictory address, 'The Combinatory Analysis.' On the same evening the De Morgan medal will be presented to S. Roberts, F. R. S., who will be the fifth recipient of the medal.

According to the authorized announcement of the University of the State of New York, Prof. W. M. Davis, of Harvard University, has been invited to prepare, for publication and distribution in the New York schools, a pamphlet, similar to that prepared for the State of Connecticut, as an aid to the more interesting and profitable study of geography. Prof. Davis has also consented to speak at the next University convocation on the present trend of the study of geography.

The will of the late Sir John Erichsen bequeaths to University College his surgical instruments and appliances, and to University College Hospital £2,000 for the rebuilding fund exclusively.

The thirty-sixth annual meeting of the National Educational Association will be held in Milwaukee during the first week of July of next year.

We learn from *The Lancet* that the new Pathological Institute, which has been erected in the grounds of the Western Infirmary, Glasgow, was formally opened on the 14th inst. The institute comprises a large lecture room, post-mortem laboratory, practical class room, chemical and bacteriological laboratories, photographic room and private working rooms, in which original researches may be conducted, as well as a large and commodious museum. The total expenditure has exceeded £15,000. At the inaugural ceremony Prof. Gairdner delivered an address on the relation of the study of pathology to the art of medicine and the public health. Speeches were also delivered by Prof. Coats, Prof. Boyce (Liverpool), Dr. Leith, (Edinburgh), Mr. J. G. A. Baird, M.P., and Mr. J. Wilson, M.P.

It is announced that The Yerkes Observatory will be ready for dedication and occupancy by the middle of the present month. The first bulletin of the observatory giving an account of its organization has already been issued. The bulletins will be published regularly and will contain announcements of new discoveries, and of the work of the observatory. There will also be published, under the title 'Contributions from the Yerkes Observatory,' papers contributed to various journals; and in quarto volumes 'Annals of the Yerkes Observatory,' containing accounts of research. The *Astrophysical Journal*, published by the University of Chicago, is now in its third volume and has maintained a high position as an international journal devoted to astro-physics and spectroscopy.

The foundation stone of the Marine Biological Station, Firth of Clyde, was laid on the 18th of last month by Dr. Thomas Reid, who has given £500 toward the building fund. The site was given by the Marquis of Bute.

A new laboratory of bacteriology has been established at the University of Pennsylvania by the State Live Stock Sanitary Board, in connection with the veterinary department. The purpose of this is to study all diseases connected with poultry and cattle. Dr. M. P. Ravenel, of the medical faculty, has been made director and bacteriologist.

D. Appleton & Co. announce the early publication of the completion of Herbert Spencer's system of philosophy. As first stated, this division of the *Synthetic Philosophy* was to be treated in two volumes, but in their preparation the amount of matter grew to such proportions that a third volume became necessary. It contains: Part VI., Ecclesiastical Institutions; part VII., Professional Institutions, and part VIII., Industrial Institutions.

Among other forthcoming books we notice 'Charles Darwin and the Theory of Natural Selection,' by E. B. Poulton (Cassell); 'An Autobiography of George Biddell Airy, Astronomer Royal from 1836 to 1881,' edited by Wilfrid Airy (Cambridge University Press), and 'Ancient Volcanoes of Britain,' by Sir Archibald Geikie, F. R. S., two volumes, illustrated (Macmillan).

A house divided against itself:

"I am much mistaken if the scientific spirit of the age is not doing us a great disservice, working in us a certain great degeneracy. Science has bred in us a spirit of experiment and a contempt for the past. * * * We have made a perilous mistake in giving it too great a preponderance in method over every other branch of study.''—Professor Woodrow Wilson, in the official oration at the Princton Sesquicentennial. ''Religious themes must be discussed in a scientific spirit and according to scientific principles.''—President Patton in the official sermon.

BACTERIOLOGY is probably the newest of the sciences, but germs and animalculæ have for centuries been regarded as possible causes of disease. The *Lancet* makes the following curious quotation from the 'Life of Aly Pasha,' who was Governer of Janina about the beginning of the century: "'That man,' continued Aly, 'is one of those who see in the dark. Would you believe it? He pretends that the plague is composed of a vast number of minute animalculæ, which would be visible through a magnifying glass, if one could be procured of sufficient power.'"

Appleton's Popular Science Monthly for November contains, as usual, a number of interesting articles. Among them may be mentioned an illustrated article by Dr. Bashford Dean reviewing the public aquariums of Europe, more especially those at Naples, Amsterdam, Plymouth, Paris, Berlin and Brighton. Prof. A. S. Packard contributes an article describing an ascent of of Mt. Shasta and a description of its crater. Prof. Harrison Allen publishes an address first delivered before the Academy of Natural Sciences, Philadelphia, describing the contributions to natural history made by Sir Thomas Brown and Sir Thomas Stanford Raffles. Prof. W. R. Newbold continues his interesting series of articles treating double personality. Prof. E. R. Shaw urges the employment of motor activities in teaching, and Prof. R. W. H. Hudson argues in favor of a natural moral standard. There is a sketch of William C. Redfield.

PROF. F. MAX MÜLLER'S translation of the Kant's *Critique of Pure Reason*, originally issued in 1881 in commemoration of the centenary of its first publication, has been reprinted with alterations by The Macmillan Company. As people seem more inclined to read books about literary and philosophical classics than the classics themselves, it is gratifying to find that there is a sufficient demand for a translation of Kant to warrant a new reprint in America. This must mean that there are many who read Kant, for it may be assumed that the great majority of those who care to read his works at all prefer to do this in the original. Prof. Max Müller has a perfect command of both German and English and effaces himself in the translation, not overburdening the text with philosophical or bibliographical notes. Kant was himself a man of science as well as a metaphysican, and while students of science are likely to find a certain insubstantiality in his *Critiques*, no one can read and understand them without securing a firmer foothold and a clearer outlook.

THE Open Court Publishing Company is performing a real service to science and philosophy by publishing, in excellent typography and at a low price, reprints of standard works. The last volume issued in the series, which is published bi-monthly at a yearly subscription price of $1.50, contains the English translation of Prof. Ernst Mach's *Popular Scientific Lectures*. Prof. Mach is one of those leaders in science who, like Helmholtz and Huxley, regards it as part of his service to interest the general public in scientific questions. These lectures when delivered must have attained their end to an unusual degree. As reprinted they are of somewhat unequal merit. So much progress has been made in physiological optics and acoustics during the past thirty years that lectures on these subjects written in the sixties are somewhat out of date. The polemic against the classics seems extreme. A judicial adjustment of claims is not forwarded by speaking of the 'narrow provinciality of mind' of the Greeks, or of 'Aristotle with his incapacity to learn from facts.' On the other hand, several of the lectures, such as the one on 'The Economic Nature of Physical Inquiry,' contain important contributions to scientific method.

WE take from the foreign journals the following details of the life of Moritz Schiff, whose death was recorded in the last number of this

Journal. Schiff was born at Frankfort-on-Main in 1823, and was therefore 73 years of age. He studied medicine at Heidelberg (under Tiedemann), Berlin (under Johann Müller), and Göttingen. After taking his degree, he proceeded in 1845 to Paris, where he worked under Magendie and Longet. On his return to Frankfort he was appointed Director of the Ornithological Department of the Zoological Museum there. During the political disturbances in 1848 he served as a military surgeon on the Revolutionary side. His Liberalism practically closed the doors of the German universities against him, and he was refused a qualification as *Privatdocent* in zoology by the University of Göttingen on the ground that his teaching would be dangerous to the young. In 1854 he was appointed to the chair of comparative anatomy in the University of Berne, and this post he occupied till 1863, when he accepted an invitation to become professor of physiology in the Instituto degli Studii Superiori at Florence. There he remained till 1876, when he accepted an offer of the chair of physiology in the University of Geneva, which he held till his death. In January, 1894, Geneva celebrated the fiftieth anniversary of his medical doctorate and his pupils undertook to publish his researches in a special edition, the last volume of which was completed just before his death. These volumes show the great range and importance of Schiff's physiological researches. These, as is well known, were especially on the nervous system, but he also made important contributions to the physiology of digestion and of secretion. Earlier in his life he had published valuable contributions to ornithology. Schiff had been driven from Germany for his liberalism and from Italy on account of his experiments on living animals, though, as in the case of Ludwig, his treatment of these was always most kindly. His character, was not, however, affected by this treatment, and he was greatly beloved by his students and by all who knew him.

Several committees made reports in the department of meterology at the recent meeting of the British Association. The Committee on Meteorological Observations on Ben Nevis gave the details of the year's work. The observers have been investigating in past years the influence of cloud or fog and clear weather respectively on the daily fluctuations of barometric pressure. For these observations the directors have resolved to establish a temporary station, intermediate in height between the summit and the low-level station at Fort William. The report on solar radiation was presented, also that on seismological observations. The latter stated that, now that it had been proved that any important earthquake is felt all over the globe, the committee consider that arrangements should be made for the record and study of these movements. The committee believe that such records might prove as important as those of, *e. g.*, terrestrial magnetism, and, just as they had magnetic observatories in various parts of the world, so in its opinion should there be seismological ones. For the experimental work of the coming year the committee had one instrument, and could have the use of another (constructed under a grant to Prof. Milne by the Royal Society); it wished to purchase two others, and would have to build piers, etc., and pay for photographic necessaries and an assistant to run the instruments, which, altogether, would probably cost £200. In the report of the Committee on Meteorological Photographs full details were given of the method by which simultaneous photographs are taken, at two stations, 200 yards apart, of the same cloud in order to obtain the distance of the cloud from the observer. The sun is included in the photograph and serves as a reference mark in the measurements.

A correspondent of the *N. Y. Evening Post* states that, to hold the new liquid fuel which is to be used hereafter in the German navy, large reservoirs holding over 100,000 gallons have been erected at Wilhelmshaven, and similar arrangements will be made at Kiel and Dantzic, a credit of nearly $45,000 having been provided for this purpose in the last budget, besides $22,500 for pumping plant in connection with the basins. After various trials, the authorities have decided to fit all existing large men-of-war with apparatus for heating their boilers partly with oil, and the use of liquid fuel will be provided for in all new constructions.

UNIVERSITY AND EDUCATIONAL NEWS.

THE regents of the University of the State of New York will hereafter strictly enforce the law prohibiting the unauthorized use of the names college and university. An institution to be ranked as a college must have at least six professors giving their entire time to college and university work and a course of four full years of college grade in liberal arts and sciences, and must require for admission four years of academic or high school preparation in addition to the preacademic or grammar school studies. The regents believe it sound educational policy to encourage the establishment and maintenance of colleges wherever these minimum conditions can be met. The small college follows naturally the high school, and the more widely it is scattered about the country the better for higher education, but to give college instruction is a very different matter from exercising university powers in conferring degrees. The council earnestly recommended, as vitally important for protecting and promoting higher educational interests, that the regents should not, except for extraordinary reasons, increase the number of institutions in this State holding degree-conferring powers. Students completing the courses in colleges newly established may obtain from the university of the State the bachelor's degree, which will be more valuable and more widely recognized than a degree conferred by a local institution.

THE will of the late Miss Abby G. Beckwith leaves $5,000 to Brown University for the founding of two Scholarships.

THE first graduate of the University of Wales by examination is a woman, Miss Maria Dawson, B. S.

PROF. HOELDER, of Tubingen, has been appointed professor of mathematics in the University at Königsberg; Prof C. von Seelenhorst, of Jena, assistant professor in the University of Göttingen, and Dr. H. Stuhr, assistant in the Anatomical Institute at Breslau, in succession to Dr. Endres; Dr. Andreas Obrzut, of Prague, to the chair of anatomy at Lemberg. Dr. Joseph Blaas, of the University at Innsbrück, has been promoted to an assistant professorship of geology and paleontology.

DISCUSSION AND CORRESPONDENCE.

A REPREHENSIBLE METHOD OF DETERMINING PRIORITY OF PUBLICATION.

QUESTIONS of nomenclature and of priority of discovery in relation to matters of fact must, of course, be decided by the date of publication of the works in which the names of the species or the facts in question were first announced; hence it is important to determine the date of publication with the greatest possible definiteness. It is, therefore, necessary to define at the outset what is meant by the term publication. On this point the 'Century Dictionary' will be admitted as good authority. In this work the word publication, in the sense in which it is used in the present article, is defined as follows: "The act of offering a book, map, piece of music, or the like, to the public by sale or by gratuitous distribution." Publication thus implies distribution, and has no necessary relation to the date of printing, except that, of course, printing must precede publication.

Unfortunately, however, it is often difficult to determine the exact date when a book, pamphlet, or any regular part of a serial publication, or the signature of any work issued in signatures, became accessible to the public, or even to those especially interested in the subject to which the treatise relates; in a word, when it was *published*, or, to use the 'Century Dictionary' expression, *when it was offered to the public.*

We have only to look through the various codes of nomenclature for biology to find that the matter of determining the 'date of publication' has received attention from those who have made this question the subject of special consideration. The rule generally adopted by scientific bodies which have legislated on the subject is to the effect that the ostensible date, as that given on the title page of a book or pamphlet, or at the bottom of the signatures, when works are issued in signatures, shall be taken as the correct date, unless known to be erroneous, and that whenever such dates are found to be erroneous the true date of publication shall be taken in all cases where it can be established. The date of printing is thus wholly ignored as having any bearing on the date of publication. Hence the long accepted date of some well-known work is liable at any time to be overthrown and some later or earlier date established as the real and proper date of publication, leading, of course, to great inconvenience and often to the overthrow of long accepted names.*

In view of the general unanimity of action on the part of naturalists on this question, it is a matter of surprise and deep regret that the Zoological Section of the American Association for the Advancement of Science should have recently adopted a set of resolutions wholly at variance with not only the concensus of opinion concerning 'the date of publication,' but with common sense; the only redeeming feature being the fact that they will fall harmlessly in consequence of their obvious absurdity. These resolutions were adopted at the Springfield meeting, held in August, 1895, and appear in the recently issued volume of the 'Proceedings' of the Association for that meeting (p. 159).† The whole pith of the resolutions is that 'the date of publication of books is the date at which they are printed.' This is the phraseology adopted in the second '*whereas*,' while the resolution covering this point is, in full, as follows:

"Resolved: *First*—The Section of Zoology of the American Association for the Advancement of Science recommends that the date of the completion of printing of a single issue be regarded as the date of publication.

"*Second*—That the Section recommends that such date be printed on the last signature of all publications, whether books, periodicals or 'separates.'"

The reasons given in support of this resolution show a surprising lack of familiarity with the subject in hand on the part of the framers of these resolutions; and it is not a little remarkable that they should have been adopted in such a body 'with but one pertinent objection,' as the editor of the *American Naturalist* states. The gist of the argument in favor of the above quoted resolution is given under the final '*whereas*,' as follows: "The determination of the date of printing will generally depend on the records of the printing office and the testimony of several persons, while the time of mailing will be known generally to but one person;" or, as said just previously, "the actual date of mailing will be often impossible to ascertain with precision, owing to lack of record and irregularity in the period of transmission."

While these allegations may be true, they have really no bearing on the question at issue, namely, the *date of publication*, as commonly understood.

The absurdity and mischievousness of this ruling may be easily illustrated. The U. S. National Museum has within the last few months distributed two 'Special Bulletins' bearing date 1895. These important quarto publications were *printed* in 1895; in one case the printing was completed six or eight months, and in the other nearly or quite a year, before any copies were distributed, or before these works were 'published.' In one of these a new genus of fishes was described, under a name which before the work was published was also given to a genus of birds. The paper in which the bird genus was described and named is dated and was distributed June, 1896, while no copies of the work in which the fish genus was described were distributed before August, 1896, as I am informed by one of the authors of the latter work. According to current usage, the generic name in question must stand for the bird genus, and the fish genus must be renamed. According to the 'resolutions' of the Zoological Section of the American Association for the Advancement of Science, the name must stand for the fish genus and the bird genus be renamed. This is only one out of many parallel instances that might be cited.

When, as often happens, a work appears from the Government Printing Office months or even years after it was printed and dated, it is obviously absurd to claim, when the facts in the case are known, that the work was published at the date borne on the title page, if it

*A case in point is the 'Proceedings' of the London Zoological Society, some parts of the earlier volumes being dated from three months to two years and a-half in advance of their delivery by the printer to the Society. *Cf.* Sclater (P. L.), Proc. Zool. Soc. London, 1895, pp. 435–440.

†They appear to have been first printed in this Journal for October 11, 1895 (N. S. Vol. II., pp. 477–8), and have been recently reprinted with editorial commendation in the *American Naturalist* (August, 1896, pp. 651, 652).

was not distributed and rendered accessible to the public till a long time after it was printed. Indeed, it has often happened that books have been printed, even under other than Government auspices, and held in storage for years before any copies were distributed. In the usual course of trade books are often printed and held in stock, for trade reasons, for issue on a certain date, which is recognized as the date of publication. On a certain fixed day, generally previously announced, the book is placed on the market, and the advance orders for it from booksellers and others are filled on that day, which, in the records of the trade, is the date of its publication. For this purpose books are often dated several months ahead of the time when they are printed, in order that the date on the title page may agree with the date of their issue.

These simple facts show clearly how little claim the date of *printing* has to be taken as the date of *publication*, as advocated in the resolutions here under notice. If the same effort were made to find out the real date of distribution that is contemplated in these resolutions as necessary to establish the date of printing, the result would probably be worth the labor expended, for we should then be placed in possession of the real date of publication. How and by whom this needed work is to be done might form a subject worthy of consideration by even the Zoological Section of the American Association for the Advancement of Science.

J. A. ALLEN.

AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK.

SCIENTIFIC LITERATURE.

Geological Survey of New Jersey. Annual Report of the State Geologist (John C. Smock) *for the Year 1894:* Trenton, 1895. Pp. 303, Plates I–XI, fig, 1. One map in pocket.

In the first paper of the volume before us, entitled 'Part I., Surface Geology,' Prof. Salisbury continues the record of his observations on the surface deposits of the northern part of the State, that is, of that portion which lies within or near the terminal moraine. For about one hundred pages the reader will find a valuable record of phenomena, which furnish a basis for subsequent deductions and which are of local importance, both to residents of the district and to visiting geologists. These pages deal with the drift deposits north of the moraine, taking them up under three different areas, viz., (*a*) drift deposits west of Green Pond Mountain, (*b*) drift on the Bearfort, Kanouse, Green Pond and Copperas Mountains, (*c*) drift east of the Green Pond Mountain range. Under each the unstratified drift, till or ground moraine is first described, and then the stratified. The former is chiefly on the mountains, the latter in the valleys. The glacial striæ next receive attention and from about 380 recorded observations it is shown that, as a rule, on the Palisade ridge the ice moved east of south, while west of it the direction is west of south. There are some cases of intersecting striæ and some minor local variations, but the above is the rule. The topics of changes in drainage and lakes are next discussed. The former are insignificant and of the latter the important cases are mostly due to obstructions of drift across streams. The post-glacial changes within the glacial area occupy Section IV. The post-glacial erosion is shown to be small, and the remaining topics—the alluvial deposits, peat and marl, and the changes of level—present little of great moment, except that under the latter the changes of level in the shore lines of Lake Passaic indicate post-glacial deformation in this region.

The remainder of Prof. Salisbury's paper is occupied with the surface formations south of the terminal moraine. The one earlier called the Beacon Hill is first discussed and is correlated with considerable certainty with Dr. W. B. Clark's Miocene beds farther south. The overlying Pensauken formation is considered as an equivalent of the Lafayette, and the still later Jamesburg is made the representative of the Columbia. Surface formations of even later date are briefly cited. A few pages are devoted to road materials and then in the concluding section the author describes the large map that accompanies the report. This exhibits the surface formations over the northeastern portion of the State in as great detail as has ever been attempted for an American area. Thirty different signs appear on the map, a number that will emphasize at once the refinements in distinctions of glacial deposits that have been adopted.

The second paper of the volume is by Lewis Woolman and continues the important records of artesian wells, that the same writer has contributed to earlier reports. A moment's reflection will convince the reader, that the problem of water supply in the towns of the flat country of southern New Jersey is a serious one. The surface relief is slight and natural head is not available. Artesian wells have been developed with marked success, and, thanks to the careful records of Mr. Woolman, the productive horizons are now well identified. There are six in Miocene strata, of which one, the lowest exceeds the others in productiveness. There are four in the Cretaceous, all large producers. The remaining ones are less uniform and embrace Quaternary sands and gravels, Triassic sandstones and even Archean metamorphic rocks. Mr. Woolman discusses the several geographical areas of the state, and gives many sections and lists of fossils from borings, of which those of diatoms are particularly complete. The report contains a great deal of matter important in connection with water supply, but no less valuable as regards general geology.

The next paper is a Report on Forestry, by C. C. Vermeule and John Gifford. This is divided into a final report on the northern portion of the state by Mr. Vermeule and a preliminary one on the southern by Mr. Gifford. Many interesting topics are discussed and a good forestry map is appended. For the general reader the pages of the latter report that deal with the swamp cedar industry and the resurrection of old and buried logs will prove especially interesting.

The usual mineral statistics of iron ore and zinc ore conclude the volume. Of the former there were mined in 1894, 277,483 tons, a falling off of over 75,000 tons from the production of 1893. Despite this fact New Jersey was eighth on the list and outranked New York, whereas with the larger production of 1893, she was only ninth. The zinc ore raised was 55,582 tons, a falling off from 1893 of nearly 22,000 tons.

The report before us approaches very nearly to what we conceive to be the proper scope of a geological report for one of our older States. It gives, as the reports of New Jersey have given for many years, a large amount of material that the average taxpayer can appreciate and use. At the same time, as much pure science is introduced as may be wise and safe from the administrative point of view.

J. F. Kemp.

Demon Possession, and Allied Themes. By Rev. John L. Nevius, D. D. With an introduction by Rev. F. F. Ellinwood, D. D. Second Edition, pp. 520. F. W. Revel Co., New York. 1896.

The late Rev. Dr. Nevius was for many years a missionary to China, and while there had a number of opportunities to witness or to learn about cases of mental disease which, he became convinced, could not be ascribed to natural causes, but were the result of demonic possession, or the entrance into a man of an alien evil spirit.

In this work he describes a number of such instances and then discusses the naturalistic explanations which have been offered, especially the pathological and the psychological theories. Both of these he rejects, and prefers the 'biblical' theory of demonic possession. He argues that no other explanation is either consistent or proper as applied to the cases recorded in the Gospel, and if they are to be literally understood as of supernatural origin there is no reason why those wholly analogous in course and symptoms which he describes should not also be so regarded.

Against this argument little can be said by one who concedes the premise; but modern psychology does not. It explains the phenomena of the human mind by the ascertained laws of the human mind, and does not grant that any other explanation is necessary. Let us apply this reasoning in the present instance.

Facts such as Dr. Nevius brings forward belong to the most common of irregular mental phenomena. Such seizures are extremely frequent in the Shamanistic cults of savage tribes. They are cited by the hundred among Australian blacks, American Indians and African Negroes. Bishop Calloway, formerly of the diocese of Natal, says that nearly all his converts among the Zulus suffered from them for a few years after conversion. They are identical with the 'ecstasy' and prophetic 'manteia' (*i. e.*, mania) which played such a large part in the orgiastic rites of Greece and, indeed, of the whole ancient world. The human soul was everywhere regarded as a gift of, or akin to, the Divine, and in its nature, prophetic; so that when, in these moments of strange emotion, it spake with tongues and entered into rapt communion with the Spirit, it simply expressed its true naturé and noble origin.

Christianity, which taught that 'the gods of the heathen are devils,' changed the meaning of *daimon* from a beneficent guardian to a diabolic imp; and called the inspiration of the Pythoness a 'possession by the devil.'

Psychology, unable to recognize the god as the devil in these attacks, sees in them the emotional outbreaks of the sub-liminal consciousness, examples of pathological psychic automatism, occurring always in weak or weakened minds, excited by auto- or collective suggestion, limited always by the boundaries of the individual mind itself, never in any proved instance exceeding its powers, though sometimes seeming so to do, owing to deficient observation on the part of the observer. The proof of the correctness of this position is that experienced alienists never see a case of demonic possession. Their arrival is as certain to dispel it as is, according to Dr. Nevius and many other good men, the 'sacred name' itself. What the alienist sees is hysteric or epileptoid convulsions, or emotional contagious mania, and the like; and this is all that any one will see who carefully studies such conditions.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

Naual oder die Die Hohe Wissenschaft der Architectonischen und Künstlerischen Composition bei den Maya-Völkern deren Descendenten und Schülern. By A. EICHHORN. Berlin. 1896. Pp. 1–126.

It seems the time has not yet come when it will be understood that the treatment of anthropological problems requires as much training and knowledge as work in other branches of science; else a book like the present would not have been published with any serious pretensions. The scientific method of the author is sufficiently characterized by the naïve etymology of meander from the Maya word *mai*, hand, and *andros*, genitive of ἀνήρ, *i. e.*, a man's hand. His other etymologies are of the same value. The author treats words in the most arbitrary manner, changing the order of sounds and syllables, and fits this material to fanciful theories on a heoric language of the Mexicans, and to no less fanciful interpretations of sculptures. As a scientific contribution the work is of no value.

F. BOAS.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES, SECTION OF GEOLOGY AND MINERALOGY, OCTOBER 19.

THE first paper of the evening was by Arthur Hollick, entitled 'Geological Notes; Long Island and Block Island.' Previous investigations on Staten Island, Long Island, Martha's Vineyard and Nantucket have proved a unity of geologic conditions throughout, and it was confidently expected that a careful examination of Block Island would show this also to be part of the same general series. During the past summer the island was visited and proofs were obtained of drift phenomena, identical with those of the other localities. A collection of fossils was made which demonstrated the former existence of cretaceous strata on the island. The material collected consisted of plant remains, imperfectly preserved and of mollusks in a good state of preservation. These latter were identified by Prof. R. P. Whitfield and the list numbers ten species, in addition to fragmentary remains of perhaps half a dozen more. They are typical of the lower greensand marl and were found as drift material in the moraine, under the same conditions in which similar fossils have been found in the other localities mentioned. It was also thought advisable to visit again the eastern end of Long Island in order to ascertain whether more definite fossil remains could be found on Montauk Point, where imperfectly preserved fossils had been discovered on a previous occasion. Here also well preserved mollusks were found, likewise identified by Prof. Whitfield, who has furnished a list of five species and two genera, in addition to which were a number of imperfect specimens, representing about five additional species. The discoveries were highly satisfactory, and furnished the proof that had been confidently expected. The specimens collected were exhibited.

The second paper was by Prof. J. F. Kemp on the Glacial or Post-Glacial Diversion of the Bronx river. The speaker showed that the Bronx river from its source to Williamsbridge follows an old valley, excavated in limestone. This valley continues from a point below Williamsbridge to its end, on the Sound opposite Randall's island and there is a depression the entire distance. Just below Williamsbridge, however, the river turns from its old valley and breaks through a ridge of enclosing gneiss on the east. It has excavated a gorge about 70 feet deep, with large fresh pot holes remaining on the sides, respectively at altitudes of 20 and 50 feet above the stream. The maximum height of the divide between the present channel and the older one is only 10 to 15 feet. The speaker found difficulty in accounting for the diversion, in that no barrier of gravel or other deposit is visible along the line of the old channel, which would turn the stream from this across the high ridge in which is the gorge. The freshness of the pot holes indicated that the stream had cut the gorge during the glacial times and since then. He therefore referred the diversion to the ice of the continental glacier a lobe of which must have filled the earlier channel. It is probable that the early excavation was done by a sub-glacial stream, heavily loaded with sediment.

The third paper of the evening was by D. H. Newland on the Eclogites of Bavaria. The speaker described the extent and mineralogy of the rocks and his attempts to discover their unmetamorphosed originals. Chiefly on chemical analysis he was led to infer that they had been originally diabases or gabbros.

J. F. Kemp, *Secretary.*

SECTION OF ANTHROPOLOGY, PSYCHOLOGY AND PHILOLOGY, OCTOBER 26, 1896.

The Academy met with Prof. F. H. Giddings in the chair. The Sub-section of Psychology and Anthropology immediately organized and the following papers were presented:

J. McK. Cattell, 'On Physical and Mental Measurements of Students of Columbia University.' This paper described the results of a series of tests that has been made in conjunction with Dr. Farrand on students of Columbia University during the past two years. The members of the Freshmen class were requested to come to the psychological laboratory, where their physical, psycho-physical and mental traits were tested. An hour was given to each student, 10 records and 26 measurements being made. The tests selected, the methods of making them, and the results were described. Special stress was laid on the value of such work in the study of development and of the correlation of physical and mental traits. The paper will appear in full in the current (November) number of *The Psychological Review.*

Franz Boas, 'On the Limitations of the Comparative Method in Anthropology.' This paper will appear in full in an early number of Science.

Livingston Farrand,
Secretary of Sub-section.

NEW BOOKS.

A Popular Hand-book of the Ornithology of Eastern North America. Thomas Nuttall. Second revised and annotated edition by Montague Chamberlain. Boston, Little, Brown & Co. 1896. Vol. I., liv+473; Vol. II., xi+431.

A-Birding on a Bronco. Florence A. Merriam. Boston and New York, Houghton, Mifflin & Co. Pp. x+226. $1.25.

Hand-book of Courses Open to Women in British, Continental and Canadian Universities. Isabel Maddison. New York, The Macmillan Co. 1896. Pp. iv+155. 50 cts.

The Elements of Electro-Chemistry. Max C. Blanc. Translated by W. R. Whitney. London and New York, The Macmillan Co. 1896. Pp. x+284.

Transactions of the American Climatological Association for the Year 1896. Vol. II., The Report of the Committee on Health Resorts. Philadelphia. 1896. Pp. xxviii+293.

SCIENCE

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SCIENCE

FRIDAY, NOVEMBER 13, 1896.

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

HONORS TO JAMES HALL AT BUFFALO.

ONE of the noteworthy features of the recent meeting of the American Association for the Advancement of Science at Buffalo was the celebration of the sixtieth anniversary of Prof. James Hall's public service to science as State Geologist of New York. To this event the afternoon session of Section E (Geology and Geography) was devoted on Wednesday, August 26; and many officers and members of the Association withdrew from other sections for the purpose of participating in this memorial meeting. Prof. Hall was present, having crossed the continent from the Pacific slope (whither he had been ordered by his physician a few weeks before for much needed recuperation) to attend the meeting on receiving notice that his presence was especially desired by his friends.

The session was opened by Vice-President Prof. B. K. Emerson, Chairman of Section E., on behalf of the Association and of the Geological Society of America, which united with the parent body during the Buffalo meeting. Prof. Emerson's opening address was as follows:

It was a fortunate coincidence that the Geological Society of America, which swarmed so recently from the larger Association, should have returned this summer for a union meeting in the parent hive. This assemblage is thus made fully representative of American geology and paleontology. This seems fitting when we consider the purpose which has brought us together to celebrate three score years of most arduous and most fruitful official work; nay, to commemorate a scientific life of almost the Psalmist's span. "The years of a man are three score years and ten." Here by reason of strength they have gone far beyond four score years. We may congratulate the veteran that he has by the mandate of a great State been enlisted for life in this warfare of science, the armor of which has become a part of his very life.

It is a second happy coincidence that the meeting should have been held in this most hospitable city of Buffalo, in the heart of that old 'Fourth District,' where more than half a century ago the foundations of American stratigraphical geology were so broadly and so soundly laid; where the very names of villages were given new meanings and sanctified to geological uses.

It is a curiously interesting illustration of this that, wherever in the world a group of geologists is gathered together, the word Niagara, or Nia-*gar*-a, as our friends beyond the water would call it, would be, perhaps, a little more apt to call to mind the Upper Silurian limestone than the great waterfall and gorge from which the name was taken.

As I came through Albany on my way hither I was shown the house in which, in 1839, a little conference of the geologists of the New York State Survey discussed the proposal from which grew, in the next year, the Association of American Geologists. Of those who made that party only one man remains, besides the master, whose work we celebrate to-day. The American Association for the Advancement of Science grew out of the Association of American Geologists, and we have heard in general session of the little group of the founders of the American Association in the center of which stands, as its first President, James Hall, of Albany.

The Geological Society of America is the sturdy grandchild of the Association of American Geologists, and it is a final happy coincidence that in gathering to commemorate the work of the first President of the Geological Society we should have in the last president of the same Society the veteran geologist of the Pacific coast, the man best fitted to coin into golden words the greetings of us all to the Nestor of the Paleontologists of America and of Europe—James Hall, of Albany. I call upon Prof. Joseph LeConte, of the University of California, President of the Geological Society of America, to speak in behalf of that Society.

Prof. LeConte responded to the invitation of the presiding officer in the following terms:

I am sure that no words of mine are necessary to introduce to you the much-loved, much-revered Nestor of American geology, Prof. James Hall. I am asked to say a very few on behalf of the Geological Society. If it were for any other man I should have begged off; but when it is for him whom we all delight to honor, this is impossible.

Sixty years of unremitting work—of unswerving purpose, directed toward one end, and that the noblest! Is not this the definition of a great work; more of a great life; still more of a great man? Such a work, such a life and such a man are united in the person of James Hall. Surely in an important sense he may be called the *founder* of American geology. Others with him, and even before him, have done good work, for which we are grateful; but he alone not only laid a foundation as others helped to do, but continued for 60 years to build thereon a solid and beautiful edifice. The geology and paleontology of surveyors in his hands thus became an organized, systematic body of knowledge, about which gathered as a nucleus our whole knowledge of American geology.

But I am not here to give an analysis and estimate of his great work. Others more intimately associated with him can do this better than I. Yet, perhaps, as one of the oldest among you, I may be allowed to give some personal reminiscences of my early association with Hall, touching only such as have had an influence on my own career. I give but two:

In 1850, with Louis Agassiz, and as his pupil, I visited Prof. Hall in Albany, and accompanied Hall and Agassiz on a geological excursion in the Helderberg Mountains. It was my first lesson in field geology. The intense interest developed in my mind by the rambles; the observations, and especially the discussions between these two men, definitely determined my chief scientific work in the field of geology rather than zoology, which, as we all know, was Agassiz's favorite department.

One more reminiscence: In 1856 occurred the meeting of the A. A. A. S. at Albany under the presidency of Prof. Hall, a meeting memorable for its enthusiasm. At this meeting Dana gave his epoch-making address as retiring President on the development of continents. At the same meeting I gave my first scientific paper showing how barrier reefs are formed on the coast of Florida without subsidence. But with this I am not not concerned. In 1857 the A. A. A. S. met at Montreal, and Hall as retiring President gave his memorable address on the formation of mountains by sedimentation. I can never forget the impression produced. The idea was so entirely new, so utterly opposed to prevailing views, that it was wholly incomprehensible even to the foremost geologists. There was no place in the geological mind where it could find lodgment. It was curious to observe the look of perplexity and bewilderment on the faces of the audience. Guyot was sitting immediately behind me. He leaned forward and whispered in my ear: "Do you understand anything he is saying?" I whispered back, 'Not a word.' And yet the seed sown in that address has borne abundant fruit among American geologists. The views foreshadowed and imperfectly presented then by modification and classification have developed into what has been called the American theory of mountain formation. Whatever of fruitful work I have myself done in this direction I owe to the seed planted then.

I have spoken thus far of Hall the geologist; now a single word, in conclusion, of Hall the man. Greater than all the results of science is the true spirit of science which accomplishes these results. So, greater than all Hall's work—great as this is acknowledged to be—is the character of the man, and the man himself. Hall is an example to us all in his unswerving, incorruptible, self-sacrificing devotion to pure science for its own sake. In this age of profitable science, and even often of science for profit, we cannot too highly value such an example. But if the man determines the character of the work, the work also reacts to determine the character of the man. A great man is necessary for a great work, but a great work continued through life reacts to ennoble and elevate the man, and even illumines the face with a higher intellectual and moral beauty. As Dante, while gazing steadily on ideal beauty in the face of the divine Beatrice, is drawn upward to the seventh heaven, even so the man of science, gazing steadily on the face of Truth, is drawn upward to higher and higher planes of intellectual and moral elevation.

Deeply moved by the expressions of his associates, themselves among the older geologists of the country, Prof. Hall responded briefly and modestly, acknowledging his indebtedness to contemporary investigators for much of the success which has attended the Geological and Natural History Survey of New York for many years, and expressing full appreciation of the honor shown him by this meeting.

The two more formal papers, which follow, were then presented.

JAMES HALL, FOUNDER OF AMERICAN STRATIGRAPHY.

Sixty years ago the budding science of geology received an impulse by which it was started toward the front rank of the sciences. This impulse was a well-considered enactment authorizing a survey of the geology and natural history of the Empire State. Although it was not the first State Geological Survey in the country, this scientific survey was among the pioneers, was more broadly planned and brilliantly executed than its predecessors, and has long outlived its successors during the same generation. So in the light of events it seems just to say that the Geological and Natural History Survey of New York was the model by which other official institutions for research concerning resources were shaped, the exemplar by which the statesmen and savants of the country have been inspired and guided.

The institution of this survey of New York marked an epoch in the development of American science. The sumptuous series of tomes by Torrey and DeKay, Beck and and Emmons, Mather and Vanuxem, Conrad and Hall and their associates, and the continuation of the series by Hall, are prominent among the classics of the New World. Fortunately, too, the treatises are well known; under an admirably sagacious policy the lawmakers made liberal provision not only for printing, but for distributing the results of the investigations; thus the noble books emanating from the Survey passed into the hands of citizens and found their way into libraries in other lands, as well as throughout this country, where they stirred emulation to the benefit of many States. Through the diffusion of knowledge concerning her resources, these documents contributed much toward the enrichment of the Commonwealth; and through the diffusion of exact knowledge and sound method they enriched science and the Nation. So the delver among rocks, who works for human weal, may well pause to pay a tribute to the New York pioneers who laid the foundation for scientific agriculture and entomology as well as for paleontology and stratigraphic geology, and at the same time aided in the making of botany and zoology in this country.

One of the side issues springing from the institution of the New York Survey is especially significant to members of the American Association. As the surveys progressed it was found desirable to arrange for conferences among the geologists; and when similar surveys were confronted with scientific problems in Pennsylvania, New Jersey, Virginia and other States, conferences among surveyors were found increasingly useful. So in 1840 the geologists at work in these States united in an 'Association of American Geologists;' and in 1841 the same geologists, with their confrères in natural history, reorganized themselves into a society under the name 'Association of American Geologists and Naturalists.' In September, 1847, this body 'agreed to resolve itself into the American Association for the Advancement of Science.' Thus the present National organization for the advancement of science originated in the semi-annual conferences among the New York geologists, and may (at least in part) be reckoned among the results flowing from the impulse given to American science by the statesmen of New York in 1836.

When the official Survey was organized in July, 1836, special prominence was given to the geologic work; and the State was divided into four districts, assigned respectively to William W. Mather, Ebenezer Emmons, Timothy A. Conrad and Lardner

Vanuxem, James Hall being Assistant Geologist. Within a year the districts were redefined and the assignments were changed by appointing Mr. Conrad Paleontologist, transferring Mr. Vanuxem to the Third District, and placing Mr. Hall in charge of the work in the Fourth District.* These assignments were continued until the primary survey was completed and the four formal reports on geology were prepared for publication. Subsequently other assignments were made, including the transfer of Hall to paleontology; and this work was continued, with minor modifications in the law, and remained constantly in charge of the vigorous geologist of the western district from the middle of the fourth decade to the middle of the ninth decade of the century. So this summer is the sixtieth season of the work of Prof. James Hall as Geologist and Paleontologist in charge of the Surveys in New York. This period of State service in behalf of science is beyond all parallel in the annals of geology in America, if not in the world. One of the pioneers in American earth science, a student in the days of William Smith, Rhoderick Murchison and other makers of the science, Hall has survived his early scientific associates, even the contemporaries of his prime, and remains the sole representative of the first generation of American geologists. Growing up, as he did, among the first Western readers of the great stone book, and continuing, as he has, down to the present day in active research, Hall's biography is the history of American geology.

While his contributions to the science of geology have been many and varied, certain lines of Prof. Hall's work are prominent; among these his work in stratigraphy and nomenclature, his contributions to paleontology, his researches concerning the principles of deformation, his work in geologic mapping, and his contributions to knowledge of economic resources, are especially noteworthy.

It is not easy, even if it were needful, to distinguish Hall's work in stratigraphy and nomenclature from that of his early associates; it suffices to observe that it is in the Fourth District especially that the 'New York System' has been found so clearly defined and justly applied as to survive the changes due to later research; though one who has had occasion critically to study all of the New York reports, for the purpose of platting the recorded observations on a geologic map, may be permitted to say that the voluminous report on the Fourth District is notable as bearing on every page inherent evidence of accurate and comprehensive work. Time has shown the wisdom of the founders of the 'New York System.' The definition of formations was a singularly successful application of the principles developed by William Smith in England, and many of the major and most of the minor divisions recognized in 1837–43 are accepted to-day. Other classifications of rocks came into vogue, both earlier and later, yet they have not endured, while that of New York, especially that of the western district, has been tried and found not wanting. The nomenclature adopted was equally happy. Half of the names applied in the western district are in current use, and there is reason for opining that, as detailed surveys are completed, more than half of the others will be revived. Thus, although the term 'New York System' has dropped out of use save in descriptive sense, while the 'Ontario division' is forgotten, and while the 'Champlain division' and 'Erie division' have been abandoned and the names re-employed in other connections, the Trenton, Utica, Hudson River, Oneida, Medina, Clinton, Niagara, Onondaga, Oriskany, Schoharie, Marcellus, Hamilton, Tully, Genesee, Port-

* [Second Annual Report of the New York Geological Survey,] Assembly Document 200, 1838, p. 2.

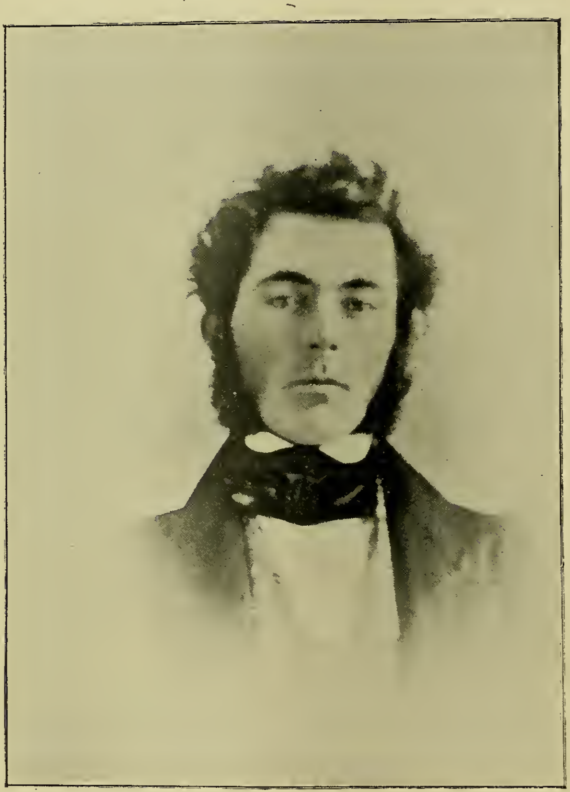
age and Chemung are familiar terms, in constant use among the geologic workers and teachers throughout eastern United States. Other systems of nomenclature have come and gone; the brilliant and attractive, yet essentially procrustean, system proposed by the Rogers brothers for a time competed with the system devised in New York; but no other system has endured the test of time. Yet the trite statement that the New York formations and formation-names have been found so acceptable as to outlast the many transformations in the growing science does scant justice to the New York work. The chief merit in the New York method resides in the principles recognized, and these principles have not only been adopted in New York and neighboring States, but have extended throughout the country, and indeed have shaped American geology. The New York formations were defined by fossil contents, as were those of England and the Continent, while the nature and genesis of deposits were given greater weight than before; and this method has been followed more or less closely by the geologists of the world engaged in researches among clastic rocks. Most of the New York formations were named from geographic features so chosen as to indicate type localities and to permit endless rearrangement of the duly labeled rock divisions as research progressed and other divisions were recognized; and this system of nomenclature, which was practically original in the New York Survey as applied to minor divisions in geologic column, stopped not at the boundaries of the State, but has spread over the country and the world, and is to-day the accepted system of civilized lands. It might be invidious to claim that any one man originated the method of defining and naming formations now in general use; but it is not too much to say that the method was established by the New York Survey, and that it finds its best illustration in the classic Fourth District; here it was that American stratigraphic geology was founded.

Of Hall's work in paleontology, paleontologists must speak; yet the geologist may well note in passing that it was in New York, and especially by the veteran scientific officer of that State, that the geologic use of fossils was first and most completely established for the western hemisphere. A hundred men of genius have found in fossils a key to the past history of life on the earth; others, like Walcott and White and Neumayr and Barrois and a score of contemporaries, have followed the method devised by William Smith and applied by James Hall, and have thereby unlocked the treasure-house of earth's resources.

It is sometimes forgotten that, though Hall was officially transferred to paleontology a full half century ago, his geologic work was continued. Without severing his connection at Albany he availed himself of opportunities for researches in other parts of the country and in the neighboring Dominion of Canada; his work in Wisconsin was especially extended, while in Iowa he organized and carried to successful completion a State Survey which was long the standard for the Mississippi Valley. Partly through these researches in other regions, partly through the New York work, he fitted himself to deal with problems of dynamic geology, and to this subject he made important contributions in papers and addresses and through conferences with fellow students. One of the most noteworthy of these contributions, first stated in his presidential address before the American Association for the Advancement of Science in 1856, was the inference that loaded areas of the earth-crust sink at a rate conditioned by the rate of loading. This noteworthy inference was formally enunciated and discussed in the introduction to the third volume of the reports on the paleontology of New York. While Babbage, Hopkins, Herschel and other Britons previously discussed the mobility of the earth-crust, and while Powell later made the correlative discovery that mountainous areas rise with unloading and Dutton still later formulated the doctrine, this publication by Hall was one of the most important contributions ever made to the doctrine of isostasy.

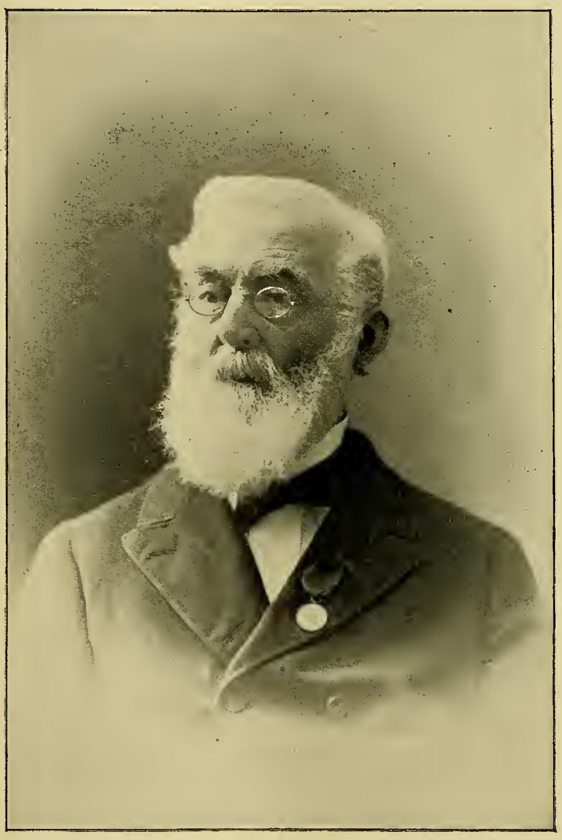
One of the early publications of the New York Survey was a preliminary geologic map of the State. Portions of this map (particularly the western portion, or Fourth District) may be characterized as accurate to scale, and up to the geographic knowledge and cartographic methods of the times; other portions (particularly the complex districts of the east and north) were far from satisfactory. When Hall assumed charge of the entire geologic and paleontologic work of the State he planned to revise the early cartographic work and to issue a map comparable with the splendid quarto volumes in accuracy and dignity. Many obstacles stood in his way; the State was practically unsurveyed, so that there was no trustworthy basis for the geologic mapping; the structure, especially in the eastern and northern districts, was intricate and obscure; extensive areas were so deeply covered by Pleistocene deposits as to conceal the substructure which he desired to represent; the means at disposal were limited; and from time to time official obstacles, which need not be stated in detail, arose to prevent the execution of his plan. So the months grew into years and the years rolled into decades, and his ambition remained unfulfilled. About ten yerrs ago a number of detailed surveys were brought to completion, an urgent demand for a geologic map of the Empire State had arisen, and the plan seemed about to mature. At this stage Prof. Hall sought the cooperation of Major Powell, then Director of the Federal Survey, and a cooperative plan was adopted, under which it fell to me to aid in the work. Unhappily the difficulties in the way of mapping the formations of the State were by no means overcome, and once more the months grew into years, which rolled into another decade before the ambition of the veteran officer was even partially gratified. First it was found necessary to examine and reduce the records accumulated during fifty years; then field studies in type localities were required in order that the records might be interpreted; next it was found that the base maps were wholly inadequate. So the geologic mapping was suspended and a base map was compiled from the best available sources; then the geology was revised and duly transferred; with every operation the standard of accuracy and general excellence rose, and it was found that in many districts geologic knowledge was insufficient to warrant mapping on the scale adopted. Thus fresh surveys were required; and many days were spent in company with Prof. Hall in reconnoissances and surveys in the Mohawk Valley and about the southern flanks of the Adirondacks, and I can never forget the vigor and determination with which the octogenarian geologist pushed over the rugged hillsides, sometimes plowing through snow and wading through floods, in the hope of raveling complex relations among the rocks. Many others were enlisted in the work. Kemp, Merrill, Smythe, Clarke and Beecher, and, especially toward the last, Darton, made important contributions; with the aid of these and other collaborators the map was finally brought to such state of completion as to warrant issue. A small proof edition of the map was printed early in 1896, through the courtesy of Hon. Charles D. Walcott, Director of the Geological Survey. No one can be more painfully aware than the compiler of the many imperfections of the map; the colorless areas are an eyesore to worker and teacher, and even more trying to the conscientious student are the minor inconsistencies in classification and the local inaccuracies in the tracing of boundaries. While the map is incomplete, it seemed to its real author, Prof. Hall, best to issue it as a stimulus and guide for future research, and in this view most of the citizens of the Empire State will doubtless coincide. The map is noteworthy as representing the fruits of an unprecedented period of labor, and as marking the fruition of an ambition outlasting the average span of human life.

Although engaged primarily in scientific research, the veteran State Geologist of New York never forgot the original demand of statesmen for practical knowledge whereby resources might be developed; and quarry rocks and clays, iron and cement, salt and petroleum, and many other natural sources of wealth, were conscientiously examined by him or under his direction. This part of the work of the State Survey can better be treated by others; it must suffice for one who looks on from outside the State to express the opinion that the great Commonwealth has been materially enriched through the sixty years of unremitting labor by the State Geologist.



JAMES HALL—1843.

It is not easy to characterize a man still in vigorous life without flattery and without derogation; yet it is possible to characterize a great work without fear or favor. The science of geology, as now accepted, is a scant century old; there is one among us who has contributed constantly to its progress during two-thirds of that period. American geology has come up in two-thirds of a century and has become a far-reaching science whose ramifications extend to many industries and contribute much to national welfare and human pleasure; there is one among us whose hand has stayed not from the beginning to the present. The development of earth-science has been due to the genius and devotion of many men, often for years, sometimes for decades, seldom for half centuries; there is one among us who has nearly reached the Psalmist's span in continuous work for the science. Many of the geologists who honor this occasion with their presence are hoar with time and bent with weight of years; there is one among us who laid the foundation for our work before most of us were born. Some of the men who have made geology are known at home as benefactors; others, like the prophets of old, are not without honor, save in their own country; a few have come to be known by their works at home and abroad; there is one among us who is



JAMES HALL—1891.

known wherever the language of science is spoken, who is honored in his State, revered in his friendly circle, and esteemed in far countries—he is the founder of stratigraphic geology and applied paleontology in America, James Hall. W J McGEE.

BUREAU OF AMERICAN ETHNOLOGY.

PROFESSOR JAMES HALL AND THE GEOLOGICAL SURVEY OF THE FOURTH DISTRICT OF NEW YORK—1837-1843.

"HAVING been appointed by the late Governor, the Hon. William L. Marcy, to investigate the geology of the Fourth District, * * * my duties in that region commenced in the spring of 1837."

In making this statement, in the preface of his final report upon the Fourth District of New York, Prof. Hall does not mention any connection with the Geological Survey of the State during the season of 1836. Under the law governing the Survey as then constituted, the four chief geologists were each allowed an assistant, and Mr. Hall had served during the previous year in the Adirondack region of the Second District as the assistant of Dr. Ebenezer Emmons. Strangely enough, there is, I believe, no reference in Dr. Emmons's reports to Mr. Hall's cooperation with him in this capacity, although the other chief geologists rendered public acknowledgement to such assistants and Emmons himself was profuse in his expressions toward others who had been associated with him.

Reference is made to these facts simply to show that Professor Hall's activity during his first season of official life, sixty years ago, is virtually unrecorded.

This circumstance, however, was not, I am convinced, in any way, directly or indirectly, the occasion of his promotion in the following year to the position of Chief Geologist.

The original apportionment of the four geological districts as made in 1836, had

FIG. 1. Geological Districts of New York. 1836.

not proved satisfactory to the geologists. The central-western extension of the State had been divided as nearly as possible in half by an east and west line which maintained the integrity of the county boundaries. This division was unquestionably due to the influence of Prof. Amos Eaton, of the Rensselaer School at Troy; for Prof. Eaton himself, aside from the power he wielded in the creation of the Survey, had already reconnoitered this unexplored region

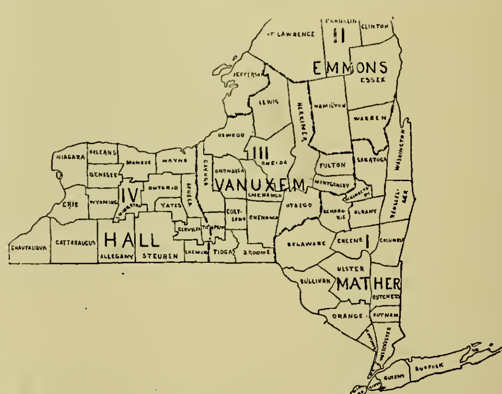


FIG. 2. Geological Districts of New York. 1837.

in his geological survey of the country adjoining the Erie Canal, had demonstrated the latitudinal outcrops and easy succession of the formations, and in pursuance of his suggestions the line of division was so drawn that the geologists of the respective districts should each have the fullest possible representation of different parts of these formations, to the one the lower, to the other the upper part. To the Fourth District was given a single full section of the rock series from Lake Ontario to the Pennsylvania line by including within it the counties of Niagara and Erie.

The division was certainly a philosophical one with the knowledge then at hand, but the geologists of this part of the State, Vanuxem and Conrad, had found, from their first season's work, the disadvantages of independent observation in an unknown field, and the importance of opportunities for comparison of results from different meridional sections of the same formations. Moreover, Conrad, who had been assigned to the Third District, which covered an area richer far than any other in the State in extinct organisms of beautiful preservation, had become enamoured of them. A zoologist before he was a geologist, his own preferences were consulted when, upon recommendation of the geologists, he retired from the field to become the Paleontologist of the Survey.

Conrad thereafter became the fifth wheel of the geological equipage; it could not turn without him; but when the work was done according to the statutory requirements he felt that his part of it was hardly begun. As he left for Philadelphia with the remark, "If I were to work a hundred years I could not describe the fossils of New York," he left behind a magnificent opportunity.

Dr. Emmons, also, was not wholly satisfied with the boundary of his district, and wished to have Jefferson county included within it. Thus at the opening of the season of 1837, the First District alone retained its original extent, Lieut. Mather in charge. Emmons's district (the Second) was enlarged by the addition of Jefferson county, the Third and Fourth Districts were remodeled by dividing them with a north and south line passing through Cayuga lake, observing county lines, except in the case of Tompkins county, which was cut nearly in half. Vanuxem, who had the previous season been in charge of the old Fourth District, was transferred to the new Third, and Mr. James Hall, former Assistant Geologist, was made Chief Geologist in charge of the new Fourth District.

Mr. Hall was then a young man, just past his twenty-fifth year, a very young man for so responsible an undertaking, and, as I have often heard him say, he was not allowed to forget the fact. Between this young man and the new conditions by which he was surrounded there was a happy adjustment that led to the production of the exhaustive and superb report on the Fourth Geological District, a work which, in philosophical treatment, in content and in its influence upon geological science has but few equals among works of this character.

The merit of this report must not be ascribed, to any large degree, to the simplicity of its subject. It had, indeed, so happened that the geological structure of this division of the State was the least complicated of them all. It presented no obscure problems of succession, no crustal disturbances, no intricate topography. From bottom to top the formations follow with the regularity of tiles upon a roof; the water courses, the lake basins, the sculpturing of the highlands, all evidence the most uniform submission to fundamental law; indeed, it would be difficult to find another region of equal extent upon these older rocks from which nature has so unequivocally banished all complicated problems.

The simplicity of the problems undoubtedly rendered the results more easy of acquisition and left to the distinguished chief more abundant opportunity for the accumulation of detailed information than fell to the fortune of his colleagues further east who had some difficult knots to untangle.

I have read the report on the Fourth Geological District of New York more often, with more assiduity and precision than I have read any other geological book. I have studied it for information, for guidance in the field during nearly twenty years. I have perused it critically, purposely blind to its merits and alive to any discrepancies, shortcomings or errors; and I have, too, endeavored to read it in the spirit which dictated it. To-day I do not hesitate to say that I know no other work of this character so distinguished for its fidelity to the facts, so strongly stamped with accuracy of observation. The work begun by Prof. Hall in this region fifty-nine years ago stands to-day squared with the truth as it stood fifty-three years ago, when his final report was rendered.

In 1837 western New York was only a sparsely settled country. It had already, indeed, centers of civilization. Buffalo was its most populous point; Rochester was a rapidly growing town, and there were various thrifty villages dotting the valley lands. Their population had been drawn very largely from the New England towns; the Phelps and Gorham Company, and the Holland Company, whose lands included nearly the whole of the region, had attracted purchasers of a superior class; the country north of the Helderberg escarpment, in the lake region, and in the fertile valleys, had become stippled with enterprising settlements, which were increasing in size and number under the influence of the chief highway, the Erie Canal. But away from the lowlands, over the high intervales of the central area and the broad plateau covering the southern half of the district, the region was largely a virgin wilderness. These circumstances were, no doubt, contributory to the simplicity of the geological problem, for it was in the low lands, those which civilization had taken possession of and rendered comfortably accessible, that the greatest number of distinct geological formations were present; the Medina, Clinton, Niagara, Salina, Corniferous, Waterlime, Marcellus and Hamilton; while the highlands, the wilderness covering more than one-half the area of the district, proved to belong almost wholly to the two divisions, Portage and Chemung.

It is not my intention to pass in review the geological determinations of Prof. Hall in this district; they are too well known. The great value of the results attained lies, as I apprehend it, in the stable, indestructible foundation upon which they placed a large portion of the paleozoic succession. Let the geologist now approach it from any quarter, whatever the position, whatever the lever, he will labor in vain to overthrow or disturb these foundations of the geological edifice in New York. The work was not done for a day, but for all time. Upon this foundation workers of to-day must build. Other foundation can no man lay.

No one has contributed so much to the superstructure as has Prof. Hall himself. The study of this great series of fossil-bearing rocks during his six seasons in the field aroused in him a conviction of the preeminent importance of a knowledge of extinct organisms as a means of substaniating strictly geological evidence. "The New York geologists have made out a classification of their older rocks," said Sir Charles Lyell; "let them now prove the truth of it by means of their fossils." It was for this very end, to prove the validity of the New York Series that Prof. Hall, upon the close of the Fourth District survey, sought and obtained encouragement to carry forward purely paleontological studies, with results of surpassing value. To the survey of the Fourth District we must ascribe the chief stimulus in the production of the 'Paleontology of the State of New York.'

Through these investigations and in many collateral channels he has amplified and augmented the results of his original survey.

It is not to be thought that he ever regarded his work in this region completed with his reports, for those here who have known him best will bear me out in the statement that no man of science is more open to conviction, to the correction of his own observations if evidence shows them to be imperfect; he was always strong to maintain his conception of the truth, but ready to yield if the facts were against him or to modify his conclusions, if needful, with the acquisition of new data.

Not long ago we completed a somewhat exhaustive treatise on the Brachiopoda. It had been the consecutive work of nearly seven years. Very extensive collections had been at the disposal of the work; every effort had been made to bring together the sum of knowledge pertaining especially to the paleozoic genera of these most significant organisms. When the last proofs of the last quarto volume had been read, Prof. Hall made this remark to me, "We have labored very hard on this book and have brought out some knowledge that will be useful to the scientific world, but, for my part, I feel that I would now like to *begin* the study of the Brachiopoda."

Thus in all his lines of activity no work is finished; it may be done for the present and laid aside in hope of a return thereto, or taken as preliminary to the upbuilding of a more elaborate superstructure.

To-day, with sixty years behind him of service to the geology of New York, no one can realize as he the vast amount of work yet remaining, requiring prime abilities and the best equipment.

Our conviction of the great success of this survey is not lessened by the fact that Mr. Hall's colleagues were men of high accomplishments, careful training and a larger professional experience than he. Lieut. Mather, a West Point graduate, had been with Featherstonnaugh on his western survey. Dr. Emmons had learned and taught mineralogy and geology both at Troy and on the complicated rocks of Massachusetts, and possessed an admirable equipment for combatting the difficult problems presented by the Second, or northern District; Lardner Vanuxem, after receiving a technical training in the schools of France, had done no little geological work in the Ohio valley and elsewhere. I have heard him characterized by one who knew him well as at this time the most proficient geologist of the country. He certainly was a most acute observer, and the value of his work in the Third District is becoming constantly more evident.

Mr. Hall, but four years before the organization of the Survey, had emerged from the Rensselaer school at Troy and the inspir- tutelage of Prof. Eaton. In the interval he had been associated with Prof. Eaton and Dr. Emmons in teaching geology and mineralogy as well as chemistry and physiology at this school, and had acquired the good will of both Prof. Eaton and Mr. Stephen Van Rensselaer, whose influences in the organization of the Natural History Survey were paramount.

It is an interesting fact that Prof. Hall was the only one of the geologists to seriously attempt a correlation of the New York formations with those of Europe as they had been described by Murchison and Sedgwick. It was, indeed, too soon for any such attempt to be successful and, though it was made only as a corollary to his elaborate descriptions, it seems a most natural undertaking for a student of Prof. Eaton, who had employed, perforce perhaps but often perfunctorily, such classifications of the rocks as had emanated from the European geologists. But it was emphatically the chief business of the geologist to make a classification of the New York rocks independent of any correlation with the formations of other countries or other States, and the New York column, as they erected it, is constantly achieving new importance, a perpetual memorial of their accomplishments and a monument to their patriotic pride.

All of the four geologists found subsequent opportunity to test the validity of their conclusions in other States. Vanuxem had, indeed, undertaken such a correlation before the survey opened; but of them all, chiefly Prof. Hall, who, beginning his correlation during the period of his work in this district, has done more than any other to find in the geological structure of other States of the Union corroboration of the work done in New York and to extend its influences over them.

We should not, on this occasion, omit at least a passing reference to the aid rendered in the survey of the Fourth District by the assistants during the various seasons of work. These were Dr. G. W. Boyd, who died before the work was completed; Prof. E. S. Carr, of the Medical College at Castleton, Vt., and especially the late Prof. E. N. Horsford. Prof. Horsford had been raised among the Seneca Indians of western New York, his home being at Moscow, near the center of the Fourth District. He had graduated from the Rensselaer School in 1838, and the season of 1839 was spent on the Fourth District survey. Although this was the only season of his official connection therewith, he had, while still a student at Troy, aided Prof. Hall by conceiving and executing the ingenious geological contour map of the Genesee valley accompanying the first report on this district. To his intimate acquaintance with this region much of our knowledge of the important Genesee section is doubtless due. Throughout all the upward course of later years this eminent man remained, until the end of his life, at all times the cordial friend and active supporter of the Geological Survey of New York.

It is fitting, too, that we again observe here the influences inspiring these official investigations which emanated from the Rensselaer Polytechnic Institute, at Troy. Van Rensselaer himself, from his own pocket, promulgated the first extended geological exploration of the State; the inspiring Eaton, who had delivered, by request, lectures on geology to the Legislature of New York and had even set Governor DeWitt Clinton to collecting fossils, not only promoted the work in all ways, but made it possible by furnishing the right sort of men to do it. Emmons and Hall; Horsford and Carr, of the Fourth District, and Briggs, of the First District, were all pupils of his. And it is a pleasure to refer to the fact that the influences of this famous institution upon the geology of New York are in renewed evidence. The Hon. T. Guilford Smith, of Buffalo, President of this Library Association, a Regent of the University and the chairman of its committee on the State Museum, is also a graduate of the Troy school.

The geological survey of the Fourth District has never been completed. To its determinations there is a constantly growing increment of facts, and from them problems of great interest are ever rising. Now and again novel and important forms of organic life show that we have not yet fathomed the wealth of its sediments, in evidence of which stand the sixty or more species of silicious hexactinellid sponges from the Chemung group, nearly all of which are the discoveries of the last few years. A fauna described by the Canadian geologists, but barely known in this State, the Guelph fauna, has been recently shown by Mr. A.

L. Arey to exist here in a well defined development.

The exploitation of the Lower Helderberg, a typically eastern New York formation and fauna, through this western district, brings out much important knowledge as to its relations with the under and overlying faunas, and this region will play an important rôle in the determination of serious questions bearing upon the geological age of the Lower Helderberg group and the integrity of the New York Series.

The Portage group also presents a number of interesting problems. Its fauna in the original sections is an exotic one, the most complete replica, in the American paleozoic rocks, of an European fauna. It may almost be said that here in New York it had neither predecessors nor successors. But eastward in the State the fauna changes, and Portage time is represented by a rock series whose fauna has nothing in common with that in typical Portage sections, but which has been derived, and, indeed, is often difficult to distinguish from the Hamilton fauna, which preceded it. And within the same time element further east, a portion of this fauna is again replaced by the meager, shallow and brackish water fauna of the Oneonta beds. Along such lines as these pertaining to the historical geology and the evolution of the life of the Fourth District, the labors of Prof. Hall have been followed by those of Professors Henry S. Williams and Charles S. Prosser, whose results have been most suggestive and important; and others have cooperated in the increase of this knowledge, Prof. S. G. Williams, Luther, Ringueberg, Lincoln, Bishop, Mixer, Harris, Pohlman, Grote, Pitt and some others.

The facts recorded in the report of this District concerning its surface contour, the later changes of topography, the distribution and mode of accumulation of superficial deposits, the presence of buried valleys, and other data especially inviting the glacialist and geomorphist, are in suggestive abundance, and it is no wonder that remarkable and beautiful results have been obtained from this region during the later rapid growth of these special lines of geologic research. Witness the work of Gilbert, Spencer, Dryer, Fairchild, Taylor and Leverett, and that old geological clock, Niagara Falls, which has been the center of such many-sided discussion. The elaborate account of it, its topography and changes, published by Prof. Hall, in 1843, has been regarded as of such fundamental value that, more than fifty years afterward, it is reprinted in its entirety by another department of the State government.

We have come to a period in the history of geologic investigations in the old Fourth District of New York where nice questions bearing upon the significance of variations in faunas, their origin, dispersion, taxonomy and chronology are pressing to the front. Their solution may involve the weakening of the conventional division lines upon which we have so long depended, but which are only confessions of faulty knowledge. In the study of such questions the labors of Prof. Hall have given to the State of New York a supreme advantage. Only with their solution will come accurate geologic maps and a precise knowledge of our geology.

As we are accustomed to look back into these paleozoic faunas for initiatory types of organic life whence depart into the later history of the earth a multitude of diverse organic expressions, so we find in the original survey of the Fourth District the kernel of all later work along the lines indicated, the suggestion of the completed geology of the State of New York.

Albany, N. Y. John M. Clarke.

Prof. Clarke's address was illustrated by various maps, particularly the two sheets reproduced above showing the primary and secondary districting of the State by the Geological and Natural History Survey in 1836 and 1837. He also exhibited an early daguerreotype of Prof. Hall, long forgotten by its living original and only accidentally discovered, in which the strong features of a vigorous prime were revealed for the first time to most of those participating in the meeting. This daguerreotype, together with a recent photograph, is reproduced above.

Hon. T. Guilford Smith, of Buffalo, a Regent of the University of New York, addressed the meeting on behalf of the State and the University, as follows:

I thank you very heartily, Mr. Chairman, for calling upon me on this occasion, and allowing me to join with others in the congratulations to Prof. James Hall, our State Geologist, one of the oldest and most distinguished of his profession.

I am particularly pleased to have this opportunity because Prof. Hall graduated from the Rensselaer School in 1832, and is one of the oldest, if not the oldest, of its living graduates. This school he has ever regarded with profound affection and respect, and as his reputation grows he is pointed out by its authorities as an example for us all to emulate. When I remember that this gentleman graduated from this school before I was born, and is to-day in the active practice of his profession, and with faculties unimpaired, it seems almost incredible. As every alumnus looks with more or less affection on distinguished graduates of the same Alma Mater, I may be pardoned in indulging a justifiable pride in Dr. Hall's success, from the fact that I graduated from that school in 1861, many years later.

It was somewhat at the suggestion of Dr. Hall that, in 1890, I was elected a Regent of the University of the State of New York, and in 1891 (through the favor of the late Chancellor Curtis) was made chairman of the State Museum Committee. This committee had charge, at that time, of the scientific work of the State, and I had many opportunities of meeting Prof. Hall, and of being made thoroughly aware of his ceaseless activity and ability to do two or three men's work.

In this connection, after much deliberation, Dr. Hall finally consented to the publication of the new geologic map of the State, a copy of which he was good enough to send me recently, and which I have hung upon the walls of this Society; there it is. I hope it may remain there, with your permission, Mr. Chairman, in commemoration of this meeting, with some suitable inscription, stating that it was presented to the Geologic Society, and by them deposited with the Buffalo Society of Natural Sciences, in commemoration of this meeting.

Please examine this map closely. Dr. Hall does not claim it is perfect, and forbore publishing it for many years in order to improve it and to increase its accuracy. You will notice on the map that there are many spaces perfectly white and left entirely plain. These, as Dr. Hall has stated to me and to others, are suggestions to his collaborators, and to those who come after him, of the necessity of further work before a final and complete geologic map of the State of New York can be had.

The map which preceded this, and which, you may remember, was a very different affair, served its purpose at that time; yet Dr. Hall felt that, in deference to the work that had been done since, any map which bore his name, and which was issued by the authority of this State, should embody all that has been found out since.

In the work connected with his high office, Dr. Hall has surrounded himself, in the many years of his service, with many men whose names are well known in scientific research, some of the older of whom have passed away, but leaving a record of which their descendants may well be proud. Others, who are now in active life, and in the practice of their profession, do not hesitate to speak gratefully of the instructions received under him when serving on his personal staff. In fact, up to 1849, when the Rensselaer School became the Rensselaer Polytechnic Institute, it was the only school especially devoted to the study of natural history in the United States, and it is with much pride that we all look up to it as a pioneer in this direction; and while it has broadened its field it still devotes a very considerable part of its curriculum to study of the natural sciences, and has had for many years in its faculty Dr. James Hall, as Emeritus Professor of Geology.

It was not only in connection with scientific research, and the work and study connected with the examination of field notes, and the proper recording of them, which earned for the State Geologist a great reputation, more particularly in the early days. Dr. Hall was one of the pioneers in this respect. It was necessary not only that this work should be done, and should be put in proper shape, but that the people at large, and particularly the Legislature, should be thoroughly convinced of the importance of the work done, and the necessity of printing the same for general distribution.

When one looks at the long array of volumes devoted to the geology and paleontology of this State, and which have been published by this Commonwealth at a cost of over a million and a half of dollars, anyone will say that Dr. Hall needs no other monument. He is the most successful of all scientists in obtaining appropriation for this purpose, and it may be well doubted whether any successor to him, no matter how young, how active, how efficient and how distinguished, will ever be able to equal him in this respect. I may be pardoned for dwelling upon this part of Dr. Hall's record, because many of the younger men do not know of these difficulties. In some of the States the State Geologist's reports go to the State Printer, as a matter of course, and are printed and distributed; but it was not always so; it is not always so to-day; and those of us who have been in Albany and seen this octogenarian facing the snows of winter, at all hours of the day and night, and traveling about in the face of storms which appalled many others, will never forget his persistency, his good humor and his final success in the face of the greatest difficulties. Wherever and whenever he thought he could obtain a vote for an appropriation of this character, he never failed to try for it, and generally succeeded in getting it. And you must remember that many of the members of the Legislature are prejudiced against scientific research of all kinds, and we have had Governors who publicly announced their opposition to the use of public money for this purpose; so that often, after a long and weary winter in the passage of a bill giving the necessary funds for this purpose, it became necessary to see the Governor and obtain from him the approval of what already had caused so much work to obtain.

In closing these remarks, Mr. Chairman, I take great pleasure in joining with you all in wishing to Dr. Hall a long continuance of his life of activity. I understand that he has taken a long journey from the Pacific coast for the very purpose of being here with us on this important occasion, which certainly marks an epoch in his life and in the history of the Society. Not content, however, with stopping here for a brief visit, and then continuing in well-earned repose, I understand that in a few days he takes the field again, as a geologist, and may be found next week, perhaps, examining some of the portions of the State and adjoining States which have not yet been fully investigated. This is so characteristic of his energy and activity that it seems fitting to allude to it.

Prof. Fairchild, Secretary of the Geological Society of America, then presented the following communication from Dr. George M. Dawson, Director of the Geological Survey of Canada:

It would be inappropriate to permit the occasion of the meeting in commemoration of the sixtieth anniversary of Prof. Hall's work on the New York Survey to pass, without placing on record, on the part of the Geological Survey of Canada, an expression of indebtedness to the distinguished geologist of Albany. Upon his already well founded classification of the fossiliferous rocks of the State of New York the investigation of the connected region to the north has from the first been based, practically without change of plan or nomenclature.

Reviewing the geological nomenclature adopted by the Canadian Survey, for the general report of 1863, the Director, Sir William Logan, wrote:

"But, in addition to such general guidance, the Canadian Geological Survey has throughout been under special obligation to Prof. Hall. Soon after Sir William Logan began this Survey, in 1843, he established intimate relations with Prof. Hall and his colleagues of the New York Survey. In 1854 Prof. Hall took the trouble to appear personally before a select committee of the Legislative Assembly appointed to report on the work already done by the Canadian Survey. In the same year he undertook the examination of the Graptolites of the Quebec group, the results of which were eventually published as the Second Decade of our Paleontological Series. In 1855 he assisted in the field in tracing out the Devonian rocks of the peninsula of Ontario and, for the purposes of the geological map of Canada of 1866, he freely placed all his materials and knowledge of the northern part of the United States at Logan's disposal, becoming thus responsible for the delineation of nearly one-half of the completed map."

There is thus a particular fitness, at the present time, in adding a tribute of acknowledgment from Canadian geologists to the numerous felicitations which Prof. Hall will undoubtedly receive on the occasion of this commemoration.

Prof. John J. Stevenson, of the New York University, called attention to certain unwritten chapters in the history of the New York Survey, and expressed appreciation of Prof. Hall's remarkable fidelity to the interests of his Commonwealth, in the ensuing language:

Some matters, which exhibit most clearly Prof. Hall's unselfish devotion to his work, have not been referred to by the preceding speakers. They should not be overlooked. If I speak of them without reserve, it is to be hoped that Prof. Hall will not think me guilty of breach of confidence, for, unless the story be told now, most of us will die without hearing it. He has discovered the fountain of perpetual youth, and his obituary is not likely to be written until after the majority of us have been buried.

The care of collections made by the Survey was transferred to the Regents of the University in 1845, and Profs. Hall and Emmons were compelled to give up their rooms in the old State hall. Prof. Hall at once erected a building next to his residence to provide accommodations for his work; this proving too small, he erected a large brick building in 1856 for the same purpose; but no allowance for office rent or other incidental expenses was made by the

State until 1871.* The cost of collecting new material for elaboration of the reports was borne by himself absolutely until 1856, after which appropriations were made until 1866, from which date for many years very little assistance was granted.

The State abandoned the work in 1850, when appropriations for salary and current expenses were refused by the Legislature. Confident that the work would be resumed, Prof. Hall retained his assistants and continued the collecting and drawing until 1855, paying practically the whole cost. Despairing then of any assistance from the State, he accepted the proposition, made years before by Sir William E. Logan, that he go to Canada as paleontologist, with the expectation of becoming head of the Survey upon Sir William's retirement in the near future. But, during those five years, Prof. Hall had exhausted his cash resources and had incurred obligations which were pressing. A large amount of money was needed to pay his debts and to take him to Canada.

In 1838, with Mather and some gentlemen of Albany, New York and Philadelphia, he had purchased a large tract of land in southeastern Ohio ; in the division there fell to him, as his share, 2,000 acres within Jackson and Lawrence counties, rich in iron ore and coal. This he laid aside, not to be sold until advancing years rendered him unable to work. In 1855 the importance of the mineral resources in southeastern Ohio was beginning to be appreciated, and all recognized that, within a very few years, property in that region would be extremely valuable. But Hall had nothing else that could be turned into money and his debts were urgent. He accepted an offer of $15,000 for the property; with that money he paid off the obligations incurred in order to continue his work. Ten years later the same land was valued at $200,000 and the accuracy of Hall's foresight was proved. Had it not been for this sacrifice the Paleontology of the State of New York would have been closed with the second volume in 1850.

In 1855 Hon. Elias Leavenworth, then recently elected Secretary of State, learned that Prof. Hall had determined to go to Canada. Realizing that to abandon the work in its incomplete condition would be discreditable to the State, he urged Prof. Hall to delay and called a meeting at his house to consider the matter. That meeting was attended by, among others, Prof. J. D. Dana, Prof. Agassiz, Sir William E. Logan, and Mr. Blatchford, Chairman of the Assembly Committee of Ways and Means. As the result a form of agreement was prepared, and Prof. Hall consented to remain in case the Legislature should confirm the arrangement. The influence of Mr. Leavenworth and Mr. Blatchford prevailed; the agreement was confirmed, and for forty years Prof. Hall has continued the work, until now it has been completed according to the original plan. Mr. Guilford Smith has told you with what energy he has carried it on, and how he has succeeded in overcoming what to others would have been insurmountable obstacles.

You have been told of the Wisconsin work, but not of the primitive manner in which the final settlement of arrears was made. At the close of the work the State owed Prof. Hall $4,000 ; thirty per cent. of this was paid in money ; the remainder was paid in fossils which Prof. Hall had collected, largely at his own cost, as he had consented to the transfer of much of his appropriation towards a survey of the Lead Regions.

We should not forget that Prof. Hall

*Prof. Hall informs me that this statement is inexact, and that, while Hon. Homer A. Nelson was Secretary of State, an appropriation was made to cover pay of assistants and other expenses ; but he cannot remember the details.

fitted out at his own expense the Meek and Hayden expedition to the Black Hills, which gave us our first accurate knowledge of the Rocky Mountain Cretaceous. In studying the collections obtained during this exploration F. B. Meek prepared himself for his own great work on the Jura and Cretaceous.

Prof. LeConte has told us that Prof. Hall led him into geology. When Prof. Hall made his memorable journey to the Mississippi Valley, in 1841, he remained for a short time at Cuyahoga Falls, in Mr. Newberry's house. Prof. Newberry was then a youth intelligently interested in collecting coal plants, which abounded in the roof shales of his father's mine, but he had no more intention of becoming a geologist than Prof. LeConte had when with Agassiz he visited Hall. Newberry used to say that Hall came as an angel, but before he went away he had become almost divine; the youth, before the separation, had made the final determination to be a geologist.

The paleontological laboratory at Albany has been the training school of great men, and through them the impress of the master remains upon American paleontology. In the fifties the assistant was Meek, whose painstaking and conscientious work in later years enriched the literature of Carboniferous and Cretaceous as that of no other American; C. A. White laid the foundation of his honored career when associated with Hall; Whitefield, whose contributions to Cretaceous and Miocene are already classic, was Hall's assistant for eighteen years; of the younger men, who have made American science respected, one need mention only Walcott, Beecher and Clarke to prove that the type of work and the standard of excellence have shown no deterioration since the time of Meek, more than forty years ago.

Several members of the Association and Geological Society made brief addresses, eulogizing Prof. Hall's work and recounting incidents in his history and the work of the Survey; the address of Dr. H. C. Hovey concerning Hall's remarkable energy and perseverance when, as a youth in eastern Massachusetts, he acquired his geologic education under difficulties and hardships which would have broken any but the strongest resolution, was particularly appropriate and significant.

Prof. Hall again responded briefly but appreciatively, touching on the remarkable development of geologic science in America since the institution of the official Survey in New York, and expressing the hope that the enrichment of the nation through the encouragement and constant application of research might long continue.

Vice-president Emerson then closed the session with the following remarks:

In bringing these interesting services to a close I permit myself to go far afield, beyond the dry light of science into the softer light of sentiment, and to draw a parallel in the manner of Plutarch. A veteran geologist, a past master in the art and science of geology, Josiah D. Whitney, has just died in New England—a man who was held by many to be of cold and repellant nature. I found him through many years a kind and appreciative friend. He was an enthusiastic and most critical lover of music. It was his custom to secure yearly two seats for his wife and himself in the front of the balcony in the Music Hall for the grand symphony concerts in Boston. His wife died many years ago, yet every year since then he secured the same seats where he listened to the music, and the seat beside him was always to him filled with her presence.

Amid the conflicting interests of a great and long-continued public service like that of Prof. Hall differences were inevitable, and the sounds of conflict carry further than the quiet words of helpfulness and friendship. There was put in my hands recently by the wife of our former member, still greatly mourned and missed, Prof. George H. Williams, a massive medal of pure gold and beautiful workmanship, newly struck by James Hall, of Albany, to conserve the memory of the long-continued friendship and public support of a distinguished and influential publicist and patron of science, Daniel Wood, of Syracuse, who died many years ago. I do not need to say that Mrs. Williams, who is in deep sentiment still a member of the guild of geologists, values this unique monument to her father's memory. Four such medals were struck to the memory of four public men of this great State, each of whom was in turn two and three generations ago the Mæcenas of this struggling scholar and the patron of his public work. We may call these medals the monuments of the old-fashioned and enduring gratitude of a warm heart; they explain the strong friendship of his friends, and are more significant than the transient dust of conflict. The monument of the man himself is builded in the rocks of New York, a monument more enduring than bronze or gold.

And now I declare closed the proceedings of this afternoon, which, spread upon the archives of this ancient and enduring Society, will furnish a many-sided and appreciative estimate of a great scientific personage.

CURRENT NOTES ON ANTHROPOLOGY.

MALTHUSIANISM IN ANTHROPOLOGY.

Our French colleagues are nothing unless practical. They cannot see the use of laboriously developing theories of sociology, and fighting them over in learned societies, unless the product is utilized for the public.

This tendency gave rise, at a recent meeting of the Paris Anthropological Society, to a scene that, allowing for difference in longitude, was not very unlike that which 'Truthful James' describes in the scientific society 'on the Stanislaw.'

M. Paul Robin, a declared 'neo-Malthusian,' commented sharply on a paper of M. Guyot on the diminishing population of France, the burden of which was, 'Faites des enfants.' M. Robin urged that improvident generation is destructive to individual and social development, unworthy of scientific endorsement and ruinous to true happiness. M. Dumont, another member, used some hard words, such as 'a homiside' and 'a degenerate,' with obvious application to M. Robin, who in turn took up the cudgels with alacrity and requested these terms to be noted. 'Degenerates,' he claimed, were brought about by parental indifference to the size of the families engendered by the passions. Self-restraint, here as elsewhere, is noble; and the limitation of families by artifical means, if the end in view is desirable, should be considered legitimate.

It is interesting to observe that anthropologic students recognize that their science is one eminently practical and 'actual.'

CRANIA FROM FLORIDA.

Dr. Harrison Allen's 'Crania from the Mounds of the St. John's River, Florida,' just published in the Journal of the Academy of Natural Sciences, Philadelphia (4to, pp. 85, Plates XXII.), is the most thorough piece of work on American Craniology which has appeared since Dr. Matthews' studies on the Rio Salado remains.

It is broader than its title, for it not only describes the skulls collected by Mr. Clarence B. Moore from prehistoric Indian graves in Florida, but it enters into minute comparisons of these with others from remote parts of North America, and outlines the science of craniology as taught by the author, and explains the terms which he has selected to express its new departures.

The plates are accurately drawn and beautifully lithographed, aiding greatly the demonstrations of the text.

The classification adopted by Dr. Allen is that of the late Dr. James Aitken Meigs, to which he called attention some time since in the pages of Science. It has been overlooked even by such writers as Topinard and Sergi, although it anticipated both of them in important points.

The functions which determine the form of the skull are considered by Dr. Allen to be mainly three, the growth of the brain, the interstitial changes in the bones, and the action of the muscles attached to the skull. The last mentioned he justly considers deserves more attention than it has received.

The Memoir is rich in such suggestions and should be consulted by all students of the subject. D. G. Brinton.

University of Pennsylvania.

CURRENT NOTES ON METEOROLOGY.

THE HIGHEST KITE ASCENT.

Although Science of October 16th contained a brief note on the recent high kite ascent from Blue Hill Observatory, some further facts as to this record-breaking feat will not be out of place here. Reference has already been made in these notes on previous occasions to the kite work now being done at Blue Hill, and attention has been called to the scientific value of this exploration of the free air. On October 8th all previous kite records were broken by an ascent which carried the meteorograph to a height of 9,375 feet above sea level, the greatest altitude previously attained having been 7,333 feet (see Science, Oct. 2, 1896, 489). The ascent began at 9.52 a. m. and ended at 9.05 p. m. Seven Eddy and two Hargrave kites were used, and more than three miles of wire were paid out. The meteorograph entered and passed through the clouds, as is shown by a record of very dry air above the clouds. The temperature fell from 46° on the Hill to 20° at an altitude of 9,375 feet above sea level. The pull on the wire was from 20 to 50 pounds at the start and ranged from 50 to 95 pounds at the highest point. The instrumental record was one of the best yet obtained.

The more the probable future of kite meteorology is considered, the more important does this means of exploring the upper air seem to become. The expense is very trifling as compared with the establishment of mountain observatories, or of balloon ascents, and as mechanical appliances are perfected for winding in the wire, and saving labor in other ways, the work of flying the kites will continually grow less arduous, and the heights attained will become greater. If the upper kites are sent up high enough to be out of reach of the varying and irregular currents near the earth's surface, there seems to be no reason for lowering the instrument at night, and if kept up 24 hours at a time, the results would be still more valuable than those now attained. Indeed it may be that continuous records may in time thus be obtained from the upper air by means of kite meteorographs.

WATERSPOUT PHOTOGRAPHS.

What is probably the best photograph of a waterspout ever taken was secured by Mr. J. N. Chamberlain, of Cottage City, Mass., on August 19th, last. On that day, at about 12:45 p. m., a very perfect waterspout, lasting 12 minutes, formed offshore from Cottage City. The photograph is remarkably clear, and brings out in a striking manner the dark clouds overhead, between which and the surface of the ocean is seen the spout, very symmetrically developed and almost exactly perpendicular. The top of the spout is but slightly enlarged, so that the funnel-shaped is not so marked as it is often figured, while at the bottom the disturbance of the surface water of the ocean results in enlargement of the lower end of the funnel by the formation of an irregularly shaped cloud of vapor or spray. After the disappearance of this waterspout two others, both less perfectly developed, appeared in succession. These were also photographed, but the views are not so striking as in the first case. No authentic scientific account of these waterspouts has, so far as we have seen, been published. The 8 a. m. weather map of August 19th, shows an area of high pressure central north of the Lakes, with cool north and northwest winds over New England. It seems likely, therefore, that these waterspouts were due in part to the low temperatures brought by the winds. Most of the waterspouts which occur over the Gulf Stream in winter are produced under similar conditions of cool offshore northwest winds, although, of course, the temperature contrasts are much more marked in winter than in summer.

SEVEN-DAY THUNDERSTORM PERIODICITY.

KASSNER, of Berlin, has been investigating the matter of thunderstorm periodicity in Germany during the past few years and has reached some interesting results. In 1893 (*Das Wetter*, 1893, 12–16) he found that for the period 1883–92 the thunderstorms of Berlin showed a maximum frequency on Thursdays and a minimum on Mondays. Further study of the records for Berlin from 1830–40 and 1848–92 indicated a Saturday maximum and a Sunday minimum. Polis found that the thunderstorms of Aix-la-Chappelle also had a Saturday maximum and a Sunday minimum. This fact was naturally supposed to be connected in some way with the increased smoke resulting from extensive firing up in factories and foundries on Saturday, when much work often still remains to be done and has to be hurried through, or, as in the case of iron foundries, the metal is melted on that day in order that it may cool over Sunday. On Sunday, on the other hand, there is little smoke because little use is then made of fires. In *Das Wetter* for August and September, 1896, Kassner has continued his inquiry, using data for other places, and reaches the conclusion that in general the frequency of thunderstorms increases everywhere from Monday to Tuesday, and that a minimum occurs on Thursday or the next adjoining days. In cities with extended industries which require fires on a large scale there is everywhere an increase from Friday to Saturday, and a decrease from Saturday to Sunday, while in places without many factories the reverse is usually the case. The variations in atmospheric electricity are believed to stand in close relation to the variations in the amount of smoke, as previously suggested by Arrhenius and Ekholm (1894).

R. DEC. WARD.
HARVARD UNIVERSITY.

NOTES ON INORGANIC CHEMISTRY.

THE manufacture of acetylene, at a low price, from calcium carbid, and its remarkable power as an illuminant, promised rapid development of its production upon a commercial scale. Two schemes are in use for its distribution. In one the plant is local, acetylene being made on the premises where it is used. In the other the acetylene is made on a larger scale and delivered in steel cylinders, condensed under high pressure.

The fact that acetylene is an endothermic compound has given rise to fear that grave danger attends its use, especially when stored in cylinders under high pressure. Hence recent experiments of Berthelot and Vieille (Comptes Rendus, CXXIII.: 523) on the explosive properties of acetylene possess considerable interest. They find that, at atmospheric pressure, a decomposition induced by ignition, or by the explosion of a fulminate, does not propagate itself to an appreciable distance. Hence it would seem that local acetylene generators, where the gas is not exposed to a pressure much above that of the atmosphere, are free from danger of explosion. When, however, the pressure on the gas is greater than two atmospheres, the decomposition induced by an incandescent wire, or otherwise, is propagated through the whole mass, the rapidity of propagation and the pressure of explosion increasing rapidly with increased initial pressure. Thus acetylene, at a pressure of twenty-one atmospheres, when exploded, generated a pressure of two hundred and twelve atmospheres and a calculated temperature of 2750° C. The acetylene is decomposed quantitatively into hydrogen and compact amorphous carbon. Acetylene condensed to a liquid may be similarly exploded by spark, incandescent wire, or detonator, and in one experiment 18 grams of acetylene exploded in a bomb of 49 c.cm. capacity showed a pressure over 5000 atmospheres, an explosive force about that of gun cotton. Experiments as to the effect of shock showed that acetylene is not thus exploded. In one case where the receptacle was broken by the shock, the acetylene was ignited, evidently by the friction of the shattered pieces, the mixture of the liberated acetylene and air forming an easily ignited explosive mixture. In this case no carbon was deposited, the gas burning and not decomposing. There seem to be two prominent dangers in compressed acetylene: the heat generated in the rapid compression of the gas may be sufficient to explode it; in case of fracture of the receptacle the explosive mixture of acetylene and air may be ignited by friction.

The authors conclude that the advantages in the use of the gas more than compensate for the dangers attending its use, which, with sufficient care, may be reduced to a minimum.

Another question has been raised regarding the use of acetylene which is not touched upon in this article. Acetylene forms, with certain metals, very explosive compounds. Whether in its use as an illuminant there is danger of such compounds being formed, is a point which deserves investigation.

In the last *Chemical News*, Dr. Geo. F. Payne, of the Georgia Department of Agriculture, offers a just criticism of a statement in the last edition of Blyth's 'Poisons.' Dr. Blyth states that cotton seed is poisonous to animals, and its use as an adulterant of linseed cake has caused the death of sheep and calves. Dr. Payne calls attention to the extended and successful use of whole cotton seed, cotton-seed meal and cotton-seed hulls in the South for fattening cattle, and suggests that the cases cited by Dr. Blyth may be due to castor-oil pomace, either accidentally mixed with the cotton-seed meal, or in a mixture intended for fertilizing purposes and inadvertently used for feeding animals.

In the recently published second edition of 'The Cyanide Process of Gold Extraction,' by James Park (Auckland, N. Z., Champtaloup and Cooper), it is stated on the authority of Johann Antal, a Hungarian toxicologist, that a solution of cobalt nitrate is a perfect antidote to cyanid poisoning. A matter of so much importance if true, deserves very careful investigation and confirmation. J. L. H.

ASTRONOMICAL NOTES.

The *Astronomical Journal* of October 16th contains a determination by Mr. Eric Doolittle of the secular perturbations of Mercury arising from the action of Jupiter. Gauss's method was employed.

In the *Astronomische Nachrichten* of October 8th Dr. Marcuse, of Berlin, publishes an account of the new photographic zenith telescope recently constructed for the Geodetic Commission, and gives an extended trial series of observations which he has made with it. The instrument is used like an ordinary zenith telescope, except that the stars are allowed to trail across a photographic plate in the focal plane, instead of being bisected with the usual filar micrometer. The distance between the trails can then be measured under a microscope. For the determination of the scale-value Dr. Marcuse uses Pleiades trails, and for the Pleiades stars adopts places based on the Yale triangulations of Elkin and the photographic observations made at New York by Rutherfurd. Dr. Marcuse finds as the result of the whole research that the photographic method is capable of about the same precision as the visual method. The output of work seems to be about the same for the two methods also; and in this respect the zenith telescope would seem to be an exception. For in most other applications of photographic astrometry the great advantage of the photographic method has been found to be the immense saving of labor permitted by it.

WE have received the first volume of the Annals of the Strassburg University Observatory. It is a large quarto containing xcviii. and 340 pages. After a description of the new observatory, there follows an elaborate investigation of the Repsold meridian circle and the observations made with it between 1882, March 15, and 1886, September 9. The volume closes with a series of plates illustrating the construction of the meridian observatory. The next volume is stated to be in course of publication, and will contain a definitive catalogue of stars derived from the Strassburg meridian observations.

THE Observatory of the University of Virginia has issued Part 7 of its publications, containing observations of the nebula in Orion, by Ormond Stone.

THE second part of the proceedings of the 1895 meeting of the International Geodetic Commission has been issued. It contains the usual reports upon the present condition of geodetic work in Europe.

H. J.

SCIENTIFIC NOTES AND NEWS.

M. AUG. LUCIEN TRÉCUL, botanist, member of the Paris Academy, died at Paris on October 15th, aged 78 years.

WE regret to notice, among other recent deaths of men of science abroad, those of Dr. R. E. Kerry, director of the bacteriological laboratory of the Vienna Veterinary Institute, at the age of 34; of Dr. Eugen Sell, associate professor of chemistry in the University of Berlin and director of the chemical laboratory of the Imperial Health Office, on October 13th, at the age of 54; of Dr. Julius Theodor Wolff, astronomer at Bonn, on October 11th, at the age of 70 years; of Dr. E. Czerkawski, formerly professor of philosophy at Lemberg, on September 21st, at the age of 74, and of Dr. Saul Kowner, formerly medical director of the Njeschin District Hospital (Russia), author of a work on the philosophy of Spinoza and of a history of medicine, in three volumes, aged 58.

WE regret to record the death of Dr. H. Newell Martin, which occurred at Burley, England, on October 29th Martin was born, in 1848, in Newry, Ireland. He studied at University College, London, and received the degrees of B. S. in 1870, of M. B. in 1871, and of D. Sc. in 1872. From the University of London he went to Christ College, Cambridge, where he took the degree of B. A. in 1874, and that of M. A. in 1877. He became a fellow of his college, and lecturer on natural history. On the organization of the Johns Hopkins University, in 1876, Martin, on the recommendation of Huxley, was made professor of biology, and retained this office till 1893, when his health became impaired. Martin belonged to the faculty of the Johns Hopkins University when its six or seven members gave the University its great reputation and trained a large part of the American students now engaged in university teaching. Martin did his full share in the accomplishment of this work. His lectures were admirably clear, and by teaching and example he greatly stimulated his students in original research. His own work on the physiology of the heart and in other directions is well known. His friends and former students published recently a collection of his scientific papers and addresses, which we hope to review shortly in this Journal. Only a month ago we called attention to the revised edition of 'The Human Body,' and stated that "the book remains the best compendium we have covering the anatomy, physiology, psychology and hygiene of the human body." Martin's untimely death is in every way a cause for deep regret.

The Association of American Agricultural Colleges met in Washington, D. C., on November 10th, 11th and 12th.

The annual convention of the American Society of Mechanical Engineers will be held at the house of the Society, 12 West Thirty-first street, New York City, from December 1st to 4th.

The Bradshaw Lecture, by Dr. W. R. Gowers, on 'Subjective Sensations of Sound,' was delivered before the Royal College of Physicians of London on Thursday, November 5th.

The comet medal of the Astronomical Society of the Pacific, founded by Joseph A. Donahoe, has been awarded to M. Giacobini, of the Observatory at Nice, France, for his discovery of an unexpected comet on September 4, 1896.

Mr. J. Wolfe Barry gave his presidential address to the London Institution of Civil Engineers on November 3d.

Dr. Ludwig Reh, of São Paolo, Brazil, has been appointed permanent assistant to the Concilium Bibliographicum, Zurich.

The Academy of Sciences at Budapest has received a bequest of 10,000 fl. from the late D. P. Von Palast.

It is proposed to raise the subscription to the Physical Society, of London, and that hereafter members shall be known as 'fellows.'

The lecture of M. Moissan before several of the scientific societies of New York, on October 27th, was followed with great interest by a large and representative audience. Even those unable to understand French appreciated the experiments with the electric furnace, showing the artificial production of diamonds and the volatilization of silica.

Dr. Felix Klein has been the guest of the faculty of the University of Pennsylvania. The graduates from Göttingen who reside in Philadelphia gave him a dinner, and he was also entertained by the Mathematical Club.

Popular Astronomy states that Prof. Winslow Upton, of Ladd Observatory, Brown University, is now at Harvard College Observatory, at Arequipa, Peru, engaged in making latitude and longitude observations. Mr. DeLisle Stewart, a graduate of Carleton College, is now one of the regular observers in the Observatory. He is engaged largely in photographic work, the photographs being sent to Harvard Observatory.

Dr. L. Serrurier, director of the Ethnographic Museum in Leiden, has resigned because the state will not rebuild the museum building.

The Flower Astronomical Observatory of the University of Pennsylvania has been completed and will be used at once by graduate students. It is well equipped with instruments, the lenses of which were made by Brashear and the instrumental parts by Warner & Swasey. The Flower Observatory is outside the city, but a working observatory, for the benefit of the undergraduates taking the college course in astronomy, has been erected near the other university buildings. This building will be equipped with a transit instrument, zenith telescope and a four-inch equatorial—the gift of Horace Howard Furness, Jr.

A despatch from Madrid says that the town of Huelva, in the province of that name, has been swept by a tidal wave from the Atlantic Ocean. No details are given, but the report says it is known that the loss of life has been great. The steamer Carthegena was overwhelmed by the great wave and most of the persons on board were drowned. Huelva is a town on an inlet of the Atlantic, forty-nine miles west, northwest of Seville. The population of the town is about twelve thousand.

A MUSEUM of natural history, geology, archæology and technology is proposed (says *Natural Science*) for Hertfordshire, and a site near St. Albans has been offered by Lord Spencer, upon certain conditions. A sum of at least £5,000 must be raised for building and endowment, and the museum is to be in the hands of the County Council. We are glad to see that a curator is thought of as much importance as a building. A provisional committee has been appointed, including Lord Cowper, Sir John Evans and the Hon. Walter Rothschild.

ACCORDING to *Die Natur*, a Congress for astronomers of all nations, met at Bamberg on September 17th. There were present thirty foreign members, including Father Hagen, of the Georgetown Observatory, who described his Atlas of Variable Stars, which is now in press; papers were also read by Prof. Bauschinger, the new director of the Astronomical Bureau of Calculations at Berlin; Prof. Schur, director of the Göttingen Observatory, and others. The next Congress will meet at Budapest, 1898.

A NOTE in the N. Y. *Evening Post* (quoting from an account in the London *Times*, of a report of Mr. Gosselin, of the British Embassy in Berlin) states that the authorities in German East Africa have put into force a series of regulations intended to check the indiscriminate slaughter of elephants and other big game. These rules, promulgated at Dar-es-Salaam, provide that every hunter must take out an annual license, for which the fee varies from five to 500 rupees. The shooting is prohibited of all young game—calves, foals, young elephants, either tuskless or having tusks under three kilos, and of all female game, if recognizable. Further, in the Moschi district of Kilima-Njaro, no one, whether possessing a license or not, is allowed without the special permission of the Governor to shoot antelopes, giraffes, buffaloes, ostriches or cranes. Those who are not natives have to pay 100 rupees for the first elephant killed and 250 for each additional one, and 50 rupees for the first rhinoceros and 150 for each succeeding one. Special game preserves are also to be established. Major von Wissmann suggests that the station authorities should endeavor to domesticate zebras (especially when crossed with muscat and other asses and horses), ostriches, and hyena dogs crossed with European breeds. It is thought that the best means of preventing the extermination of elephants would be to fix by international agreement among all the powers on the East African coast a close time for the animals, and to forbid the exportation or sale of tusks under a certain size.

UNIVERSITY AND EDUCATIONAL NEWS.

BY a decision of the University of the State of New York the degrees B. A. or A. B. and Ph. D. shall not, in the State, be conferred *causa honoris* after January 1, 1897.

THERE are 107 students in Wellesley College taking a course in geology which extends through the entire year. The course is given by Prof. Wm. H. Niles and Miss Elizabeth F. Fisher.

IT is proposed to build next year a laboratory of hygiene for the veterinary school at Berlin. Dr. Ostertag has been appointed to the chair of hygiene.

WOMEN have not been able to study medicine in Russia since 1882. Widely signed petitions, asking for the admission of women to the universities, have not been granted, but the Czar has sanctioned a decree creating a medical school for women in St. Petersburg.

SOME months ago the Bellahouston Trustees promised to the Glasgow University a donation of £12,500 towards the foundation of an engineering laboratory, provided that a similar sum was obtained by private subscriptions or otherwise. To fulfil this condition a committee was formed, and the Glasgow correspondent of *The Lancet* learns that nearly the whole of the sum required has been raised, so that the erection of the new laboratory will be commenced in the coming spring.

PROF. SCHENK has been promoted to a full professorship of anatomy in the University at Vienna, and Dr. London, of the University of Breslau, to an associate professorship of mathematics. Dr. Kippenberger, Privatdocent at Jena, has been called to the professorship of chemistry in the medical school at Kairo.

DISCUSSION AND CORRESPONDENCE.

THE LENGTH OF A CURVED LINE.

I SHOULD be very sorry to have anyone interpret my remarks in a recent number of SCIENCE (see page 533) as imputing ignorance of fundamental principles to so distinguished a geometer as Prof. Halsted. In saying that Prof. Halsted 'appears to believe' that he has given a logically complete discussion, my meaning was that he so appears to the unassisted reader of his 'Elements of Geometry.' My criticism was directed at the book rather than at the man. Further, as he says in his reply on page 656 of SCIENCE, the criticism is not applicable to his more recent work, 'Elementary Synthetic Geometry.'

In my opinion, it is not possible to discuss, in an elementary manner, propositions relating to the magnitude of curved lines until after the introduction of the following postulate: *The magnitude of a curved line is the limit toward which a broken line made up of consecutive chords of that curved line approaches, when the number of chords is increased in such a manner that the chords are all diminished without limit.* After the introduction of this postulate it is possible to compare the magnitude of a curved line with that of a straight line.

To turn again to Prof. Halsted's 'Elements of Geometry,' not only was it an error of logic to attempt to demonstrate without this postulate, or its equivalent, that a straight line is the shortest line joining two fixed points; but it was an error of the same sort to introduce, on pages 162–165 of that work, propositions relating to isoperimetric figures, which from their very nature depend on a comparison of non-congruent lines.

It seems worth while to insist upon the points made in this note and in my preceding note, because they relate to subjects treated in almost every American text-book of geometry; but in none, so far at least as the writer is aware, has a thoroughly satisfactory treatment been given.

In the very recent text-book of Beman and Smith, of which the writer has expressed a high opinion (See SCIENCE, this volume, page 203), the following appears on page 187:

"POSTULATE OF LIMITS. The circle and its circumference are the respective limits which the inscribed and circumscribed regular polygons and their perimeters approach if the number of their sides increases indefinitely.

"This statement is so evident that a proof is not considered necessary. Like valid proofs of many fundamental principles, it is too difficult for an elementary text-book."

The statement consists of two parts, one relating to superficial magnitude, the other to linear magnitude. The former is capable of simple proof. The circle is greater than any inscribed polygon, and any circumscribed polygon is greater than the circle; by the axiom, *the whole is greater than any of its parts.* Proofs based upon these considerations are older than the text of Euclid. The second part of the statement is a 'postulate' in a strict sense. It cannot be proved at all except from equivalent assumptions.

THOMAS S. FISKE.

OCTOBER 31, 1896.

ON CRITICISMS OF ORGANIC SELECTION.

A LONG absence in Europe has prevented my seeing several criticisms of my papers in this JOURNAL, until very recently; and although the issues may now be forgotten by the critics as well as by the readers of SCIENCE, I venture to write a few lines, if only to express my thanks for the kindly words which have aided me to see where the articles were not clear.

First, I may say that I have published, in the *American Naturalist* (June and July, 1896), a paper of some length under the title 'A New Factor in Evolution,' gathering the positions of the SCIENCE articles into a single sketch, thus carrying out, to a degree, the suggestion made by Prof. Wesley Mills in SCIENCE, May 22 (a suggestion which, however, I did not see until my return in September). Condensed summaries of the two main positions involved in the doctrine of Organic Selection (which I ventured to call a 'new factor') were quoted in this JOURNAL for July 31, p. 139, and I need not stop to requote them.

I am glad to know, both from Prof. Mills' article in SCIENCE, May 22d, and also from a personal letter from him, that he accepts the class of facts which I have emphasized, and admits their importance (having himself before pointed out the imperfection of instinct)*; the point of difference between us being in their interpretation with reference to the inheritance of acquired characters. I hope the charge of obscurity which he brought against my Science articles holds to a less degree of the fuller presentation of the case against Lamarckism in the papers in the *Naturalist.* I may express the wish—in the way of a friendly suggestion of a reciprocal kind to Prof. Mills—that he take up the arguments which I have advanced to show that the Lamarckian view of heredity is not entitled to the exclusive use of the principle of use and disuse, but that evolution may profit by the adaptations of individual creatures without the inheritance of acquired characters, through what I have called Organic Selection, and show why they do not apply.

As to the 'newness' of the general view which I have published, that is a matter of so little importance that I refer to it only to disavow having made untoward claims. Of course, to us all 'newness' is nothing compared with 'trueness.' As to the working of so-called Social Heredity, I am not aware that I called the position new, *i. e.*, that social influences do aid the individual in his development and enable him to keep alive. This had been taught by Wallace, and later was signalized—as a note on my papers points out in *Nature*—by Ritchie and by Weismann. What I thought was new about Social Heredity was the name, which seemed to me appropriate for reasons given in the *Naturalist* articles, and also the use made of it to illustrate the broader principle of Organic Selection—which latter principle I did and do still think to be new. A word in regard to it.

If we give up altogether the principle of modification by use and disuse, and the possibility of new adaptations in a creature's own lifetime, we must go back to the strictest Preformism. But to say that such new adaptations influence phylogenetic evolution only in case they are inherited, is to go over to the theory of Epigenesis. Now what I hold is that these individual adaptations are real (*vs.* Preformism), that they are not inherited (*vs.* Epigenesis), and yet that they influence evolution. These adaptations keep certain creatures alive, so put a premium on the variations which they represent, so 'determine' the direction of variation, and give the phylum time to perfect as congenital the same functions which were thus at first only private adaptations. Thus the same result may have come about in many cases as if the Lamarckian view of heredity were true. A case of special miportance of this is seen in *intelligent adaptations*, and one of the most interesting fields of intelligent adaptation as that of *social cooperation.** The general principle, therefore, *that new adaptations effected by the individual may set the direction of evolution without the inheritance of acquired characters* is what I considered new and called Organic Selection (also for reasons set out in the *Naturalist* articles).

Prof. Cattell, writing with thorough appreciation of the principle (in *The Psychological Review*, September, 1896, p. 572), cites Darwin's doctrine of Sexual Selection as a case from the literature. This case also occurred to me this summer. Apart altogether from the truth or falsity of Sexual Selection, the use which Darwin made of it was directly in the way of what it seemed well to me to call Organic Selection. Sexual Selection would be, if proved, a particular and special case of Organic Selection. But Darwin, as I think—subject to correction by those more familiar with the literature—found the importance of Sexual Selection in the fact that it took effect directly in the pairing of mates and so influenced posterity. I do not know that Darwin advanced the general truth that all personal adaptations which were of 'selective value'—*i. e.*, which were useful enough to enable a creature to escape with his life—would bring about indirectly the sort of effect upon pairing that Sexual Selection would. But whether he did or not, if that be true, then evidently the special case of Sexual Selection does not cover the whole influence, and there is the same reason for giving the whole influence or 'factor' a name that Darwin had for giv-

* The phrase 'half-congenital,' referred to by Profs. Mills and Bumpus, was used as expressive rather than as a suggestion in terminology!

* These are the two main cases dealt with in my Science articles, and to my mind (speaking for no one else) the main interest attaching to the imperfection of instinct, discussed lately by various writers in these pages, is that it shows this 'factor' at work.

ing a special name to the particular case of Sexual Selection.

In short, does not the formulation of any positive influence which regulates the operation of Natural Selection really indicate a 'factor' in the whole evolution movement? Darwin formulated Sexual Selection as such a factor. Wallace's 'recognition-mark' theory of the origin of bright plumage in male birds is another such formulation. Organic Selection formulates the general factor which both these positions—and possibly others—illustrate; 'newness' in any other sense I am not disposed to maintain for it.

Darwin's personal use of the principle of Sexual Selection, I may add, seemed to require a very high psychological development on the part of the choosing mate, the female; but the way that the principle may be generalized—although still with reference to the special case of mating—may be seen in the very interesting suggestions of Groos (*Die Spiele der Thiere*, pp. 230 ff).

More than one of my critics have spoken of the relation of Organic Selection to Natural Selection. It is discussed at some length in the *Naturalist* article (July, pp. 549 ff). Prof. Cattell says: "It is the essence of Natural Selection that under changed environment those individuals will survive who can best adapt themselves to it." Certainly it is. But I think that the advocates of Natural Selection have considered as useless or uninfluential in evolution those adaptations of individuals which were not adequately represented in the *congenital equipment* of the individual. Certainly the tendency, at least, of the Neo-Darwinians has been to deny the influence of the principle of use and disuse on evolution—to consider it altogether a part of the machinery of Lamarckism.* *The influence of new adaptations, however, in determining the limits of variation in subsequent generations without appealing to the inheritance of acquired characters;* that (to repeat) is the combination which I considered new, although I should not have had the courage to label it so if certain biologists familiar with the history of discussion had not so characterized it.

If Romanes, for example, had thought of this answer to Lamarckism, I cannot conceive that he would still have pressed his argument for the inheritance of acquired characters drawn from the coordinated muscular movements seen in instinct; and in this particular case—the origin of instinct—I think the doctrine of Organic Selection gives a new theory.

So far, however, from opposing Natural Selection appeal is made directly to it. The creature that can adapt itself gets its value only because it is selected, as Natural Selection does all its selecting. Even might we say that the very ability to make personal adaptations may possibly be due to Natural Selection. But I can not go with Prof. Cattell in saying: "If Organic Selection is itself a congenital variation, as Prof. Baldwin indicates [as possible,]* we are still in the *status quo* of chance variations and Natural Selection." Not entirely, I think, since the future variations are narrowed down in their range within certain limits. Say a creature is kept alive and begets young because he can adapt himself intelligently or socially, and say his mate has the same character; then the drift of variations in the next generation will be in the same direction, as Prof. Cattell himself recognizes.† Of course, as far as this point goes, we do 'remain ignorant as to why the individual makes suitable adaptations;' that is quite a different question, involving I think, for adaptations in the sphere of muscular movement, another application of Natural Selection, *i. e.*, to overproduced or excessive movements‡; but we do not remain ignorant as to 'why congenital variations occur in the line of evolution,' admitting that they occur at all. And, of course, we do remain in ignorance as to why 'they [variations] are hereditary;' that again is a matter of the mechanism of heredity.

In connection with this question of 'newness'

*Thus they would say: The intelligence is congenital, but the particular things learned by intelligence, not being inherited, have as such no influence on race development, except as the children also learn to do these things intelligently.

*Cf. my *Mental Development*, pp. 172 ff. 204 ff.

†In the illustration he gives of Organic Selection, *i. e.*, of dogs becoming granivorous from feeding on grain during many generations.

‡Criticisms of this hypothesis I can not consider now, but hope to answer them soon in *The Psychological Review*.

—as much as I dislike to dwell upon it—I must refer to another remark by Prof. Cattell. He says that I leave it in doubt whether I mean to say that this principle of Organic Selection was stated in my book on *Mental Development*, and also that he can not tell from his memory of the book. This is a fair question. The principle was suggested in the book, as the following quotations will suffice to show: "It is necessary to consider further how certain reactions of one single organism can be selected so as to adapt the organism better and give it a life history. Let us at the outset call this process 'organic selection,' in contrast with the natural selection of whole organisms." * * * "The facts show that individual organisms do acquire new adaptations in their lifetime, and that is our first problem. If, in solving it, we find a principle which may also serve as a principle of race development, then we may possibly use it against the 'all-sufficiency of natural selection,' or in its support" (Pp. 175–6). Then in speaking of the results of the individual's adaptations on the course of evolution: "This again is exactly the same result as if originally neutral organisms had learned each for itself. * * * The life principle has learned, but with the help of the stimulating environment and natural selection (173)." Again in speaking directly of heredity (p. 205 f): "It [Neo-Darwinism] denies that what an individual experiences in his lifetime, the gains he makes in his adaptations to his surroundings, can be transmitted to his sons. This theory, it is evident, can be held on the view of development sketched above, for granted the learning of new movements in the way which I have called 'organic selection' * * yet the ability to do it may be a congenital variation. * * * And all the later acquirements of individual organisms may likewise be considered only the evidence of additional variations from these earlier variations. So it is only necessary to hold to a view by which variations are cumulative [*i. e.*, the view of Organic Selection] to secure the same results by natural selection as would have been secured by the inheritance of acquired characters from father to son." (See also p. 206.) I may be allowed, also, in view of the charge of obscurity made by Mr. Cattell—and the appearance of which comes in part, at least, from the need of condensation—to cite the following sentences from a review of my book in the London *Speaker*. Giving an exposition of the position which the book takes on the subject of heredity, the reviewer says: "If, however, creatures having the ability to make intelligent adaptations which become consolidated into habits (called 'secondary instincts)' are selected for survival, it is just as if secondary instincts were acquired by actual transmission to offspring of the modifications produced in parents by the exercise of their own intelligence. Psychologists may, therefore, practically speak as if acquired mental characters were really inherited, though what is inherited may be only the ability to acquire them. Such ability, of course, natural selection would accumulate like any other variation." The passage which this reviewer refers to is in *Mental Development*, p. 207, a passage which was expanded, *apropos* of Romanes' doctrine of the origin of instinct, in my paper in SCIENCE, March 20, 1896.

While suggested in the book, however, it is not enlarged upon, since the section on heredity was written only to show that either of the current views might be held together with the main teaching of the book.

I regret taking so much space for these personal explanations, but the editor of this JOURNAL can spare the space, since it is he who asked the question!

Prof. Cattell also finds obscurity in my view of the place of consciousness in evolution. The obscurities are possibly cleared up somewhat in an article on 'Consciousness and Evolution' in the May, 1896, issue of *The Psychological Review*.

J. MARK BALDWIN.

PRINCETON UNIVERSITY,
October 27, 1896.

THE relations of individual adaptations to race evolution will shortly be reviewed in this JOURNAL by Prof. Lloyd Morgan and by Prof. Osborn. I think that the important principle called by prof. Baldwin 'Organic selection' is implicit in Darwin's works, and has been clearly formulated by Prof. Weismann.

J. MCKEEN CATTELL.

THE INSTINCTS OF BIRDS.

To the Editor of Science: So much interest is now taken in psychology that, although it is not the field of science with which I am most familiar, I believe that the statement of an observation I made this summer may be of interest.

My hired man brought home a nest of young hawks, probably a week old. We tried to rear them on meat. After a few days I noticed in some way that they tried to peck at a *red* rag. It occurred to me to try if the color had any influence. I found that, while they would sometimes peck at any rag, they would always attack a red one. It would seem, therefore, that they noticed the red of the meat.

We also found that they were cannibals, for, not being fed quite enough meat one day, they attacked the weakest one, and would have killed it; in fact, it did die in a day or two.

Geo. Chas. Buchanan.

Henning, Minn.

FINAL SUMMARY REPORT OF THE GEOLOGICAL SURVEY OF PENNSYLVANIA.

To the Editor of Science: In your issue of June 12, 1896, there appeared over the signature of Dr. J. J. Stevenson a brief review and criticism of the Final Summary Report of the Geological Survey of Pennsylvania, in which Dr. Stevenson was good enough to commend, in general, the results attained under such adverse circumstances as the general public could hardly be expected to realize.

It was several weeks after this article was written that my attention was called to it, and in writing to the author of it, to thank him for his very generous praise, I expressed chagrin and regret that he should have taken apparent exception to the *manner* and *place* in which credit was given to the various assistants whose work and reports formed so large a part of, and the basis for, Volume III., in the compilation of which I was so largely responsible.

In his reply, as well as in the original article, Dr. Stevenson was courteous enough to realize the absence of any intention to detract from the very high merit due him and others for the painstaking work they performed in elucidating the geology of the State, but very properly pointed out that the casual reader of the Final Summary, from the character and number of references to his name in connection with the chapters on the bituminous coal measures in southwest Pennsylvania, might readily fail to give credit to him for his labors in that district.

After carefully reviewing the chapters referred to, pp. 2448 to 2564 in Vol. III., Part 2, I cordially endorse Dr. Stevenson's criticism, and ask the medium of your widely read journal, not only to express my sincere regret for that deficiency in the Summary, but to accord to Dr. Stevenson the fullest possible credit for his exceptionally excellent work in the coal district.

To all who have had access to the reports of the Geological Survey this tribute is hardly necessary; for the several volumes* which bear his name attest the fidelity and general value of his work as well as the high scientific character of his investigations; but to such as have not become familiar with these individual volumes it gives me only pleasure to say, that not only were his several reports (in common with those of many other assistants) freely used by me in my compilation of the survey in the Bituminous Region, but his sections, plates and measurements of coal beds as well, and I regard them as amongst the most valuable and reliable data secured during the progress of the survey.

This was the object of the 'Summary Report,' and if space and means had permitted it, every assistant's name should have been attached to his particular work, in the body of the report as well as in my prefatory letter (see Volume III., Part I., pp. 1855 and 1856), where a general acknowledgment was made of the work of all the aids.

To Dr. Stevenson, as well as to the Messrs. Platt, White, Ashburner, Chance and Sherwood, is Pennsylvania indebted for a wealth of facts concerning the geology of the Appalachian coal field. To them all, and individually, are due my heartiest acknowledgments in the preparation of the 'Summary Report,' and above all, to the venerable Director of the Survey, Dr. J. P. Lesley, whose notes, illustrations and valuable prefatory notices, were all freely

*Reports K, K_2, K_3 and T_2.

accorded and made use of by me for the benefit of the object in view.

E. V. D'INVILLIERS.

PHILADELPHIA, PA.

SCIENTIFIC LITERATURE.

General Principles of Zoology. By RICHARD HERTWIG. Translated by GEORGE W. FIELD. Henry Holt & Company, New York. 1896.

The most pressing need for teaching elementary zoology in American schools is a suitable text-book; one that treats the general principles in a way that clothes with flesh the skeleton of systematic zoology; one written with genius that holds the attention and inspires. It must be clear and compact. Prof. Hertwig's 'Lehrbuch der Zoologie' is such a book, and an English edition will doubtless give an impulse towards better teaching and better discipline in acquiring the foundations of animal biology. The separation of the 'General Principles' from the 'Systematic Part' as an independent volume may be regarded as an advantage, since its clear, comprehensive, though brief, generalizations and discussions make it a useful handbook for teachers, students and general readers who want to find and understand the latest position of the science.

In the introduction the author defines the purpose of zoological study, morphology, comparative anatomy, ontogeny, etc. The body of the book proceeds under two general heads—'The History of Zoology' and 'General Morphology and Physiology.' The former covers sixty-seven pages in which are presented with surprising satisfaction and impartiality the positions of the creators of the science from the systematists and anatomists of classic antiquity to the investigators and teachers of to-day. Two-thirds of this space is justly given to the theory of descent, its history and proofs. Lamarckianism and Darwinism are succinctly interpreted and the additions and modifications suggested by advocates and opponents stated. In the general morphological part after certain definitions are given comes the history of the cell and the general principles of cytology; the latter and the chapter on general embryology are perhaps the most helpful in the book and leave little to be desired in a summary of these subjects. If one wants to know the position of zoologists on mimicry, distribution, promorphology, or the nature of species, this modest manual will afford him a reliable exposition.

The translator certainly deserves much credit for his part, scarcely an involved or muddy sentence occurs. The illustrations are familiar but well selected.

One so disposed might make a case in apparent criticism, for example, the young sponge figured on page 159, named '*Spongilla fluviatilis* (after Huxley),' some would prefer to see as *Meyenia fluviatilis* (after Lieberkühn); again on page 199: "Many *Protozoa* fuse with one another and form large bodies in which the individual animals can still be recognized." This seems to imply more than some feel like granting. *Ophrydium versatile* and *Proterospongia haeckeli*, for example, occur in large masses with hundreds of individuals imbedded in the support of cast-off or accumulated matter for protection; it seems to mean no more than the compound pedicels of other forms, or a chain of the loricæ of *Cothurnia variabilis.* But such differences may not be criticisms and certainly do not detract from the usefulness of the book.

Surely all who read this treatise will earnestly hope that the systematic part of the 'Lehrbuch' may speedily follow in the same admirable style.

D. S. KELLICOTT.

OHIO STATE UNIVERSITY.

Lehrbuch der vergleichenden mikroskopischen Anatomie der Wirbelthiere. DR. MED. ALBERT OPPEL. Erster Theil; Der Magen. Jena, Gustav Fischer. 1896.

Since Leydig's 'Histologie' appeared forty years ago there has been no systematic attempt at a summary of our histological knowledge. The works on histology have confined themselves chiefly to the histology of man and the higher animals, except in cases where a lower form happened to be especially favorable for purposes of illustration. The study of histology has been so closely connected with that of medicine that this is not to be wondered at; but now, when the value of comparative study is so obvious, and when the lower animals are being studied from a purely scientific point of view, an attempt to collate and arrange the scattered facts of histology must be welcomed as affording a comprehensive review of past work and a firmer basis for investigation. The author of this Comparative Microscopical Anatomy has made this attempt for the Vertebrata and has succeeded admirably, if one may judge from the character of Part I., which is all that has appeared.

The work is conceived with the characteristically German disregard of difficulties and long years of labor, although the author recognizes the magnitude of the task before him. Indeed, in his preface he states that his notes are so arranged that his successor will be perfectly able to continue the work, if it should drop from his hands.

Part I. treats of the histology of the stomach. Just why Dr. Oppel should have begun with this organ is not clear. It would seem that the study of the organs in some natural series would preserve a more logical order. Why not begin with the upper end of the alimentary canal, for instance, and follow with the different sections in their order?

A work of this nature must, of necessity, be largely a compilation of facts or opinions gathered from the literature on the subject. Furthermore, it is important that the authorities be given, in order to avoid confusion and to enable the student to refer to the original papers. This end the author has had in view throughout the work. As he himself states, the book is intended not to replace the literature, but to serve as a key to it. In his references not only the name of the author is given, but also the year of publication, and an empirical number referring to the alphabetical index of authors, where the title and place of publication are given in full. The summary of each author's view, whether it be a few words only or several paragraphs, is enclosed between two straight bars placed obliquely (//). This arrangement aids distinctly in separating sharply the work of different authorities. The typographical work is good, the number of errors being exceedingly small. The figures are, as the author states, mostly copies, some of which he has found it necessary to schematise. Except five lithographic plates, they are all wood-cuts (375 in number) and nearly all extremely good.

The subject-matter is divided into chapters corresponding to the classes of Vertebrates. Following the introduction—a short statement of the purpose and scope of the work—is a chapter on the general plan of structure of the vertebrate stomach. The following chapters deal successively with Fishes, Amphibia, Reptiles, etc. Each chapter opens with a general summary of the structure of the stomach in each class, given under the various heads of Epithelium, Muscular Layers, Lymphatic Tissue, etc. Following this the various forms of the class are discussed in their proper systematic order, so far as they have been investigated. Considerable space is also given to a discussion of the physiology of the glands and the constitution of the gastric juice, especially in the higher animals. The chapter on the mammalian stomach occupies somewhat more than half the book and is, of course, much more complete than the other chapters.

As the various points of theoretical interest arise, they are thoroughly discussed, the author in most cases giving his own views after a summary of the literature. An important question, the phylogeny of the gastric glands, is discussed in the first chapter. Oppel concludes that it is by no means proved that the oldest Vertebrates did not possess gastric glands, and that those cases among fishes where they are absent are to be explained through degeneration. The absence of the glands in these forms is thus wholly a secondary modification, as is well shown by the fact that the near relatives of those species in which the glands are absent often possess them in well-developed form. The glands have arisen, not by a deepening and narrowing of the folds of the mucous membrane, but as independent invaginations starting from a very limited area. The absence of gastric glands among the Monotremes, where the whole stomach is lined with a stratified epithelium like that of the œsophagus, is due to secondary changes, the œsophageal epithelium having gradually grown down and displaced the original gastric epithelium.

An exhaustive discussion of the physiology of the mammalian gastric gland-cells is given, and the variety of views held by different authorities shows very clearly the difficulty of such investigation. The author's conclusion is that the 'central cells' (Hauptzellen) of the fundus-glands are certainly very closely connected with the secretion of the gastric juice. It is very probable that they secrete pepsin, but they may also secrete the hydrochloric acid, though there is no good evidence that they do. The cells of the pyloric glands also probably secrete pepsin. The function of the 'parietal cells' (Belegzellen) of the fundus-glands is not so well understood, but it is probable that they also secrete pepsin. The 'parietal cells' of mammals are by no means identical with the fundus-cells of lower Vertebrates. In closing the discussion he says: "I have emphasized the point that a certain function in one kind of cell does not exclude the possibility of the same or a similar function in another kind." In fact the whole discussion only tends to show how much in the dark we are as regards the actual functions of these cells.

It is impossible to take up the different chapters in detail, as they are so largely summaries of the work of various investigators.

Following the text appears a table of the animals mentioned, arranged according to their systematic position. The classification is in part that followed by Claus in the fifth edition of his 'Lehrbuch der Zoologie.' This table is followed by a list of the same names arranged alphabetically, their systematic position being indicated by the name of the family, order, etc. The next thirty pages are occupied by the literature, and a good index finishes the book. Thus this part is complete in itself as a histology of the vertebrate stomach.

The volume comprises some 530 octavo pages. In reading it one cannot fail to be impressed with the patience of the author, nor to admire the temper of a man who enters single-handed on a subject of such magnitude. It is to be hoped that the work may be carried to completion, for it will constitute a most valuable aid to future research. It is not a book for the general reader, nor is it a text-book, but the student and investigator will find in it a careful resumé of our present knowledge of the histology of the vertebrate stomach. It is, in fact, as the author has said, a key to the literature, and thanks are due to the man who is willing to undertake the so often thankless task of compilation necessary to such a work.

C. M. CHILD.

UNIVERSITY OF CHICAGO.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON; 264TH MEETING. SATURDAY, OCTOBER 24.

DR. ERWIN F. SMITH exhibited specimens of *Leuconostoc mesenteroides* from a sugar house in Louisiana. These were in the shape of fist-large gelatinous aggregates. If the vats are not sterilized at frequent intervals this organism multiplies very rapidly in the sugar cane juice and causes much inconvenience and loss.

Mr. Frederick V. Coville exhibited specimens of the *Hæmatococcus* which is the cause of the so-called 'red snow,' and also the seeds of the Western water lily, *Nymphæa polysepala.* These seeds, in spite of their small size, are an important article of food of the Indians of western Oregon and are extensively collected in Klamath Lake. The seeds are dried and parched in baskets by the use of heated stones.

Mr. C. L. Pollard noted the addition of *Iresine paniculata* to the fauna of the district, specimens having been found on Plummer's Island.

Mr. B. E. Fernow exhibited a series of shrubby and arborescent plants from Arizona, in which many growing points and shoots are changed into spines; the series beginning with *Ceanothus* and ending with *Kœberlinia* and the rare *Holacantha emoryi* showed, with the decrease in the amount and size of foliage, an increase of the number and size of spines, the latter two species consisting entirely of spines, the leaves being reduced to early caducous bracts.

Mr. Albert F. Woods spoke of a plant disease of the foliage of maples, caused by 'red spiders' and excessive atmospheric moisture.

Dr. C. Hart Merriam described a 'New Fir from Arizona,' which he named *Abies arizonica.* It differs from its nearest relative, *A. lasiocarpa*, in the character of the bark, which is a fine-grained cork and in the shape of the cone scales.

Mr. Frederick V. Coville briefly noticed

Britton and Brown's Illustrated Flora of the Northern United States and Canada.

Dr. Erwin F. Smith described a *Bacterial Disease of Potatoes, Tomatoes and Eggplants,* caused by a new micro-organism, *Bacillus solanaceanum,* which he believed to be the cause of a large part of the potato rot of the United States. Numerous infection experiments performed in 1895 and repeated this year have set the parasitic nature of the organism beyond dispute. The following are some of the peculiarities of this bacillus: Organism motile; forms zoögloea in liquid cultures; does not liquefy gelatin; strictly ærobic, does not produce any gas or any acid when grown in the presence of sugars; produces an abundance of alkali (ammonia) in various media; develops a decided brown pigment when grown in the presence of various sugars (agar cultures, fermentation tubes, potato cultures, etc.); grows readily in the thermostat at 37° C.; thermal death point (ten minutes' exposure) about 52°C. The organism is probably transmitted from diseased to healthy plants by means of insects. In the greenhouse, under strict control conditions, very successful infections have been obtained by means of the Colorado potato beetle (*Doryphora 10-lineata*). A bulletin giving a full account of this parasite will soon be published by the Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture.

F. A. Lucas,
Secretary.

ENTOMOLOGICAL SOCIETY OF WASHINGTON, OCTOBER 8, 1896.

The President announced the death of Mr. Henry F. Schönborn, a Washington entomologist, who possessed the largest private collection of Lepidoptera in the city.

Mr. Ashmead exhibited a female specimen of the family Thynnidæ which he had found in the National Museum collection labelled 'Alameda County, California.' This is the second North American species of this family recorded from America. Mr. Ashmead will call it *Glyptometopa americana.* Some discussion ensued and it was suggested that both species had been accidentally imported into America.

Mr. Heidemann exhibited a drawing of the winged male of *Rheumatobates rileyi,* showing that the description of the species must now be revised.

Mr. F. C. Pratt exhibited specimens of the spine-like cases of *Coleophora octagonella,* taken from orange, and which exactly resembled the thorns of orange.

Mr. Hubbard presented a preliminary notice of a new Coccid on birch from the Lake Superior region. This insect is very abundant and causes the general destruction of the bark of birch trees, so much so that it is difficult to find near the Lake a tree of any size with smooth or natural bark. The outer bark is roughened, covered with curls and splits, blackened with sooty mold, and in bad cases entirely removed down to the last layer. Often the cambium itself is invaded and the tree is killed or seriously injured. The young larva of the Coccid crawls into the lenticels of the bark and, growing and forming thick masses of wax, causes the bark to heave and layers to separate in curls. He had studied the development of the species, which exhibited several remarkable features. The female undergoes three molts and has four stages, of which the larva and adult are active and possess legs and antennæ. The two intervening stages are stationary and degraded. The author considers the species to belong in all probability to the genus *Xylococcus.*

Dr. M. G. Motter presented a paper entitled 'A Contribution to the Study of some Necrophagous Diptera,' giving a preliminary announcement of some results of his study of the fauna of cadavers which he has been carrying on for some months with a view of substantiating or contradicting conclusions of Mégnin and other writers.

L. O. Howard,
Secretary.

NORTHWESTERN UNIVERSITY SCIENCE CLUB.

At the first meeting of the college year, October 9th, Dr. Marcy in the chair and eighteen persons present, Prof. Young presented for the department of chemistry 'Notes on the Development of Explosives,' in which he reviewed the processes of explosion and the nature and use of explosives.

A. R. Crook,
Secretary.

SCIENCE

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SCIENCE

FRIDAY, NOVEMBER 20, 1896.

CONTENTS:

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

*ON MODIFICATION AND VARIATION.**

UP to a date still comparatively recent, the transmission to offspring, in greater or less degree, of those modifications of habit or structure which the parents had acquired in the course of their individual lifetime, was generally accepted. Lamarck is regarded as the intellectual father of the transmissionists. In his 'Histoire Naturelle' he said: "The development of organs and their power of action are continually determined by the use of these organs." This is known as his third law. In the fourth he insisted on the hereditary nature of the effects of such use. "All that has been acquired, begun or changed," he said, "in the course of their life is preserved in reproduction and transmitted to the new individuals which spring from those which have experienced the changes."

Darwin accepted such transmission as subordinate to natural selection, and attempted to account for it by his theory of pangenesis. According to that hypothesis all the component cells of an organism throw off minute gemmules, and these and their like, collecting in the reproductive cells, are the parental germs from which all the cells of the offspring of that organism are developed. This theory, here given in briefest outline, came in for its full share of

* Being a chapter from a forthcoming work on *Habit and Instinct* communicated at the request of Prof. Henry F. Osborn.

criticism. The problems of heredity were recognized as being of supreme biological importance and were warmly discussed. Meanwhile a different view of the relation between the organism and its reproductive cells came into prominence. With it the names of Francis Galton, in England, and August Weismann, in Germany, are inseparably connected. Of late years it has gained the approval of many, though by no means all, of our foremost biologists. This view, again given in briefest possible outline, is as follows: The fertilized egg of any many-celled organism gives origin to all the cells of which that organism is composed. In some of these, the reproductive cells, germinal substance is set aside for the future continuance of the race; the rest give rise to all the other cells of the body, those which constitute or give rise to muscle, nerve, bone, gland and so forth. Thus we have a division into germ-substance and body-substance. Germ gives origin to germ plus body; but the body takes no share, according to Prof. Weismann, in giving origin to—though it ministers to, protects, and may exercise an influence on—the germinal substance of the reproductive cells.

The logical development of this theory led Prof. Weismann to doubt the inheritance of characters acquired by the bodily substance in the course of individual life, and to examine anew the supposed evidence in its favor. For if brain substance, for example, contributes nothing to the reproductive cells, any modification it acquires during individual life can only reach the germ through some indirect mode of influence. But does it—does any modification of the body substance—so affect the germ as to become hereditary? Prof. Weismann answers this question by asserting that the evidence for the direct transmission of acquired characters is wholly insufficient, and by contending that, until satisfactory evidence is forthcoming, we may not accept transmission as a factor in evolution.

How, then, is progress possible if none of the modifications which the body suffers is transmitted from parent to offspring? To this question we must reply that though modification is, on this view, excluded from taking any direct share in race-progress, yet there is still variation. By modifications I mean those changes which are in some way wrought in the body-structure, and by variations those differences which are of germinal origin. That variation of germinal origin is a fact in organic nature is admitted on all hands, and that some variations are adaptive is also unquestioned. Transmissionists contend that modification in a particular direction in one generation is, through the transmission of the change in some way from the bodily tissues to the germinal cells, a source of variation in the same direction in the next generation. Selectionists, on the other hand, exclude this source of variation, contending that the supposed evidence in its favor is insufficient or unsatisfactory. But their whole theory depends on the occurrence of variations, of which those that are in unfavorable directions are weeded out, while those that are useful and adaptive remain in possession of the field. How these variations originate in the germ we need not here discuss. Let us assume that variations of germinal origin in a great number of directions do as a matter of fact occur.

This, then, is how the matter stands. All acknowledge the existence of variations and admit that their proximate source is in the fertilized ovum. All admit that the individual is, through its plasticity, in greater or less degree capable of adaptive modification. Transmissionists contend that the effects of modification are somehow transferred to the germinal substance there to give origin to variations. Selectionists deny this transmission and contend that adaptive variations are independent of adaptive modifications.

Now, what is natural selection, at any rate as understood by the master—Darwin? It is a process whereby, in the struggle for existence, individuals possessed of favorable and adaptive variations survive and hand on their good seed, while individuals possessed of unfavorable variations succumb, are sooner or later eliminated, standing therefore a less chance of begetting offspring. This is the natural selection of Darwin. But it is clear that to make the difference between survival and elimination the favorableness of the variation must reach a certain amount—varying with the keenness of the struggle. This was termed by Romanes 'selection value.' And one of the difficulties which critics of natural selection have felt is that the little more or the little less of variation must often be too small in amount to be of selection value so as to determine survival. This difficulty is admitted by Prof. Weismann as a real one. "The Lamarckians were right," he says, "when they maintained that the factor for which hitherto the name of natural selection had been exclusively reserved, viz., personal selection [*i. e.*, the selection of individuals], was insufficient for the explanation of the phenomena." * And again: † "Something is still wanting to the selection of Darwin and Wallace, which it is obligatory on us to discover, if we possibly can."

The additional factor which Dr. Weismann suggests is what he terms germinal selection. This, briefly stated, is as follows: There is a competition for nutriment among those parts of the germ from which the several organs or groups of organs are developed. These he names determinants; in this competition the stronger determinants get the best of it, and are further developed at the expense of the weaker determinants, which are starved and tend to dwindle and eventually disappear. The suggestion is an interesting one, but one well-nigh impossible to put to the test of observation. It must at present be placed among the 'may-bes' of biology. If accepted as a factor, it would serve to account for the existence of determinate variations, that is to say, variations along special or particular lines of adaption.

* *Germinal Selection*, Monist Jan., 1896, p. 290.

† *Op cit.* p. 264.

Such determinate variations are, however, explicable on the theory of natural selection—a term which, in my opinion, should be reserved for that process of individual survival and elimination to which it was applied by Darwin. Writing in 1892 I put the matter thus:* "Take the case of an organism which has in some way reached harmony with its environment. Slight variations occur in many directions, but these are bred out by intercrossing. It is as if a hundred pendulums were swinging just a little in many directions, but were at once damped down. Now, place such an organism in changed conditions. The swing of one or two of the pendulums is found advantageous; the organisms in which these two pendulums are swinging are selected; they mate together and in their offspring, while these two pendulums are by congenital inheritance kept a-swinging, the other 98 pendulums are rapidly damped down as before.

"Let us suppose, then, that the variation in tooth structure, in a certain mechanically advantageous direction, be such a selected pendulum swing. That particular pendulum, swinging in that particular direction, will be the subject of selection. The other pendulums will still be damped down as before, and in that particular pendulum variations from the particular direction will be similarly damped down. It will wobble a little, but its wobbling will be as nothing compared with the swing that is

* *Natural Science*, Vol. I., April, 1892, pp. 100-101.

fostered by selection. In this case, then, selection will choose between the little more complexity that is advantageous and the little less complexity that is disadvantageous. The little less complexity will be eliminated, the little more complexity will survive. The little less and the little more are, however, in the same line of developmental swing. Hence, the variations discoverable in fossil mammals in which tooth development along special lines is in progress, will, on the hypothesis of selection, be plus and minus along a given line; in other words, the variations will be determinate, and in the direction of special adaptation."

Prof. Weismann adopts a similar position in his recent paper on germinal selection.* "By the selection alone," he says, "of the plus or minus variations of a character is the constant modification of that character in the plus or minus direction determined. * * * We may assert therefore, in general terms, that a definitely directed progressive variation of a given part is produced by continued selection in that definite direction. This is no hypothesis, but a direct inference from the facts and may also be expressed as follows: By selection of the kind referred to, the germ is progressively modified in a manner corresponding with the production of a definitely directed progressive variation of the part."

In his Romanes Lecture, Prof. Weismann makes another suggestion which is valuable and helpful and which, I think, may be further developed and extended. He is there dealing with what he terms 'intra-selection,' or that individual plasticity to which I have frequently made reference. One of the examples that he adduces is the structure of bone. "Herman Meyer," he says,† "seems to have been the first to call attention to the adaptiveness as regards minute structure in animal tissues, which is most strikingly exhibited in the structure of the spongy substance of the long bones in the higher vertebrates. This substance is arranged on a similar mechanical principle to that of arched structures in general; it is composed of numerous fine bony plates so arranged as to withstand the greatest amount of tension and pressure, and to give the utmost firmness with a minimum expenditure of material. But the direction, position and strength of these long bony plates are by no means congenital or determined in advance; they depend on circumstances. If the bone is broken and heals out of the straight, the plates of the spongy tissue become rearranged so as to be in the new direction of greatest tension and pressure; thus they can adapt themselves to changed circumstances."

Then, after referring to the explanation, by Wilhelm Roux, of the cause of these wonderfully fine adaptations by applying the principle of selection to the parts of the organism in which, it is assumed, there is a struggle for existence among each other, Prof. Weismann proceeds to show* that "it is not the particular adaptive structures themselves that are transmitted, but only the quality of the material from which intra-selection forms these structures anew in each individual life. * * * It is not the particular spongy plates which are transmitted, but a cell mass, that from the germ onwards so reacts to tension and pressure that the spongy structure necessarily results." In other words it is not the more or less definite congenital adaptation that is handed on through heredity, but an innate plasticity which renders possible adaptive modification in the individual.

This individual plasticity is undoubtedly of great advantage in race progress. The adapted individual will escape elimination

* *Monist*, Jan., 1896, p. 268.

† Romanes Lecture on *The Effect of External Influences on Development*, pp. 11, 12.

* Romanes Lecture, p. 15.

in the life-struggle, and it matters not whether the adaptation as reached through individual modification of the bodily tissues, or through racial variation of germinal origin. So long as the adaptation is there—no matter how it originated—that is sufficient to secure survival. Prof. Weismann applies this conception to one of those difficulties which have been urged by critics of natural selection. "Let us take," he says,* "the well-known instance of the gradual increase in development of the deers' antlers, in consequence of which the head, in the course of generations, has become more and more heavily loaded. The question has been asked as to how it is possible for the parts of the body which have to support and move this weight to vary simultaneously and harmoniously if there is no such thing as the transmission of the effects of use or disuse, and if the changes have resulted from processes of selection only. This is the question put by Herbert Spencer as to '*co-adaptation*,' and the answer is to be found in connection with the process of intra-selection. It is by no means necessary that all the parts concerned—skull, muscles and ligaments of the neck, cervical vertebræ, bones of the fore-limbs, etc—should simultaneously adapt themselves *by variation of the germ* to the increase of the size of the antlers, for in each separate individual the necessary adaptation will be temporarily accomplished by intra-selection," that is, by individual modification due to the innate plasticity of the parts concerned. "The improvement of the parts in question," Prof. Weismann urges, "when so acquired, will certainly not be transmitted, but yet the primary variation is not lost. Thus when an advantageous increase in the size of the antlers has taken place, it does not lead to the destruction of the animal in consequence of other parts being unable to suit themselves to it. All parts of the organism are in a certain degree variable [*i. e.*, modifiable] and capable of being determined by the strength and nature of the influences that affect them; and this capacity to respond conformably to functional stimulus must be regarded as the means which make possible the maintenance of a harmonious co-adaptation of parts in the course of the phyletic metamorphosis of a species. * * * As the primary variations in the phyletic metamorphosis occurred little by little, the secondary adaptations would as a rule be able to keep pace with them."

* Romanes Lecture, pp. 18, 19.

So far Prof. Weismann. According to his conception, variations of germinal origin occur from time to time. By its innate plasticity the several parts of an organism implicated by their association with the varying part are modified in individual life in such away that their modifications cooperate with the germinal variation in producing an adaption of double origin, partly congenital, partly acquired. The organism then waits, so to speak, for a further congenital variation, when a like process of adaptation again occurs; and thus race-progress is effected by a series of successive variational steps, assisted by a series of cooperating individual modifications.

If now it would be shown that, although on selectionist principles there is no transmission of modification due to individual plasticity, yet these modifications afford the conditions under which variations of like nature are afforded an opportunity of occuring and of making themselves felt in race-progress, a further step would be taken towards a reconciliation of opposing views. Such it appears to me, may well be the case.

To explain the connection which may exist between modifications of the bodily tissues due to innate plasticity (intra-selection) and variations of germinal origin in similar adaptive directions, we may revert to the pendulum analogy which was adduced a few pages back. Assuming that variations do tend to occur in a great number of divergent directions we may liken each to a pendulum which tends to swing; nay, which is swinging through a small arc. The organism, so far as variation is concerned, is a complex aggregate of such pendulums. Suppose then that it has reached congenital harmony with its environment. The pendulums are all swinging through the small arc implied by the slight variations which occur even among the offspring of the same parents. No pendulum can materially increase its swing; for since the organism has reached congenital harmony with its environment, any marked variation will be out of harmony and the individual in which it occurs will be eliminated. Natural selection, then, will ensure the damping down of the swing of all the pendulums within comparatively narrow limits.

But now suppose that the conditions of the environment somewhat rapidly change. Congenital variations will not be equal to the occasion. The swing of the pendulums concerned cannot be rapidly augmented. Here individual plasticity steps in to save some of the members of the race from extinction. They adapt themselves to the changed conditions through a modification of the bodily tissues. If no members of the race have sufficient plasticity to effect this accommodation the race will become extinct, as has indeed occurred again and again in the course of geological history. The stereotyped races have succumbed; the plastic races have survived. Let us grant, then, that certain organisms accommodate themselves to the new conditions by plastic modification of the bodily tissues, say by the adaptive strengthening of some bony structure. What is the effect on congenital variations? Whereas all the other pendulums are still damped down by natural selection as before, the oscillation of the pendulum, which represents a variation in this bony structure, is no longer checked. It is free to swing as much as it can. Congenital variations in the direction of adaptive modification will be so much to the good of the individual concerned. They will constitute a congenital predisposition to that strengthening of the part which is essential for survival. Variations in the opposite direction, tending to thwart the adaptive modification, will be disadvantageous and will be eliminated. Thus, if the conditions remain constant for many generations, congenital variation will gradually render hereditary the same strengthening of bone structure that was provisionally attained by plastic modification. The effects are precisely the same as they would be if the modification in question were directly transmitted in a slight but cumulatively increasing degree. They are reached, however, in a manner which involves no such transmission.

To take a particular case: Let us grant that, in the evolution of the horse tribe, it was of advantage to this line of vertebrate life that the middle digit of each foot should be largely developed and the lateral digits reduced in size; and let us grant that this took its rise in adaptive modification through the increased use of the middle digit and the relative disuse of the lateral digits. Variations in these digits are no longer suppressed and eliminated. Any congenital predisposition to increased development of the middle digit and decreased size in the lateral digits will tend to assist the adaptive modification and to supplement its deficiencies. Any congenital predisposition in the contrary direction will tend to thwart the adaptive modification and to render it less efficient. The former will let adaptive modification start at a higher level, so to speak, and thus enable it to be carried a step further. The latter will force it to start at a lower level, and will prevent its going so far. If natural selection take place at all, we may well believe that it would do so under such circumstances.* And it would work along the lines laid down for it in adaptive modification. Modification would lead; variation follow in its wake. It is not surprising that for long we believed that modification was transmitted as hereditary variation. Such an interpretation of the facts is the simpler and more obvious. But simple and obvious interpretations are not always correct. And if, on closer examination, in the light of fuller knowledge, they are found to present grave difficulties, a less simple and less obvious interpretation may claim our provisional acceptance.

In his recent paper on Germinal Selection Prof. Weismann says:† "I am fain to relinquish myself to the hope that now, after another explanation has been found, a reconciliation and unification of the hostile views is not so very distant, and that then we can continue our work together on the newly laid foundations." As one to whom Prof. Weismann alludes as having expressed the opinion that the Lamarckian principle must be admitted as a working hypothesis, I am now ready to relinquish myself also to the same hope. Germinal Selection does not convince me, though I regard it as a suggestive hypothesis; and assuredly I am not convinced by the argument that because in certain cases, such as the changes in the chitinous parts of the skeleton of insects and crustacea, and in the teeth of mammals, use and disuse can have played no part, therefore in no other cases has use-inheritance prevailed. Even Homer sometimes nods, and Prof. Weismann's logical acumen seems to have deserted him here. But it appears to me that on the lines I have sketched out, it is open to us to accept the facts adduced by the transmissionists and at the same time interpret them on selectionist principles.

It may be well now briefly to summarize the line of argument in a series of numbered paragraphs.

1. In addition to what is congenitally definite in structure or mode of response, an organism inherits a certain amount of innate modifiability or plasticity,

2. Natural selection secures:

   (*a*) such congenital definiteness as is advantageous.

   (*b*) such innate plasticity as is advantageous.

3. Both *a* and *b* are commonly present; but uniformity of conditions tends to emphasize the former variable conditions of life, the latter.

4. The organism is subject to:

   (*a*) variation of germinal origin.

   (*b*) modification of environmental origin, affecting the soma or body tissues.

5. Transmissionists contend that somatic modification in a given direction in one generation is transmitted to the reproductive cells to constitute a source of germinal variation in the same direction in the next generation.

6. It is here suggested that persistent modification through many generations, though not transmitted to the germ, nevertheless affords the opportunity for the occurrence of germinal variation of like nature.

7. Under constant conditions of life, though variations in many directions are occurring in the organisms which have reached harmonious adjustment to these conditions, yet natural selection eliminates all those which are of such amount as to be disadvantageous, and thus acts as a check on all variations, repressing them to within narrow limits.

* Prof. Weismann's 'Germinal Selection' if a *vera causa* would be a cooperating factor and assist in producing the requisite variations.

† *Monist, loc cit*, p. 290.

8. Let us suppose, however, that a group of organisms belonging to a plastic species is placed under new conditions of environment.

9. Those whose innate somatic plasticity is equal to the occasion survive. They are modified. Those whose innate plasticity is not equal to the occasion are eliminated.

10. Such modification takes place generation after generation, but, as such, is not inherited. There is no transmission of the effects of modification to the germinal substance.

11. But variations in the same direction as the somatic modification are now no longer repressed and are allowed full scope.

12. Any congenital variations antagonistic in direction to these modifications will tend to thwart them and to render the organism in which they occur liable to elimination.

13. Any congenital variations similar in direction to these modifications will tend to support them and to favor the individuals in which they occur.

14. Thus will arise a congenital predisposition to the modifications in question.

15. The longer this process continues, the more marked will be the predisposition and the greater the tendency of the congenital variations to conform in all respects to the persistent plastic modifications; while

16. The plasticity continuing the operation, the modifications become yet further adaptive.

17. Thus plastic modification leads and germinal variation follows; the one paves the way for the other.

18. Natural selection will tend to foster variability in given advantageous lines when once initiated, for (*a*) the constant elimination of variations leads to the survival of the relatively invariable; but (*b*) the perpetuation of variations in any given direction leads to the survival of the variable in that direction. Lamarckian paleontologists are apt to overlook this fact that natural selection produces determinate variation.

19. The transmissionist, fixing his attention first on the modification, and secondly the fact that organic effects similar to those produced by the modification gradually become congenitally stereotyped, assumes that the modification *as such* is inherited.

20. It is here suggested that the modification *as such* is not inherited, but is the condition under which congenital variations are favored and given time to get a hold on the organism, and are thus enabled by degrees to reach the fully adaptive level.

When we remember that plastic modification and germinal variation have been working together all along the line of organic evolution, to reach the common goal of adaptation, it is difficult to believe that they have been all along wholly independent of each other. If the direct dependence advocated by the transmissionists be rejected, perhaps the indirect dependence here suggested may be found worthy of consideration.

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NATURE STUDY AND INTELLECTUAL CULTURE. *

IT is impossible to dissociate the intellectual effect of 'nature study' from the other factors in training which habitually accompany it. So far as I know, no 'pure culture' to determine the specific effect of nature study has ever been attempted; so that the best that can be done is in the way of reasonable inference. There can be no doubt that much of its effect is cumulative rather than specific, and so becomes merged and lost among other agencies. In addition to this general result, however, it is

* Prepared for presentation before the Department of Natural Science Teaching, N. E. A., Buffalo, 1896.

claimed that it has an effect of its own, not to be duplicated by any other subject. It is this specific effect of nature study that we are especially interested in discovering. The argument for nature study as a means of general training is based upon the claim that the subject-matter appeals more strongly to the interest of the young than almost any other that can be presented. The enormous momentum gained by interest is too well known to need discussion. That objects in nature, especially living objects, arouse the most lively interest in children, is the common testimony of all those who deal with children. It seems logical to take advantage of this interest in any intellectual training, and to press the subject matter to all its possible applications, thus reinforcing or even supplanting work technically belonging to other departments. The possible applications of nature study to numbers, to language, to drawing, are well known and extensively utilized. These propositions fail if interest in subject-matter is of no advantage in intellectual training, or if natural objects are not of large interest to children. My claim is that nature is not merely of large interest, but of supreme interest to children; that it supplies the most natural material by means of which the child may be developed intellectually in various directions; and that failure to use it is to neglect a broad highway and to attempt an advance through the thickets. I know that some will claim that power is developed by the resistance of the thickets; but it should be remembered that precisely the same power will be developed by covering a longer distance upon the highway, especially when the latter has the impetus of consent. The law of the conservation of energy has its application in things intellectual as well as in things physical. The greater the resistance, the less the distance, and *vice versa*. The method all depends upon whether we are seeking for resistance or distance; in both cases the resulting power will remain the same. I have never ceased to wonder at the systems of education which base their training, in effect, upon the proposition that the most natural impulses are to be repressed; that natural tastes are to be set aside for those artificially stimulated; that the great open book of objective nature is to be closed, and conventional subjective matter presented. From my own standpoint, this is intellectual distortion, as much as are the heads of Flathead Indians or the feet of Chinese women physical distortions. The subject is difficult to present in its true light, for we are still under the domination of a conventional education, which has worked out its results for centuries, and its good results are overwhelmingly in evidence because they are our only results. Now that the republican idea of larger rights for all subjects is persistently intruding itself, the old aristocracy needs most careful scrutiny. It has certainly done the best it could; but this is no reason why some other form of organization may not do better. The human mind develops in spite of subjects and teachers; but our purpose should be to remove all possible obstructions. It has been an annual experience of mine for many years to come in contact with the product of primary and secondary schools from which nature study has been rigidly excluded, and it must be confessed that the 'all round' training claimed has resulted in the narrowest conceivable intellectual product. The evils of early specialization are no where so apparent as in the schools which prepare for college. It is true that many colleges demand this specialization for entrance, continue it in their own courses, and then deny an adequate representation of nature study upon the ground that this means specialization. The tentacles of inquiry which the child naturally reaches out to nature become insensitive through disuse; and only here and there, in the later college experience, are some found still functional enough to be stimulated into activity. The public school system is seeking to better the product; but it is discouraging so long as colleges demand specialization rather than an 'all round' training.

It may be worth while to call attention to the fact that 'nature study' holds no relation to the study of the subject-matter as presented in text-books, and that such a presentation of it has no value in a scheme of education that does not belong to any other subject presented in the same way, and for purposes of training might as well be eliminated. The young mind does not reach out after the text-book, but after natural objects themselves. This distinction should be rigidly regarded, and text-book work should never be admitted into the category of 'nature study.' I grant to the old aristocracy all the strictures upon the results of science study it may care to impose if this study is to be one of text-books. One of the prominent things claimed for nature study is that it breaks the shackles of slavery to the book and introduces that intellectual freedom in which one sees and thinks for himself.

This position of nature study, however, as a means of general culture, as providing the most favorable subject-matter for arousing interest, is aside from the chief purpose of this paper, which is to discover its peculiar intellectual result, a result which cannot be obtained by the use of any other subject, and without which intellectual development is incomplete.

It is commonly stated that the prominent results of nature study are the cultivation of the power of observation and of drawing conclusions from observed facts. This is certainly a beneficent result, but it cannot be claimed as one peculiar to nature study; for it simply depends upon a method, the laboratory method, which may be applied to a wide range of subjects. It is certain that nature study has introduced the laboratory method into education, but having introduced the method it cannot lay claim, as a subject, to all the results. It is, perhaps, true that the laboratory method is most conveniently and completely applied in nature study; and that in most cases the definite training in observation and deduction is still obtained from nature study; but this will become less true as proper educational methods are developed. For this reason I take issue with a statement too frequently made by those who have had no training in science, that the function of science in an educational scheme is to teach laboratory methods. It is true that science, by its example, has been the great teacher of the laboratory method, but that is not its function any more than the device of algebraic symbols is the function of mathematics. A method is not a purpose, but has a purpose in view.

Another conception of the function of nature study is that it cultivates the power and habit of analysis, and that its purpose is analysis. This is a persistent conception of science in the popular mind, and also in the minds of many teachers of science, judging by their methods. This, however, is no more the purpose of nature study than is the laboratory method. The latter is its method, the former its preliminary step. This preliminary step, called analysis, is no more peculiar to nature study than are observation and deduction; although it may be more extensively and definitely cultivated in the so-called laboratories of science than in other laboratories. The ultimate purpose of nature study, and its peculiar function in a system of education is through analysis to reach synthesis. Its purpose is a constructive one, based upon facts which analysis reveals. It may seem strange to some to regard the purpose of science as a synthetic one, and the final synthesis, which gives significance to analysis, certainly does not find any place in the practice of many teachers, but without it the real purpose is missed. It may be claimed justly that the reaching of synthesis through analysis is no more peculiar to nature study than are observation, deduction and analysis; but the mental attitude involved in reaching this synthesis *is* peculiar. This peculiar mental attitude may be most clearly stated, perhaps, in the form of a comparison. A very commonly used classification of studies in general is that which divides them into the 'humanities' and the 'sciences.' It lies outside of my present purpose to take exception to this exceedingly crude and misleading classification, but for the sake of comparison it will serve as well as any other. The 'humanities' are dominated by literature in the broadest sense, and are claimed to develop in the student a kind of culture especially desirable, a flavor especially characteristic of the educated man. To this claim I would not offer the slightest objection, for the 'humanities' have been and must continue to be a noble course of intellectual development, without which an education is certainly incomplete. I realize the difficulty to-day in sharply defining those studies which should be included under the 'humanities,' and a difficulty equally great in defining those to be included under 'sciences,' for it is often a thing of method rather than of subject-matter which determines the position of a study. However, there is no misunderstanding as to the general significance and effect of the group of studies known as the 'humanities.' It is the most ancient and best known form of culture, and being ancient and bound up with the development of mankind it must continue necessarily to hold high rank.

The general effect of the humanities in a scheme of education may be summed up in the 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 the rare cases it is original and individual. 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 subject-matter. It would seem fair, therefore to state the peculiar effect of the 'humanities' as being the power of appreciation or self-injection.

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 this complementary mental attitude is developed by a proper study of the so-called 'sciences.' It has been a matter of wonder to me that the student who confines himself to 'humanities' is so often spoken of as the 'all-round' student; while the one who studies the 'sciences,' and from whom the 'humanities' are as a matter of course demanded, is spoken of as the narrow student. In the very nature of things, in the very structure of our educational schemes, the student of science is compelled to be the broadest, most 'all-round' student we have. 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 a study which acts as a complement to the humanities. It is merely more of the same thing. Teachers of science are too apt to cultivate a factitious interest in their subject-matter by this attempt at self-injection, and so destroy the peculiar advantage of the subject in intellectual training. 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 *law*, 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.

It is evident that this basis of distinction will result in a classification of subjects differing considerably from the ordinary grouping under 'humanities' and 'sciences,' but I am convinced that from the standpoint of mental development it is fundamental. It would even result in the divorcing of certain subjects now commonly included under one head. For example, it would certainly sharply cut off certain phases of language-study from literature proper, a fact which the universities have long recognized. This further emphasizes the fact that no hard and fast lines can be drawn separating the specific effects of the various studies. In our analysis 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-elminating 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 instinct. And yet the two processes and the two results are so distinct and so complementary that any system of education which does not provide for the definite cultivation of these two mental attidudes, and which leaves the complementary part merely to the chances of teaching methods and mental structure, is in constant danger of resulting in mental distortion.

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THE FATE OF A EUROPEAN BISON HERD.

In a paper entitled 'Das allmähliche Aussterben des Wisents (*Bison bonasus* Linn.) im Forste von Bjelowjesha'* Mr. Eugen Büchner gives a detailed history of the bison herd in the Bieloviejsha (or Bialowitza) forest, Province of Grodno, in Lithuania, Russia, during the present century. In his opening paragraph the author states that his purpose is two-fold: to make a critical historical study of this herd during the period for which the necessary data are available; and to find what light, if any, this history may throw on the general subject of the extinction of the larger mammalia.

Up to the year 1832 the accounts of the condition of the bison in the Bieloviejsha forest are conflicting and untrustworthy, but the number of animals in the herd during that period is estimated at from 300 to 800. Since 1832 a yearly census of the bison has been taken by the government of the forest. The count is made each winter immediately after the first snowfall, but must necessarily be only approximately accurate. The figures show an apparent slow increase from 770 head, the number recorded in 1832, to 1,898 head, the maximum reached in 1857. After 1857 there was a steady decrease until the minimum of 380 head was reached in 1889. During the three succeeding years there appears to have been a slight increase.

After presenting these figures the author at once attacks the question as to the cause

*Memoires de l'Academie impériale des sciences de St. Petersburg, Vol. III., No. 2, p. 1–30, 1895.

which can produce such marked and unfavorable results in a herd protected as carefully as that in the Bieloviejsha forest. The factors which have brought about this decrease may be divided into two principal categories: first, those wholly external; and second, those proceeding from the animals themselves. Under the first head are discussed: hunting, poaching, taking of live specimens for zoological gardens, ravages of beasts of prey and of various diseases, and finally possible deaths from shortage of food supply. As all these factors taken together are shown to be insufficient to account for the present condition of the herd, the true reason must be sought in the animals themselves. As long ago as 1830 Jarocki noticed that the bison cows as a rule calve only once in three years, and this observation has been repeatedly verified. The question at once arises whether this low grade of fertility is natural or otherwise. A careful study of the breeding habits of the bison in the Bieloviejsha forest and elsewhere leaves no room for doubt that the present slow rate of reproduction is an abnormal condition, and that to it is due the rapid approach of the extinction which is the certain fate of the herd under consideration. This diminished fertility the author regards as a stigma of degeneration caused by in-breeding. Associated with it are other stigmata, such as fatty degeneration of various organs and abnormal condition in parts of the skeleton. Many of the bison cows are known to be wholly unable to care for their calves through lack of milk. The process of degeneration has progressed so far that the more degenerate animals may be recognized by their paler color, weaker horns and thinner fur. Of eleven captured by Strahlborn in 1858, four were of the pallid, thin-haired, degenerate type. Another indication of the degenerate condition of the Bieloviejsha herd is seen in the great excess of bulls, which probably outnumber the cows two to one. This is doubtless a result of in-breeding, for Düsing (Jena Zeitschr. für Naturwiss, Bd. XVII., p. 827, 1884) has shown that close in-breeding, like a reduced condition of nutrition, is favorable to the production of an excess of males. Thus the total extinction of the Bieloviejsha bison is certain to occur, and that probably in the near future. Such a fate the author points out overtook the last herd of *Bos primigenius* in Poland during the early part of the seventeenth century, notwithstanding the most careful protection.

In conclusion, the author considers that his studies of the history of the Bieloviejsha bison leave scarcely room for doubt that in-breeding is the cause of the final extinction of most large mammals. In-breeding must begin and lead gradually but certainly to the extinction of a species when it, through any cause, has become so reduced in numbers as to be separated into isolated colonies.

If Büchner's conclusion is correct—and few will doubt that it is—we may look for the speedy extinction of the American bison, whatever means may be taken for the protection of the few remaining individuals, while the danger attending any considerable reduction in the size of the Pribilof Island seal colonies, with the expectation that they will regain their former size under subsequent strict protection, becomes fully apparent.

Gerrit S. Miller, Jr.

DENTITION OF LEMURS AND THE SYSTEMATIC POSITION OF TARSIUS.

In a recent number of Science appeared an abstract by Prof. A. A. W. Hubrecht, of his contribution to Gegenbaur's *Festschrift*, giving his conclusions upon the relations of Lemurs and monkeys, especially upon the position of *Tarsius* among the Anthropoidea. It is interesting to find, in the same collection of memoirs, a contribution from

Prof. Wilhelm Leche, of the University of Stockholm, upon the teeth of living and extinct Lemurs, in which different conclusions are reached.

He sums up his results as follows: "The observations brought together in the preceding sections include a number of facts which are of general significance and which may be of general service. During the Eocene and Oligocene periods, Europe and North America were inhabited by groups of Lemurs, which contained a number of genera distributed in both hemispheres. During the Oligocene every trace of these Lemurs disappeared in the northern hemisphere, and we find no traces of these animals until they reappear among the existing forms of the Ethiopian and Indian regions. To our complete ignorance of the Lemurs during the long intermediate period is added the fact that at first sight the modern Lemurs appear to be a group widely different genetically from those of Eocene times. Yet, as I have endeavored to demonstrate above, the difference between the living and extinct Lemurs is by no means so great as it is generally supposed to be. Among the old Tertiary forms the strong differentiation of the teeth in the anterior portion of the jaw, which characterizes the living forms, had not arisen. Yet even in these older forms we see certain indications which point towards such a differentiation. Notably supporting such a conclusion are the discoveries in the milk dentition of weight.

"Until we obtain further knowledge, as above stated, we must distinguish two groups of extinct Lemurs, the most complete representatives of which are *Adapis* and *Microchœrus*.* In spite of all the differences between these two groups, there are, nevertheless, exhibited a number of common characters, in which they together appear to present a more primitive constitution than any of the living Lemurs. To select a single illustration, among the older tertiary Lemurs we still find four premolars and three upper incisors, while in the living forms we never find more than three premolars and two upper incisors.*

"Among the living forms we have certainly to distinguish two groups, the *Lemuridæ* and *Tarsiidæ*, the latter uniting most closely with *Microchoerus* and its related forms. Now, while the modern *Tarsius*, in important parts of its structure—in the structure of its placenta, in the structure of its orbit and in the straight colon—certainly has taken a different developmental direction from the remaining Lemurs and deserves an isolated position, nevertheless, its milk dentition shows such a close approach to that of the true Lemurs that a common derivation of the *Lemuridæ* and *Tarsiidæ* must be considered as at least highly probable. For the hypothesis which I have endeavored to establish in my earlier work, that the milk teeth are to be regarded as the representatives of an earlier developmental phase, with more primitive characters than the permanent teeth, we find that the teeth of the Lemurs lend a number of supporting features: First, in *Hapalemur* the superior incisors have a more normal position in the milk dentition than in the permanent dentition. Second, the second upper premolar of *Adapis* has retained the original premolar form more completely than its permanent successor. Third, the lower incisors of the Lemurs are somewhat less modified than their successors. Fourth, the second lower premolar of the Lemurs has, as is well known, taken on the form of a canine, while the milk tooth correspondent to this retains the more ancient premolar form. Fifth, in the *Indrisinæ* and in *Chiromys* the milk dentition retains almost

*Prof. Leche considers *Necrolemur* Filhol. as equivalent to this form.

* Prof. Leche has evidently overlooked *Anaptomorphus*.

the complete typical formula, while the permanent dentition shows a very marked reduction. Also in *Lepidolemur*, in which all the superior permanent incisors are wanting, one incisor is preserved in the milk dentition.

"Almost without exception the milk teeth of the Lemurs are smaller and weaker than the corresponding permanent teeth. If the permanent dentition reaches a higher grade than the dentition it is explained by the fact, as I have already shown, that the latter has undergone a more or less pronounced differentiation in the size of its individual components; this is the case in *Tarsius*, *Indrisinæ* and *Chiromys*, without in the least diminishing the origiual number of the teeth.

"So far as I have considered the phylogeny of the different teeth, whilst among the Insectivora and the mammalia of the secondary period, and in exceptional cases among the living forms such as the Marsupial *Choeropus* and the fossil *Paleochoerus*, canines are observed with double roots—a character which is certainly to be regarded as primitive—I have found in the Lemurs, both in the milk and permanent dentition, two-rooted canines. The fact that often a one-rooted milk canine is replaced by a two-root permanent canine, and this order in other cases is reversed, requires further clearing up.

"That an elongate or more premolar-like structure of the superior canine is the original form of this tooth in the Lemurs, appears to be evident in every case in which the permanent canine differs from the milk canine; for the milk tooth is always more like a premolar than the permanent tooth, as seen in the comparison of *Chirogaleus*, *Adapis* and *Tarsius*. A comparison of the canine of the old tertiary form, *Microchoerus*, with that of the modern Tarsius, lead us to the same results."

H. F. O.

CURRENT NOTES ON PHYSIOGRAPHY.

ORIGIN OF THE LAURENTIAN RIVER SYSTEM.

UPHAM continues his discussion of the great lake problem (Amer. Geol., XVIII., 1896, 169–177), maintaining that during Tertiary time the Mississippi-St. Lawrence divide probably lay northwest of the Adirondacks, in this differing from Spencer, who regards the preglacial St. Lawrence as already an extensive river system. Certain general relations of our larger land forms and river systems would, however, seem to prove the extension of the preglacial St. Lawrence at least into the Ontario basin. All the Great Lakes, except Superior, lie along the inner lowlands, and are enclosed by the infacing uplands* of an ancient and greatly denuded coastal plain of paleozoic strata, whose oldland is the Laurentian highland. The great Appalachian valley is also an inner lowland, between the inface of the Alleghany and Cumberland plateau and the oldland of the Blue Ridge; but this inner lowland is complicated by the mountains that have been bent up and worn down along it. The normal drainage of both these regions would be from the oldland across the inner lowland and out through the scarped uplands to the Ohio or Mississippi. The Wisconsin and the Kanawha rivers are exceptional in still preserving this normal course. The Potomac, Susquehanna, Delaware and Hudson are all abnormal in flowing from the Alleghany plateau across the inner lowland and out through the oldland to the Atlantic. Now, as these abnormal courses had been attained in early Tertiary time, and perhaps sooner, it is not only possible, but probable, that a considerable part of the abnormal drainage area of the St. Lawrence had been developed much earlier than Upham maintains.

* The Spanish term *cuesta* might be used for this unnamed form. See Hill, Nat. Geog. Mag., VII., 1896, 295.

THE EARTHQUAKE WAVE IN JAPAN.

THE recent earthquake wave on the northern coast of Hondo, the chief island of Japan, is vividly described with illustrations by E. H. Scidmore (Nat. Geogr. Mag., VII., 1896, 289). The wave reached the coast in the evening of June 15th, last. Most of the people were indoors on account of rain then falling, "when, with a rumbling as of heavy cannonnading out at sea, a roar, and the crash and crackling of timbers, they were suddenly engulfed in the swirling waters." Only a few survivors on all that length of coast saw the advancing wave, one of them telling that the water first receded some 600 yards before the wave rose like a black wall 80 feet in height, with phosphorescent lights gleaming along its crest. "Ships and junks were carried one or two miles inland, left on hilltops, treetops, and in the midst of fields uninjured or mixed up with the ruins of houses." Where the coast was low and faced the open ocean, the wave washed in and, retreating, carried everything back with it. Where the wave entered a fiord or bay it bore everything along to the head of the ravine or valley and left the mass of *dêbris* in a heap at the end. On the open coast the wave came and withdrew within five minutes, while in long inlets the water boiled and surged for nearly half an hour before subsiding. Groves of large pines were cut down to short stumps; thick granite posts of temple gates were snapped off, and the stone cross-beams were carried 300 yards away.

GEOGRAPHICAL BIBLIOGRAPHY FOR 1895.

A GEOGRAPHICAL bibliography for successive years constitutes a supplement (5 fr.) to the five regular numbers of the Annales de Géographie (Colin, Paris, 25 fr.). The bibliography for 1895 is just issued with 1087 titles, the work of 49 colaborers. It is arranged under the following chief headings: history of geography, mathematical, physical, political geography and regional geography; this last being much further divided under subheadings of different countries. Brief notices are given of more important work, but with less detail than in Petermann's Mitteilungen. An index of authors cited occupies 23 columns. A three-hour cursory examination of such a work as this will guide most librarians to all the geographical works that they need order. A somewhat more careful examination will disclose many out-of-the-way essays to the scientific reader; for example, an article by Carton on '*Oasis Disparues*' (Rev. Tunis, 1895, 201), maintaining that the climate of Tunis has not changed since Roman times, that careless waste of water to-day contrasts with careful economy in ancient times, when reservoirs and canals fertilized the oases.

NOTES.

THE testimony of 'old residents' as to the reputed change in the range of vision in the Swiss Jura, supposed to be the result of earth movements, and given some credence by extended quotation in recent years, has been carefully examined on the ground by Jegerlehner, who doubts its sufficiency. He does not find the memory of untrained observers a sufficient argument to so remarkable a conclusion, and recommends the establishment of accurate measurements, which are probably now in progress (Jahresber. Geogr. Ges. Bern, XIII., 1894, 15–22).

FRÜH discusses the terminology of valleys in the Jura and Swiss Alps (Zur Kritik einiger Thalformen und Thalnamen der Schweiz, Viertelj. Naturf. Gesellsch., Zurich, XLI., 1896, 318–339). *Combe* applies to various forms, and is variously defined by such writers as Sonklar, Sievers and Reclus; and hence it does not deserve the specific meaning given to it by Desor.

Früh regards it as equivalent to *Kumm* and *Gummi* in the Alps, and to *Cwm* in Wales, and refers all these modern forms to an Indo-Germanic root, meaning valley, preserved to-day in rugged districts where the the older races sought refuge from invaders. *Ruz*, *cluse*, and other terms are similarly discussed.

A CIRCULAR issued by Domenico Locchi, Via Cibrario, 47, Turin, Italy, describes a model of the morainic amphitheatre of Lake Garda, which he constructed on order of the *Scuola di Guerra* at Turin. It is highly spoken of by the commander of the school and by so competent a geological critic as Prof. Taramelli, of the University of Pavia. A photographic print of the model shows it to be a remarkably fine illustration of a great looped moraine. The cost of the model is 250 lire, boxing extra. Its horizontal scale is 1: 25,000; the vertical scale being $2\frac{1}{2}$ times larger; its dimensions are 1.70 by 1.60 m. A list of other models by the same artist may be had on application to him.

A REPORT on the erosion of English coasts made to the British Association (1895, 352–392) records an average annual recession of 5 feet 10 inches for 37 years on the clay coast of Yorkshire from Bridlington to Spurn Head. Piers built at Dover and Folkestone catch the drifting shingle, and thus deprive the cliffs beyond of their natural protection, making costly seawalls necessary. Besides several reports from local observers, there is a local bibliography.

CURRENT NOTES ON METEOROLOGY.

CLIMATE AND MAN.

THE word anthropo-geography has been coined to meet the need of a designation for that branch of geography which treats of the earth in its relation to man. The present rapid advance of climatology has in the same way rendered necessary the coining of a similar word which can be used to designate that aspect of this study which deals with the relations of climate and man. It is natural that the word *anthropo-climatology* should be chosen for this sub-division of our subject. The length of the term makes it rather clumsy, yet its advantages more than outweigh its disadvantages, and it is to be hoped that it may come into general use. Under anthropo-climatology we should include all the various relations that exist between climate taken in its broadest sense and man. The climatic control of habitability, of occupation, of colonization; the influence of climate in stimulating or controlling migrations, invasions, and the like; the immediate and permanent physiological effects of different degrees of temperature, humidity and pressure, etc.; the relation of climates to the distribution and prevalence of diseases; acclimatization, and other related matters may all find shelter in this subject of anthropo-climatology. To some extent also, in considering the medical or sanitary aspect of climatology, some account must be taken of soil conditions, of ground water, of drainage and other matters which are usually included under the head of hygiene. Anthropo-climatology thus considers subjects which belong in many other departments of learning. It embraces within its scope matters that come up also in meteorology, geography, medicine, hygiene, history, ethnology. At present this human side of climatology receives little attention, but it is certain to become a subject of increasing importance as time goes on. Its consideration belongs properly under climatology, and instruction in climatology of a university grade should lay more emphasis than it now does on these interesting and important relations of climate and man. The student of anthropo-climatology must gather his information from many sources. He must consult writings of all the subjects above mentioned as contributing to this subject, but anyone who is alive to its importance, and who reads with his eyes open, will not fail to find abundant material.

KITE METEOROLOGY.

The literature of kite meteorology is increasing at a rapid rate, and even now anyone who wishes to be well informed in regard to this interesting subject will find that there is a good deal of reading to be done. As has already been stated in these notes, Prof. C. F. Marvin, of the Weather Bureau, has been giving a large share of his time to the development of scientific kite-flying, and the United States at present enjoys the distinction of being the only country whose weather service has officially undertaken such a piece of work. That Prof. Marvin's investigations have been very thoroughly carried on is shown in a series of articles he has written for the *Monthly Weather Review* for April, May, June and July, 1896, in which the results already attained are set forth. These articles taken together make the most complete and most elaborate publication yet issued on the subject of scientific kite-flying. The details of kite construction, the best materials for kites and cord, the analysis of the forces acting on the kites, the calculation of the heights attained, and other matters, are considered, and many illustrations accompany the text.

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CURRENT NOTES ON ANTHROPOLOGY.

THE GERMAN ANTHROPOLOGICAL SOCIETY.

This Association held its twenty-seventh annual session in August, at Speier. Prof. Virchow delivered the opening address, largely concerned with the craniology of German prehistoric graves. Most of the papers were local in character, on the Archæology and Ethnography of Central Europe. Exceptions to this were, one by Dr. Hagen, on the Papuas of New Guinea; by Dr. Ranke, on Fossil Men; by Baron von Andrian, on Word-Superstitions, and by Prof. Virchow on Criminal Anthropology.

In the last mentioned the distinguished German professor pointed out the errors in Lombroso's theory, which he compared with phrenology in its arbitrary and unscientific character. Dr. Ranke sketched the physical traits of the earliest men. They had one type. They were 'eurycephalic' (the brain-skull large in reference to the face, the face-skull small); their color was yellowish; the hair coarse; the base of the skull oblique; the third molar rudimentary. He believed they originated in Asia. Dr. Waldeyer discussed men with tails. He had microscopically examined one instance and found the tail just like that of a hog, that is, not bony, but cartilaginous, with nerves, arteries, etc. He thought the wonder is, not that men occasionally have tails, but that they are ever without them!

The next meeting of the Society will be held at Lubeck.

EARLY MEDITERRANEAN CULTURE.

The address of Mr. Arthur J. Evans, President of the Anthropological Section of the British Association this year is peculiarly rich in new facts and suggestions.

He returned but a few months since from his third archæological exploration of the island of Crete and brings back with him ample evidence of the intimate contact of the natives of that island with the culture of Egypt probably as early as 2500 B. C.

No doubt the rays of this primitive insular civilization shone athwart the middle sea to the isles of Greece and the northern shores. But not on them alone did the wise of the race depend. Mr. Evans points out that the Mycenean culture of pre-Homeric days probably sprang from roots which we must seek in the soil of Anatolia, in that

Ægean art which developed in the favored vales of Phrygia and Lydia.

Other questions, of broader scope, are also touched upon by Mr. Evans. Dismissing the 'glamour of the Orient,' rejecting the orthodox notion that the primitive Aryan was some sort of a 'patriarchial missionary of Central Asian culture,' he declares for the greater probability that what the Aryan knew he had learned by study on the spot, and that his lineage is to be traced in European or 'Eurafrican,' surroundings from far back into the darkness of paleolithic times. Even then, in that rude and distant period, he was not of the brutes, brutish; for Mr. Evans relates an unpublished find of a surface burial, dating from Quaternary times, where the corpse had been laid in a position of decent repose, the shell knife, the deer's tooth ornaments and the paint pot by its side.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

ASTRONOMICAL NOTES.

DR. SEE's recent discovery of a companion to Sirius has been followed by observations at the Lick Observatory, according to a letter received from Prof. Holden. Profs. Schaeberle and Aitken, observing with the 36-inch, find the position angle of the companion to be about 189°, while Dr. See, Mr. Douglass and Mr. Cogshall, observing with the large telescope of the Lowell Observatory, found 220°. As Dr. Auwers's ephemeris in *Astronomische Nachrichten* No. 3085 gives 176° for this position angle, it is evident that the whole matter will require further elucidation.

THE Saxon Academy of Sciences has published an extended paper by Dr. J. Hartmann on eclipses of the moon. It forms a sequel to the same astronomer's well known work on the best value of the moon's diameter to be used in the prediction of lunar eclipses.

H. J.

SCIENTIFIC NOTES AND NEWS.

SCIENCE, DEMOCRACY AND THE UNIVERSITY.

PROFESSOR WOODROW WILSON's oration at the Princeton Sesquicentenial Celebration was admirable as a work of literary art; but as an official address, representing the policy of a great college aiming to become a university, it challenges criticism. Professor Wilson chooses his words carefully and enters caveats against his own conclusions. But on the whole he advocates the monastic ideal for a university; he mistrusts modern democracy and deplores modern science. For him the university is "a place removed—calm Science seated there, recluse, ascetic, like a nun, not knowing that the world passes, not caring if the truth but come in answer to her prayer; and Literature, walking within her open doors in quiet chambers with men of olden time, storied walls about her and calm voices infinitely sweet; here 'magic casements opening on the foam of perilous seas in fairy lands forlorn,' to which you may withdraw and use your youth for pleasure."

For us Science is no 'recluse, ascetic, like a nun,' 'doing us a great disservice, working in us a great degeneracy when it mingles in the affairs of the modern world.' If we must choose a mediæval simile, Science is rather Dürer's Knight, firmly seated on truth, not minding death greatly, looking forward without fear, ready to aid and, if need be, to kill. The democracy of to-day has been made possible by science, and science will control its future. We are not ashamed of the alliance; it is better for some men to think unwisely than for most men not to think at all. Progress can only result from variations, and favorable variations cannot occur apart from such as are harmful. We do not retire from the world to use 'our youth for pleasure' and our age for contemplation. We stand as leaders amidst a conflict whose outcome we shall decide.

Professor Wilson tells us that "the world's memory must be kept alive, or we shall never see the end of its old mistakes. We are in danger to lose our identity and become infantile in every generation. That is the real menace under which we cower everywhere in this age of change." Such utilitarianism is futile. We are the past; it is alive in us and in our environment, not stored away in our libraries. Many would find life empty without its inherited wealth of literature and of art, but the function of these is as much to make us forget as to make us remember. If the past could not develop into a present better than itself, it would ill deserve our study and imitation.

Our ideal of a modern university is not a place where the walls of the colleges crumble while the dons drink their port. Rather we admire William Morris, who would leave that place and carry into the midst of the common people the best of literature and of art. True culture comes not from the elaboration of self, but from the devotion of self to useful work. Professor Wilson would have the modern university 'a place removed,' looking 'towards heaven for the confirmation of its hope.' We like to see the modern university in the midst of men, looking towards earth, that it may learn and teach.

ACADEMIC FREEDOM IN RUSSIA.

WE referred recently to the enforced retirement of Prof. Erismann (Jerismann) from the University of Moscow. The Russian correspondent of the *Lancet* gives some details from which we may quote.

The facts are briefly as follows: Political disaffection, or rather dissatisfaction with the present *régime* in Russia, with its anomalies and not-infrequent injustices, is not rarely met with among the students of Russian universities. Wherever it is met with it is put down with a very stern hand. Sometimes, however, it happens that the not unnatural aspirations of the students find sympathy and support from the professors. This was the case two years ago in the University of Moscow. A petition was at that time drawn up and signed by forty-two of the University professors and then presented to the authorities. The petition drew attention to certain wrongs suffered by the students, to the harmfulness of the system of so-called 'administrative exile' (that is to say, exile for political opinions without any reasons being given for the exile and without opportunity of appeal from the sentence), and to the fact that the present University Court, or governing body of the University, which is appointed entirely by the government and not elected by the professors, cannot in all cases be just to the students. The only result of this petition was a formal censure, from the government, of all the forty-two professors who had signed it and a severe reprimand to four, of whom Prof. Erismann was one. The reasons of Prof. Erismann's enforced resignation of his chair are not at present publicly known, but there is little cause to doubt that the incident just narrated—or, rather, the 'liberal' leanings of Prof. Erismann, of which the incident was, perhaps, one out of many proofs—were the real reasons. This explanation, which is the one most generally accepted, is further supported by the rumor that two of the other three professors who were reprimanded at that time have also been requested to resign their chairs. The circumstances of Prof. Erismann's resignation were the following: It is the custom of the Russian government every summer to send a certain number of professors to foreign countries to study foreign methods and systems and so to keep in touch with the progress made in other countries. Among those sent this summer was Prof. Erismann. He visited Berlin and then went to Switzerland. While there he was officially informed that his services in the chair of hygiene were no longer needed, the retirement to date from July 1st. No reasons were given, but three days were allowed during which a voluntary resignation would be accepted.

Prof. Erismann is eminent for his contributions to hygiene and the study of epidemics, and had organized and equipped fine laboratories of pathology and hygiene in the University of Moscow. He was president of the recent Russian Pirogoff Congress, and was to have been general secretary of the International Congress to be held in Moscow next year.

SYSTEMATIC ZOOLOGY.

THE editor-in-chief of the *American Naturalist* is a distinguished representative of the union of extensive research in systematic paleontology and zoology combined with wide biological and philosophical interests. We quote from an editorial article in the *Naturalist* an answer to certain captious criticisms of those engaged in the study of species which have recently appeared in *Natural Science* and in the *Revue Scientifique:*

"We regard the expressions above quoted as an indication of a mild form of megalomania which is not unfrequently found among the users of mechanical appliances in the biological laboratory. The most intelligent cultivators of these important branches of biologic research are, however, well aware that the exact determination of species is fully equal in importance to their own pursuit, for the following reasons, among others: If we regard biology to consist of two branches, evolution and physiology, we define evolution, with Darwin, as the origin of *species*. For physiology the question of species is not so important. Species are, however, what the labors of the ages have produced, and it is necessary to know them in order to pursue any branch of evolution (as embryology or paleontology) intelligently. The work of the embryologist and paleontologist who does not know the species whose origin he seeks to explain is greatly lacking in precision. Linnæus states that the tyro knows the higher divisions, but only the expert knows species. We also especially deny that the discrimination and description of species is within reach of the most mediocre intelligence. On the contrary, no kind of work in biology imposes as much on all the mental faculties which are used in scientific work. Those who have not attempted it have little idea what is involved in a diagnosis or an analytical key. Finally, as regards the mammalogic work of Messrs Merriam and Miller, we consider it of the utmost importance. They are pointing out the results of the evolution of Mammalian life in North America, which it is the business of the embryologist and the paleontologist to explain. And in this field the work of Messrs. Merriam and Miller is the best that has ever been done in any country."

GENERAL.

Dr. J. A. Hugo Gylden, director of the Astronomical Observatory at Stockholm and professor of astronomy at the University, died on November 9th at the age of fifty-five years.

The seventieth birthday of Dr. Stanislas Cannizzaro, professor of chemistry at Rome, will be celebrated on November 21st, by the presentation of a gold medal, of congratulatory addresses and of a fund to be used by him for the advancement of chemistry.

There will be held at Washington a memorial meeting in honor of the late Dr. G. Brown Goode. Hon. Gardiner G. Hubbard is Chairman of the Committee of Arrangements.

We learn from *Die Natur* that a monument in honor of K. Th. Liebe, who had made important contributions to geology and ornithology, especially in Thüringen, was dedicated in Gera on October 18th.

The hundredth anniversary of the birth of the eminent anatomist, anthropologist and naturalist, Anders Adolf Retzius, was celebrated with suitable ceremonies at Stockholm on October 13th.

The municipality of Paris has changed the name of the Boulevard de Vaurigard to that of Boulevard Pasteur.

The Berlin Academy of Sciences proposes, as the subject for the Cothenius prize, 'Experiments and observations on the origin and behavior of new varieties of grain during the past twenty years.' The paper, which may be in Latin, German, French, Italian or English, must be presented before the beginning of the year 1899. The prize is of the value of 2,000 M.

Mr. R. Etheridge has been awarded by the Royal Geological Society of Cornwall its first Bolitho gold medal.

The Committee on Science and Arts of the Franklin Institute, of Philadelphia, have awarded the John Scott medal for 1896 to Emile Berliner, of Washington, D. C., for his invention, the gramophone, it being, in their opinion, an invention of great merit and usefulness.

The managers of the Royal Institution, London, have appointed Prof. A. D. Waller, M. D., F. R. S., to be Fullerian professor of physiology for three years, and Dr. A. Scott to be superintendent of the Davy-Faraday Research Laboratory. The Christmas lectures specially adapted for children will this year be be given by Prof. Silvanus P. Thompson, F.R.S., his subject being 'Visible and Invisible Light.'

Major J. W. Powell will give at the Catholic University a course of six special lectures, reviewing the scope of anthropology and taking up savagery, barbarism, primitive civilization and modern civilization.

Further details regarding the Nansen research fund now being raised in Norway, are quoted by *Nature* from the *Times*. Its object is to commemorate the remarkable Arctic expedition of this explorer by the foundation of a fund called 'The Fridtjof Nansen Fund' for scientific research. It is intended that, by this means, research in various departments of science shall be promoted, and the results published. Dr. Nansen himself may be appointed director, but there will be no salary attached to the office, as the whole of the yearly products of the fund will be devoted to the objects stated. Up to the present no less than 300,000 kroner have been subscribed. Consul A. Herberg, Dr. Nansen's friend, has contributed 50,000 kroner; while others, besides numerous Norwegians, are Baron Oscar Dickson, 25,000 kroner; and Prof. Frankland, 1,000 kroner. It is stated that the fund will probably be placed under the care of the Christiania University, the Norwegian Society of Science, and the Bergen Museum. If any who are admirers of Dr. Nansen care to contribute they should communicate with the Committee of the 'Fridtjof Nansens fond, University of Christiania.'

The London *Daily Chronicle* published, on November 3, 4 and 5, a detailed and elaborately illustrated series of articles by Dr. Nansen, describing his adventures in the extreme north. The articles have been extensively copied in the daily papers and are of dramatic rather than of scientific interest. Dr. Nansen received about $20,000 for these articles, and will receive about $50,000 for his book. The scientific results of the expedition will be presented before the Royal Geographical Society, and doubtless will be published in a suitable form and place.

The Associated Press reports that Messrs. D. G. Elliott and C R. Aikley, of the Chicago Field Columbian Museum, left Southampton on November 14th, on their return to the United States, after a very successful expedition into Somaliland. Mr. Elliott states that the collections are of great value, 58 cases having been shipped from Aden to Chicago.

Mr. R. P. Currie, of the United States National Museum, left New York on November 14th, ult., for Hamburg, on his way to Liberia, where he will spend several months collecting zoological specimens. He will devote especial attention to insects showing protective mimicry.

Nature quotes from the *British Central African Gazette* news of the return of Mr. Alexander Whyte, Sir Harry Johnston's scientific assistant in British Central Africa, from a successful expedition into the Nyika plateau, on the northeastern shores of Lake Nyasa, where he has made a large collection. The flora of this district proved to be most interesting, resembling that of Mount Milanji, in the south of Nyasaland, but differing from it in many respects. Mr. Whyte failed to find any trace of a conifer, but the range is richer in heaths than Milanji. He obtained 6,000 specimens of plants and a large zoological collection.

Prof. Koch has been sent to South Africa by the German government to investigate the causes of the *Rinderpest*.

Dr. L. A. Bauer, who, as we have already announced, is undertaking a magnetic survey of Maryland, under the recently established State Geological Survey, has taken observations at about 40 stations, or one for about every 250 square miles, which gives Maryland the most detailed magnetic survey yet undertaken in America.

Houghton, Mifflin & Co. have in press 'The Life and Letters of Dr. William Martin Rogers,' prepared by Mrs. Rogers, with the assistance of Prof. W. T. Sedgwick.

Lotze's *Medicinische Physiologie*, published in 1852, may be regarded as the pioneer work in modern physiological and experimental psychology. It has long been out of print, but a reprint is now announced by the Diedrischen Buchandlung, Göttingen.

Among the large number of books announced by the Clarenden Press, Oxford, as in active preparation there is apparently only one in the physical and natural sciences: 'Practical Work in Electricity and Magnetism,' by W. G. Woollcombe.

A NEW *Bericht* will hereafter be published by the Nordoberfränkischer Verein for natural history, located at Hof, Bavaria.

MR. ANDREW CARNEGIE has let the contract for building a free library at Homestead at once, and will immediately prepare for similar institutions at Duquesne and Carnegie. He has announced that he will found as many branch libraries in Pittsburg as may be needed.

IT is stated in *Nature* that the objects exhibited in the ethnographical section of the Millennial Exhibition at Budapest are to be used as the nucleus of an ethnographical museum. The collection of machines in the special exhibition of the means of transport are to form a railway museum, and the bulk of the exhibits in the agricultural section will be used for the foundation of an agricultural museum.

The Astrophysical Journal announces the establishment of a new astrophysical observatory at Rössgen, Mittweide, Saxony. The principal instrument, which was to be ready for use by the middle of October, is a refractor of 170 mm. aperture, made in the workshop of Hans Heele, in Berlin. It is provided with both visual and photographic objectives, and the mounting embodies a number of new features. The program of the work prepared by Dr. Friedrich Krueger, the director of the observatory, includes: (1) The formation of a photometric catalogue of all colored stars within the limits of the director's catalogue of colored stars. (2) Photometric determinations of comparison stars used in the observation of variables, including such stars as are communicated to the director by observers of variables and those which are found in published papers. (3) Construction of star charts by the aid of photography of regions containing variables.

WE called attention to the celebration this year of the 150th anniversary of the Zurich Scientific Society. The Society has now issued, in commemoration of the event, two volumes edited by Dr. F. Rudio, with the cooperation of Drs. A. Heim and A. Lang. The first volume contains a history of the Society with portraits of some of its distinguished members, and the second volume contains scientific papers.

IT is stated in *Cosmos* that the International Geodetic Congress, which met recently at Lausanne, under the presidency of M. Faye, received reports on the organization of the projected four international observatories for the study of small movements of the earth's axis. The statutes adopted last year at Berlin have been ratified by fourteen of the twenty-one states taking part. The ratification of the remaining seven is expected before the close of the year.

THE Massachusetts State Board of Agriculture will hold a public meeting at Greenfield on December 1st, 2d and 3d, when a number of interesting papers will be read. It is expected that the question of prosecuting the work of the extermination of the gypsey moth will be prominently brought forward.

AT the Convention of the Agricultural Chemists of the United States, held recently at Washington, officers were elected as follows: President, William Frear, Pennsylvania; Vice-President, A. L. Winton, Connecticut; Secretary, H. W. Wiley, Washington, D. C.; Executive Committee, B. W. Kilgore, North Carolina, and Arthur Goss, New Mexico.

A CONGRESS of Medical Climatology and Hydrology, to be held at Brussels in connection with the exhibition of 1897, is being organized under the auspices of the Belgian Royal Society of State Medicine.

THE Paris Society of Hypnology and Psychology has decided to hold an International Congress of Experimental and Therapeutic Hypnotism in Paris in 1900.

THE repeal of the law practically forbidding the use of motor carriages in Great Britain was celebrated on November 14th by a race from London to Brighton. Fifty carriages took part in the race, it being won by a Duryea motor, which traversed the distance of 47 miles in four hours.

PHYSIOLOGICAL effects caused by the Röntgen rays were, we believe, first reported in this

Journal (April 10, 1896), by Prof. John Daniel. It was at the time regarded as extraordinary by others working with the Röntgen rays, but has since been fully confirmed. Cases of loss of hair, of finger nails and of dermatitis have been reported, and physicians making use of the rays should be careful that the time of exposure is not too long and that the vacuum tubes are not brought too near the body.

It is stated in *Electricity* that Herr Dormann, of Bremen, has succeeded in photographing objects, by Röntgen's method, through iron plates 22 centimeters thick. He has already taken more than fifty such photographs.

In their reports of the recent elections the daily papers almost failed to notice that the forestry amendment to the Constitution of the State of New York was defeated. This amendment permitted the leasing of small plots and certain exchanges and sales of land, and its defeat is gratifying to those interested in the forest preserve. Even the placing of the reservation under a system of scientific forestry management, as advocated by *Garden and Forest*, seems questionable. Part of the preserve might be so treated, if it were possible to depend on the good faith of the management, but there are many reasons, some of them of considerable scientific importance, for allowing part of the preserve to remain as primeval forest.

The *Nation* says: "The recent adverse decision of the Court of Appeal at Rouen in the now famous case of scientific plagiarism, Cremieux-Jamin *vs.* Lombroso, reinforces a good idea that comes from Prof. Michael Foster, Secretary of the Royal Society. Prof. Foster suggests an international organization of scientific men for the purpose of registering at frequent intervals the results of contemporary investigation. Such a body would serve not only to protect the investigator from prosecution, but also to prevent him from going over ground already trodden. For the world of science at large, it could perform a valuable service by discriminating what has become common property from what is still in the possession of the original author." The *Nation* may know of some plan other than that of the recent International Bibliographical Conference. But it is not evident what 'valuable service' a body would perform 'by discriminating what has become common property from what is still in the possession of the original author.'

Oedam, the head Sundanese gardner in the Botanic Gardens of Buitenzorg, Java, has just been decorated, by the government of Netherlands India, with the *Zilveren Ster van Verdienste* (Silver star of merit), as a tribute to over 50 years of faithful service in the Gardens. The decoration services and the presentation address in Malay, by Director Treub, took place on the 16th of September, with all the befitting ceremony so agreeable to the natives. This is the first time the silver star, which is strictly designed for native civil employes, has been accorded to one of the native gardeners. Every botanist visiting the Gardens comes to know and appreciate the value of this old man's astonishing knowledge of tropical plants. His acquaintance not only with the scientific and native names of the plants, but his acute sense of their natural relationships has made his services of inestimable value. He is a member of one of those native families from which the Gardens have drawn so many of their best collectors and gardeners. His father occupied the position of chief overseer or mandor of the coolies under the directorship of Dr. Teysmann, and his son has already fitted himself to fill the position of chief gardener, or *mantri*, on his father's retirement. This is probably the highest tribute ever paid to Sundanese botanical intelligence. D. G. F.

In a recent paper on the distribution of certain mammals in New England and northern New York, Mr. C. F. Batchelder notes the direct connection between agriculture and the distribution of the red-backed mouse (*Evotomys gapperi*), a species eminently characteristic of the Boreal zone. This species is chiefly found in New England in sphagnum swamps, and as these are drained the animal is deprived of the territory suited to its needs. In Cape Cod of late years the cedar swamps have been stripped of their trees and turned into cranberry bogs to such an extent that, if this industry should increase but a little more, there is every probability that *Evotomys* would cease to exist within the limits of Barnstaple county.

UNIVERSITY AND EDUCATIONAL NEWS.

THE corner stones of the Havemeyer Hall of Chemistry and of the Engineering Building of Columbia University have been informally laid. The buildings are already further advanced than might be supposed from the fact that the corner stones have just been laid, and it is hoped that these, as well as the Library, Schermerhorn Hall for the Natural Sciences and the Physical Building, will be ready for occupancy in the summer of 1897. The excavations, which are the most extensive hitherto undertaken in New York, for the University Hall are nearly completed. This building will contain the Academic Theatre, the Gymnasium and the Dining Hall.

THE Yale Alumni Association of California, following the example of the Harvard Alumni of the same State, has established a graduate scholarship at Yale University, yielding an income of $300, to be awarded to a graduate of one of the California colleges on nomination by the Association.

THE present registration at the University of Pennsylvania now amounts to 2,752, which is a gain of 130 over last year, although the requirements for admission have been raised.

THE number of students in German universities last summer is reported to have been 29,802 ; in 1895 it was 28,709, so that the numerical increase for the present year is 993, or 3.5 per cent. The distribution of the students among the various universities was as follows : 4,649 in Berlin, 3,777 in Munich, 2,876 in Leipzig, 1,863 in Bonn, 1,425 in Breslau, 1,415 in Halle, 1,379 in Freiburg, 1,339 in Würzburg, 1,172 in Tübingen, 1,164 in Heidelberg, 1,138 in Erlangen, 1,007 in Göttingen, 965 in Marburg, 948 in Greifswald, 938 in Strassburg, 761 in Jena, 708 in Kiel, 700 in Königsberg, 630 in Giessen, 500 in Rostock, and 420 in Münster. The number of students at Vienna was 2,228, but only 1,370 of these were regular students.

THE Right Hon. Joseph Chamberlain has been elected Lord Rector of the University of Glasgow, having a majority of 234 votes over his opponent, Mr. Augustine Birrell.

DISCUSSION AND CORRESPONDENCE.

AGE OF THE ISLAND SERIES.

IN my paper on '*The Potomac Formation*' in the Fifteenth Annual Report of the United States Geological Survey, describing the section along the Raritan River, I remarked (pp. 335–336) that "from Morgan, the most easterly point, the formation may be traced northward across Staten Island and the northern shore of Long Island, and it reappears on Martha's Vineyard in the celebrated cliffs of Gay Head. * * * Along this most eastern line a new phase is seen, viz., the occurrence of concretions in the variegated clays, in the form of hard ironstones, which, when broken open, are found to contain vegetable remains in an admirable state of preservation. I am, therefore, disposed to regard these ferruginous, concretionary beds, extending from Staten Island to Martha's Vineyard, as the very latest phase of the Potomac formation, which I shall call the Island Series, although, from the similarity in the flora, I am disposed to include them, along with the Raritan and Amboy Clays, in the Albirupean Series."

Later in the same paper (pp. 373–382) the nature of the flora of this series was set forth, and it was shown that, so far as known at the time that paper was written, it consisted of 133 species, 52 of which were also found in the Amboy Clays, and the great preponderance of which were well developed dicotyledonous forms. The nearest affinities to these plants are afforded by the Atane beds of Greenland, which have always been correlated with the Cenomanian of Europe. Dr. Newberry regarded the Amboy Clays as representing that age and therefore as belonging to the Upper Cretaceous. In his monograph of the 'Flora of the Amboy Clays,' soon to appear posthumously, he gives his argument in full. He thought them of about the age of the Dakota Group. My opinion that they were somewhat lower, and should be placed at the summit of the Lower Cretaceous, having been called in question, I defended it in the paper referred to (pp. 373–374), as I think successfully. I had never supposed that any one would attempt to place these beds lower than I had done, because it seemed impossible that such highly organized plants could have flourished earlier than the extreme upper portion of the Lower Cretaceous.

It is, therefore, a matter of the greatest surprise to me that Prof. Marsh should have discovered evidence which points to the Jurassic as the true date of the strata in question. His two papers on 'The Geology of Block Island,' published in the *American Journal of Science* for October (pp. 295–298) and November (pp. 375–377), are well calculated to stagger one who has been studying these deposits for eight years and who has visited all the exposures from the Raritan River to Nantucket, usually in company with Mr. David White or Dr. Arthur Hollick, and helped to make the extensive collections that they have yielded. It is true that until the present year I had not personally visited Block Island, but Mr. White was there in 1890, and his notes agree with my own later observations. Being a noted watering place I had naturally avoided it, and most geologists who have studied it have been chiefly interested in the glacial deposits that occupy its surface. But lying, as it does, directly in the line of the Cretaceous outcrop, and rising somewhat higher above the sea than most of the other islands, it was to be expected that the underlying clays would be exposed. I had long desired to see them, and in August last I requested Dr. Arthur Hollick, of the School of Mines, Columbia University, whose studies in this line, especially on Staten Island and Long Island, are so well known, to accompany me, and after making an excursion to certain critical localities on Long Island, including Montauk Point, we crossed to Block Island and sp three days in making a careful examination f all the exposures. We found the Cretaceou axis immediately. It originally occupied the northern half of the island. It is clearly visible at the north end of Grace Cove, on the west side of the island, but is best exposed below Ball's Point, on the east side. It has, as on Martha's Vineyard, a local dip to the northwest, due to the action of ice tilting it in the direction opposite to its normal dip. This, however, was not sufficient to prevent the Clay Marls, which immediately overlie these clays wherever conditions are normal, from coming into view on the south end of the island, and numerous exposures of these were discovered containing their characteristic molluscan fossils, of which a fair collection was made and submitted to Dr. Whitfield for identification. Fossil leaves were also found at many points, but they were usually too poor for safe determination. They were sufficient, however, to show that we were dealing with precisely the same beds as those of Gay Head, Long Island (Glen Cove), and Staten Island, which have yielded such a large flora, and, therefore, they belong to the Island Series. The characteristic red micaceous clay shales were identical with those found erratic all along the coasts of these islands, often where the clays themselves are below tide level. In Split Rock Cove, immediately east of Black Rock Point, the alternating red, black, and white clays, with a steep incline, simulate very closely those of Gay Head and leave no doubt that they represent the same conditions.

Prof. Marsh does not question the parallelism of all these beds, but refers them all to the Jurassic. He says: "An examination of both the Raritan and Staten Island clay deposits has supplied two links in a chain of evidence that I had not before known from personal observation. This chain now extends from the Potomac river to Martha's Vineyard, along the natural line of the Jurassic horizon, and indicates the Jurassic age of this series of strata beyond reasonable doubt."* In another place † he says: "The Raritan clays of New Jersey I regard as belonging to the same series as the Potomac beds." From these statements it seems clear that he regards the Potomac formation as representing one and the same horizon throughout, and believes that it is all Jurassic in age.

In his important paper just published in the Sixteenth Annual Report of the United States Geological Survey he figures a few Dinosaurs from the Potomac formation, but seems to include none that were not published by him in his paper in the *American Journal of Science* for

* Am. Jour. Sci., November, 1896, p. 376.

† Am. Jour. Sci., October, 1896, p. 296.

January, 1888. These were collected by Mr. Hatcher in an iron mine near Muirkirk, Md., associated with Sequoian cones and silicified wood. This horizon is now known to be the equivalent of the Basal Potomac of Virginia, and a rich flora of ferns, cycads and conifers has been discovered in it by Mr. Arthur Bibbins, which refers it without doubt to my Rappahannock series. From the date of this deposit to that of the Amboy clays, as I have shown, and *a fortiori* to that of the Island Series, there was an immense interval of time, and during that interval the flora completely changed. Only 15 species of plants out of 329 survived this period.*

The Potomac formation, therefore, while it is a geological unit, represents a great epoch in the history of the coastal plain, perhaps extending from the Jurassic below to the Cenomanian above, and occupying practically the entire Lower Cretaceous. It is thus to be compared with the Comanche series of Texas, and a mere reference to it without specifying which one of its six great subdivisions affords no idea of the position of any fossil that may have been found in it. The two lowest subdivisions, the James River and Rappahannock series, I have called the 'Basal Potomac.' It was of this portion of the formation that I treated in a paper read before the National Academy of Sciences in April 1888, and of which I said: "If the stratigraphical relations and the animal remains shall finally require its reference to the Jurassic, the plants do not present any serious obstacle to such reference."† I still stand by that statement, but when it is proposed to refer the 'Newer Potomac' also, with its great dicotyledonous flora allied to that of the Upper Cretaceous, to the Jurassic, the evidence for such a reference must be overwhelming. Indeed it may be questioned whether any amount of evidence from vertebrate remains would be sufficient to convince geologists generally. All geologists know that no dicotyledonous plant has thus far ever been reported with certainty from any formation lower than the Cretaceous. In my 'Sketch of Paleobotany'* this fact was clearly brought out, and in the eleven years of great paleobotanical activity that have elapsed since that paper apeared no discoveries have been made to modify it. It is true that I argued in that paper that the dictyledonous floras then known from the Middle Cretaceous, including our Dakota Group, were too highly developed to warrant the assumption that this class of plants had no earlier origin, and in my diagram (pl. lviii.) of the probable first appearance of the several great types of vegetation I projected the dicotyledonous column downward into the Jura-Trias The Older Potomac flora was then unknown, and its discovery has gone a long way toward justifying this claim. But in this, as I pointed out in the paper already mentioned,† the dicotyledons are rare, of strange aspect, embryonic, and prophetic of the great type of plant life that was to dominate the earth. Even in the Middle Potomac (my Aquia Creek series), which overlies the Rappahannock beds with some indication of unconformity, the dicotyledons are peculiar in character and are far outnumbered by the lower forms. Not so the great Amboy Clay flora. Here, and still more markedly the flora of Gay Head and Long Island, the dicotyledons are fully developed, many of them probably belonging to genera now found in our forests. They also make up the great bulk of the vegetation, and ferns, cycads and conifers are comparatively rare.

In a paper just issued and forming part of the Sixteenth Annual Report of the United States Geological Survey I have discussed the 'Earliest Dicotyledons'‡ and also certain 'Archetypal Angiosperms,'§ and have reproduced figures of forms from the Jurassic that the late Marquis Saporta thought might represent, not dicotyledons, but ancestral angiosperms, prophetic of both monocotyledons and dicotyledons, which he called 'Proangiosperms.' I sympathize more or less with the point of view of the great French paleobotanist, and fully expect that forms will yet be found in the Jurassic which,

*Fifteenth Annual Report U. S. Geological Survey, p. 378.

†Am. Journ. Sci., 3d. ser., Vol. XXXVI., August, 1888, p. 131.

*Fifth Ann. Rep. U. S. Geol. Survey, p. 441, pl. LVI., LVII.

†Am. Journ. Sci., 3d. Ser., Vol. XXXVI., August, 1888, pp. 129–130.

‡Pp. 510–515. §Pp. 535–536.

if they are not true dicotyledons, will prove to be their immediate ancestors. But I certainly do not believe that any number of well developed dicotyledonous plants will ever be found in the Jurassic, nor that such plants flourished at a period so remote.

Aside from the Carboniferous and the Miocene scarcely any geological age is better known from the botanical side than the Jurassic. From the Rhetic to the Wealden, rich Jurassic floras have been made known in many countries of Europe, in the arctic regions, in Siberia, in China and Japan, in India, Australia, South Africa and South America, and only last year the discovery was made for, the first time, of a true Jurassic flora in the United States, viz., near Oroville, in California.* Yet of all the hundreds of Jurassic forms thus brought to light not one is dicotyledonous.

In view of all this it is clear that there is no room for controversy over the age of the clays of Block Island or any of their equivalents. When the vertebrate remains that Prof. Marsh has found in these beds shall have been described, it will simply be a question of the relative weight that each one may choose to give to the two classes of paleontological evidence before the world. Many of the plants have already been published with full drawings and descriptions, and a list of them, which has since been considerably increased, is given in my paper on the Potomac Formation. Dr. Newberry's work on the 'Flora of the Amboy Clays' will soon appear as a Monograph of the United States Geological Survey, and Dr. Hollick is now engaged on a similar monograph of the flora of the Island Series. Those who are capable of supposing that such a flora as this could have flourished in Jurassic time are certainly at liberty to do so, and the geological world will doubtless duly appreciate their courage.

Lester F. Ward.

Washington, D. C.

*See Prof. Fontaine's paper in the Am. Journ. Sci., for October, 1896, pp. 273–275.

THE DATE OF PUBLICATION.

In Science for November 6th Dr. J. A. Allen objects to the resolution adopted by the Zoological Section of the American Association for the Advancement of Science at the Springfield meeting (1895), which recommended that the date of printing be regarded as the date of publication. He regards the position taken in the resolution as expressing both 'absurdity and mischievousness,' and insists that sale, or distribution only, constitute publication. He thinks that his opinion to this effect is a corollary of the definition given by the Century Dictionary, namely, that publication consists of 'the act of offering a book, map, piece of music, or the like, to the public by sale or by gratuitous distribution.'

The resolution was presented to the Section by a committee after consultation with many of the members who are engaged in scientific publications, and who are perfectly familiar with the subject in all its aspects. It was felt that, while it would be very desirable if a rule of distribution could be formulated, such a course is simply impracticable. The difficulty of so doing is set forth in the whereases that precede the resolution. Dr. Allen has not met these difficulties, but he adduces some objections to the adoption of the date of printing as that of publication. On the general position taken by Dr. Allen I make the following comments:

First. The date of printing, or alleged printing, of the last printed part of a book, the title page, has always been regarded as the date of publication. Who has ever inquired into or determined the date of sale or distribution of any scientific book published during the past, up to within a very few years? We are accustomed to refer to the title page, or last page, to ascertain this date, for further than that we cannot go. In most instances it will be impossible to ascertain the date of sale or distribution of books published in past years, apart from the date of printing.

Second. The probabilities are so great that a book is 'offered to the public' at the date affixed to it, that it is not safe to assume that it is not, except in two contingencies. The first is the case of fraudulent antedating of a book. This is likely to be of extreme rarity among scientific men, and if attempted would be easily detected by reference to the records of the printing office. The second case is the one brought forward by Dr. Allen, that of government publications which are issued at a date later than that which they carry on their title pages. This objection is not well taken, as stated by Dr. Allen, for, although some of the reports issued by our government may bear dates much prior to the dates of issue, it does not follow that the date of printing bears any such relation to the date of issue. They are, in fact, often printed as near the date of issue as are other books, the delay being prior to or during the printing. Here again the date of printing can be easily ascertained from the printing office. But in case of the detention of a book by the government subsequent to the printing, the question of the coincidence of the date of printing and of 'offer to the public' will depend on whether copies of the book can be had on demand or not. If the book can be had, it is 'offered to the public.' If it cannot be had, it is not offered to the public.

Third. The test of publication is according to Dr. Allen that it be 'offered to the public.' I agree with this, but hold that the only determinable test of date of offering to the public is the date of printing. The presumption is, that as soon as a book is printed and bound, it is offered to the public. That is the object of printing books. If the public does not buy or take what is offered, the duty of the publisher is fulfilled, the book is published just as much as though the edition were sold out in a day. How many copies must be sold or accepted in order to constitute a distributive publication? A single copy would constitute distribution, yet the scientific public might not be a whit the wiser for it.

Fourth. There is no doubt that the rule that the date of printing be regarded as the date of publication involves the difficulty which Dr. Allen cites as regards certain government books withheld from circulation though printed. However, these are really subject to the inquiry whether they may not be had on demand priately. The difficulties involved in the determination of the date of distribution or sale are in many instances insuperable, and in many cases unprofitable, since the only result of the inquiry would be the discovery of the date of issue of so few copies, often of one only, as not to constitute publication in the sense of distribution at all. Further, the assumption by Dr. Allen that in adopting this rule the Zoological Section of the American Association for the Advancement of Science were violating existing rules and customs is far from correct. It really formulated the "rule generally adopted by scientific bodies," as stated by Dr. Allen, "to the effect that the ostensible date, as that given on the title page of a book or pamphlet, or at the bottom of the signatures, shall be taken as the correct date, unless known to be erroneous." These dates are simply the dates of printing of the separate part or whole of a book on which they are placed, and are not the date of distribution, which cannot, of course, be printed with the book.

E. D. COPE.

GLACIERS IN THE MONTANA ROCKIES.

IN my paper published in SCIENCE of December 13, 1895, and giving an account of some explorations in the Rocky Mountains between the Great Northern Railway and the International Boundary, I mentioned the existence of several other glaciers than the one particularly described.* My attention has been since called to a paper presented by Mr. G. C. Culver, now of the State Normal School at Stevens Point, Wisconsin, to the Wisconsin Academy of Sciences, in which he describes his explorations in that region. Mr. Culver accompanied an exploring party commanded by Lieut. Ahern, U. S. A., and made many interesting observations. He did not personally visit any of the glaciers, but was in camp near one of the largest for two or more days. This is now located upon the military map of the state under the name of Culver glacier. In his paper on the subject Mr. Culver describes the glacier, but does not name it. The Culver glacier lies to the northwest of that described in my paper of December last and about fifteen or more miles distant. Mr. Culver locates upon his map several small glaciers in the general vicinity of that explored by myself. His route was such that at no point upon it could the glacier described by me be even seen. I am sure of this both from personal familiarity with the ground and from the testimony of friends who have penetrated the

* This glacier has since been referred to by Dr. Sperry and others as the Chaney glacier.

region for the purpose of hunting. I wish now to add that during the past summer Dr. L. B. Sperry, who was with me a year ago, has again visited the region and solved the problem of the glacial water of Avalanche Lake, as described in my former paper. His party discovered in the mountains at the head of Avalanche Basin, a hitherto unknown glacier which will hereafter be known as the Sperry glacier. Like the majority of the glaciers of this region it begins in narrow gorges, high up in the mountains, and spreads out into a hand-like mass terminating near the top of the cliffs above Avalanche Basin. In form it is the exact opposite of the glacier explored by myself. That seems to be unique among those yet discovered in filling a large amphitheatre and in extruding thence by a long narrow tongue much farther down the mountain side than do any of the others. L. W. Chaney, Jr.

Carleton College,
Northfield, Minnesota.

INTERNATIONAL COOPERATION IN AËRONAUTICS.

To the Editor of Science: The excellent article published in your issue of October 9th on an International Association for the Advancement of Science deserves the attention of every friend of scientific progress. If your suggestions are adopted, as they certainly will be, the rivalry between different nations will become beneficial, as the peculiar genius of each will serve to excite mutual emulation.

A good example of what cooperation can accomplish may be found in the proceedings of the International Congress of Meteorology held in Paris during September. I shall confine myself to a brief notice of what has been accomplished by the Committee for Scientific Aëronautics, of which Mr. Lawrence A. Rotch and I are members. It is well known that in 1892 MM. Hersuite and Besançon carried out experiments with balloons and measured the temperature of the air at altitudes exceeding 10,000 meters. By gradually enlarging the diameter of these balloons altitudes exceeding 60,000 m. have been reached and temperatures below 50° C. have been recorded. These experiments published in the *Comptes Rendus* and in *L'Aërophile*, attracted the attention of the Aëronautical Society, of Berlin, which has sent up to great altitudes a number of free balloons carrying self-registering instruments. This work was assisted by a large subscription from the Emperor of Germany.

It has now been proposed to establish a series of simultaneous ascents from Paris, Berlin and Strasburg (where an Alsatian Aëronautical Society has recently been formed), and ultimately from St. Petersburg. This work is under the charges of the Committee on Aëronautics appointed at the Meteorological Conference. A free balloon will be sent up from Paris by Wm. Hersuite and Besançon, on November 14th, at 2 p. m., and it has been requested that balloons be sent up from the German stations at the same time. This night has been selected in view of the meteoric showers, as ascensions may be made to advantage by aëronauts to observe the meteors above the clouds, and they could at the same time secure records with barometers and thermometers. I may be permitted to say that I have myself set the example of making an ascent on that night, which I did as far back as 1867. The results of this ascent by night were published in *Aërial Travels*, edited by T. Glaisher.

If this short note should induce any American observer to make an ascent or to send up free balloons at the dates fixed on in France and Germany, he will do a great service by publishing the results in Science, so that they may be known abroad. W. de Fonvielle.

Paris, October 30, 1896.

SCIENTIFIC LITERATURE.

The Life and Letters of George John Romanes: Written and edited by his wife. 8vo. Pp. IX., 360. Longmans, Green & Co., London, New York and Bombay.

This charming memorial of Romanes should be widely read. Romanes was not only an investigator of ability, a writer of great gift, but he was also a man endowed with a rare combination of personal qualities. The portrayal of his character is an interesting revelation even to those familiar with his writings. The biography is more than well done, for it bears on every page the signs of loving discrimination, and, though the editor retires entirely behind her work, yet that work in itself reveals a personality which must have influenced Romanes' career profoundly, contributing to his development and to that joyous note to which his life seemed attuned until the last years of desperate illness.

Romanes was born at Kingston, Canada, May 20, 1848, and died May 23, 1894. His life, however, belongs wholly to England. His boyhood afforded little opportunity for development, and brought no revelation of his ability, nor was it until he entered Cambridge University that his strength began to show, being called forth largely by the influence of the distinguished physiologist, Michael Foster. While at Cambridge he read for the first time Darwin's works, which became the lastingly dominant influence of his life. Darwin's theory satisfied at once his appreciation of scientific exactitude and his love of broad philosophic problems. The great naturalist formed a close and touching friendship with his young and eager disciple. Their correspondence fills much of the first third of the volume. It continued until Darwin's death. It is most interesting, not only to naturalists, but also from its revelations of character.

Romanes' life was that of a student and with no very striking external events. His biography, therefore, has no element of adventure, but shows us the rôle of one who was active in shaping biological opinion on some of the most momentous questions of the time, pangenesis, the inheritance of acquired characters, the origin of instinct and the evolution of mind. His publications show the man's intellectual magnitude; his biography shows the enthusiasm, the whole-hearted devotion to truth, the generous love of fair play and hatred of personal controversy, which marked him as a character apart.

When Darwin's Life and Letters were published, the fact that he gradually lost his interest in poetry and art made so profound an impression that many began asking whether science made life so barren. It is therefore remarkable that Darwin's foremost disciple in England should have been distinguished by an almost passionate love of both music and poetry, and have also had a deep religious instinct. The story of his religious convictions is most significant. In 1873 he won the Burney prize essay on 'Christian Prayer and General Laws,' and only three years later issued his agnostic book, 'A Candid Examination of Theism.' "It is an able piece of work," says the editor, "and is marked throughout by a lofty spirit, a profound sadness and a belief (which years after he criticised sharply) in the exclusive light of the scientific method in the Court of Reason." His last work, published posthumously, was 'Thoughts on Religion,' the outward expression of the inner change by which he returned to Christian faith.

Romanes had also the poetic faculty, and some of his sonnets are striking. His personal ties were numerous, varied and close, as was natural to a man of so many endowments and of a sympathetic temperament. It is singular to note that he cared comparatively little about painting or the beauties of nature.

The material for the biography is rich in scientific interest aud still richer in personal human interest, for Romanes himself was rich in gifts. We are grateful to his wife for so presenting the material that many who did not know him can learn to appreciate him and gain encouragement from his example of industry, sincerity and fortitude.

C. S. MINOT.

On Certain Problems of Vertebrate Development. JOHN BEARD. Jena, Gustav Fischer. 1896. 8vo.

This pamphlet of 77 pages is published to secure attention to the author's theory of animal development. He has claimed, in previous publications, that each individual begins with one generation sexually produced, which produces another genration asexually, the second generation becoming the adult animal. So far as has yet appeared, this theory rests upon the author's observation that the epidermis contributes, in early embryonic stages, to the production of nerve cells. The transformations of these cells *he has not followed*; hence, he concludes, they have disappeared or are transient; hence the whole embryo is a transient structure and, therefore, represents a separate generation. It may be questioned whether a failure to study the fate of certain cells in an embryo is a sufficient basis to construct a revolutionary theory upon.

In the present pamphlet the author discourses at length upon the well-known fact that in all vertebrates there is an embryonic period at the close of which the anlages of all are present, but not yet differentiated. This stage he calls the 'critical stage,' and he has tabulated the condition of the principal structures in various vertebrates at this stage. This table is a welcome addition to our embryological conveniences.

We have been unable to see that the elementary facts, which the author has collated, are anything more than what is commonly taught beginners in embryology, nor to recognize that they afford any arguments to support the author's theory of 'antithetic generation.' The established conception that the embryo is designed to provide undifferentiated tissue for development rests undisturbed, and offers a sufficient interpretation of embryos, without the interpolation of an antithetic hypothesis.

The note of personal exultation predominates in the pamphlet, and the author closes with the following words: "All the things mentioned above, and many more, are in agreement with the view of an antithetic alteration as underlying Metazoon development and—where are the *facts* that are opposed to it?" And echo answers—'where?'

C. S. M.

A Handbook of Rocks for use without the Microscope. By James Furman Kemp. With a Glossary of the names of rocks and of other lithological terms.

This little book is arranged to meet the special needs of those 'engaged in ordinary field work or in mining or engineering enterprise,' and to present for their use the main facts of petrography in a convenient, compact and intelligible form. As the men who nowadays are engaged in such work or in directing such enterprise usually obtain their preliminary knowledge at one or other of our technical schools or colleges, the book will prove of especial value to students in such institutions to be used for private reading in connection with their lectures and demonstrations. A thorough knowledge of the science of petrography, as of the allied sciences, botany or zoology, can, only be obtained by the continuous use of the microscope; the book, therefore, does not pretend to be a complete petrographical teatise, but for the purpose of the class of students for whom it is intended it contains an admirable presentation of the subject.

The various rock-forming minerals are first described and the principles of petrographical classification explained. Five chapers are then devoted to the Igneous Rocks. The student's attention is especially directed to the chemical composition of the several rocks, a series of analyses of each group being presented and commented upon. The mineralogical composition and relationship of the rocks of this class are excellently summed up in a tabular form on page 18, and are also represented graphically by means of diagrams which, however, would be rendered clearer if drawn to a larger scale.

The aqueous or sedimentary rocks are then taken up and finally the processes of metamorphism are explained and the principal representatives of the group of the metamorphic rocks are described.

It seems, however, unfortunate that the author has seen proper to include among the metamorphic rocks all the products of ordinary atmospheric weathering and decay, so that common clay, if a residual product, is classed as a metamorphic rock. This stretching of Lyell's original definition of metamorphism to include all alteration products of whatever kind is hardly advisable. The products of heat and pressure and those of ordinary superficial weathering are too diverse to be properly included in the same class, even if one were not willing to go so far as Prof. Dana and eliminate from the class of metamorphic rocks all those rocks which are products of alterations which take place at ordinary temperatures.

Appended to the book is an excellent glossary of rock names, which will prove of great value to beginners as well as to more advanced students, for, as Prof. Kemp observes: "One only needs to compile a glossary to appreciate what numbers of unnecessary and ill-advised names for rocks burden this unfortunate branch of science and to convince one that the philological petrographer comes near to being the enemy of his kind." This glossary is to a certain extent based upon Loewinson-Lessing's Petrographisches Lexikon and the index of Zirkel's Lehrbuch der Petrographie, but contains many additional names of American origin. As an index of rock names it is very full and correct, although a few unimportant slips were observed. The name Anarthosite, for instance, was proposed by Hunt as far back as 1863 (See Geology of Canada, p. 22), six years before the publication of the paper in the *American Journal of Science*, to which reference is made. Perthite again was not named by Hunt, but by Dr. Thompson, of Perth, while composite dykes are not in all cases formed by two intrusions of different age occupying the same fissure, but in some cases result from magmatic differentiation in a single injection.

The book is clearly written, and the fact that it deals chiefly with American rocks and American localities gives it for American students a distinct advantage over many of the text-books which are published abroad.

FRANK D. ADAMS.

McGILL UNIVERSITY.

Prantl's Lehrbuch der Botanik, herausgegeben and neu arbeitet von DR. FERDINAND PAX, ord. Professor der Botanik und Direktor des botanischen Gartens in Breslau. Mit 397 figuren in Holzschnitt. Zehnte, verbesserte und vermehrte Auflage. 8vo., pp. x+406. Leipzig, Wilhelm Engelmann. 1896. Brosch. M. 4; gebund. M 5. 30.

A text-book of botany which has passed into its tenth edition has demonstrated its fitness to meet existing conditions in its native country. Whether those conditions are good or bad is quite another question. They certainly seem to demand in Germany a book largely devoted to an account of the various groups of plants. Indeed courses upon *Systematik* are much commoner in German universities and *Hochschulen* than in this country, given over as its elementary instruction has been to 'analysis.' It would almost appear that classification there takes the place of 'analysis' here, with little advantage, if any, in favor of the German student.

The tenth edition, the reviser tells us, has been augmented both in text and illustrations, and many of the older figures replaced by better ones. This appears chiefly in the systematic part, for which the treasurers of the *Pflanzenfamilien* have been drawn upon ; but no striking novelties appear in the other parts, where the good old 'stand-bys' are much in evidence still.

The 'tief greifende Veränderungen in der Anordnung des Stoffes,' which Dr. Pax did not think it wise to make, because the present arrangement had been approved by use, seem to us the very changes which were most called for in order to make the tenth edition as valuable to this generation as the first was twenty-two years ago. For according to modern ideas a text-book which devotes 100 pages to morphology, 47 to physiology and 237 to classification, is badly balanced; it is overdoing system at the expense of life. This is all the more striking when two-thirds of the classification is of the 'dry bones' order. Of the 237 pages of 'systematische Uebersicht des Pflanzenreiches,' 164 are devoted to the phanerogams, and in them one finds the same dreary iteration of the details of flower structure that has been our portion these many years. In the 73 pages on cryptogams comparative special morphology is given chief attention,but the parts shift as soon as the phanerogams are reached. Though Dr. Pax naturally wished to keep as close to Prantl's plan as possible, who would have found fault had he shown the courage to maintain the same plan for the phanerogams as for the cryptogams? Possibly the publisher; hardly the readers.

Part II., on physiology, is much too short for a satisfactory account of plant functions, and it might have been further revised to advantage in many particulars which we cannot specify. The account of molecular structure (if it is to be given at all) and the section on water movement are two notable examples. Sex terms and the sexual and non-sexual phases are properly explained in the very brief chapter on reproduction, but when the unsuspecting reader reaches the angiosperms he will be bewildered by the application of the same terms to the flowers and even to the sporophyte !

In anatomy the Gaul-like division of all tissues into three systems is maintained against the much more satisfactory stelar classification of Van Tieghem. In morphology the root, stem, leaf and trichome are still recognized as equivalent members, in spite of the clearer presentation possible when root and shoot are regarded as primary members.

On the whole we must conclude that Prantl's book needed a thorough rewriting to modernize it and to make it a fit presentation of the botanical science of the close of the century. It has, of course, an immense amount of material that is good enough to commend it to many teachers who prefer to 'inquire after the old paths and walk therein.' But to this extent it contributes to stagnation instead of to progress.

CHARLES R. BARNES.

UNIVERSITY OF WISCONSIN.

SCIENTIFIC JOURNALS.

AMERICAN CHEMICAL JOURNAL, NOVEMBER.

Diffusion of Sulphides through Steel: By E. D. CAMPBELL. These experiments lead to some very interesting results. The method used was to drill holes in the steel bars, fill the holes with sulphide and, after filling the opening with a steel plug, heat the bars in a furnace. It was found that neither ferrous oxide nor a suboxide would diffuse through the bars; but that oxysulphides would diffuse throughout the bar and the sulphur become oxidized at the surface. Cuprous sulphide when mixed with iron-oxysulphide was found to diffuse in an unchanged state. Evidently the substances pass through the pores of the steel in a liquid and not a gaseous form, and are influenced by gravity as they accumulate at the lowest part of the bars.

Effect of Heat Treatment and Carbon upon the Solubility of Phosphorus in Steel: By E. D. CAMPBELL and S. C. BABCOCK. The soluble and insoluble phosphorus was determined by treating the iron with mercuric chloride solution, when it was found that part of the phosphorus was soluble in this reagent and part not. If the amount of carbon is small the effect of heat treatment upon the solubility of phosphorus is slight; but if the amount of carbon is increased, the solubility of the phosphorus is diminished. It is probable that at high temperatures a difficultly soluble compound of iron with carbon and phosphorus is formed, which by slow cooling is converted into an easily soluble one.

Malonic Nitrile and some of its derivatives: By B. C. HESSE. The object of this investigation was to ascertain, if possible, whether in the salts of malonic nitrile, the metal is bound to nitrogen or carbon. The bromine and silver salts were prepared and studied. When the silver salts are treated with alkyl iodides, dialkyl malonic nitriles and alkyl isocyanides are formed. These facts can best be explained on the assumption that the metal is in combination with nitrogen. The action of chlorformic esters and of alkyl iodides on an alcoholic solution of malonic nitrile and sodium alcoholate was also studied. It is probable that a sodium malonic nitrile is formed, which is then acted on by the alkyl iodides. The final product of the reaction is a monimido ether, whose formation can be explained in several ways.

On the 'Beckmann Rearrangement:' By J. STIEGLITZ. Acid bromamides when treated with a methyl alcohol solution of sodium methylate undergo a rearrangement and give urethanes and other derivatives of the isocyanates. This rearrangement is only effected by alkaline solutions. He considers it possible that this is due to the loss of hydrobromic acid and the formation of a body (RCO)N <, which would cause the separation of the alkyl R from the carbon atom holding the nitrogen.

$$\begin{array}{ccccc} R-C=O & & -C=O & & C=O \\ | & \longrightarrow & | & \longrightarrow & \| \\ >N & & -NR & & NR. \end{array}$$

Other facts point to the same conclusion and investigations are being carried out on other classes of compounds to see whether any similar rearrangements take place.

Menthene Nitrosochloride and some of its derivatives: By W. O. RICHTMANN and EDWARD KREMERS. The statements as to the melting-point of this compound are so conflicting that this investigation was undertaken to settle, if possible, this question. It was found that at least two, and possibly three, nitrosochlorides exist. A ketone was also obtained by the action of hydrochloric acid on nitrosomenthane and some derivatives obtained from it. A number of substances were obtained whose exact natures have not yet been determined.

Tetrametaphosphimic Acid: By H. N. STOKES. In this article, which is a continuation of one recently published on the phosphimic acids, the author discusses the acid, its decompositions, and the salts formed by it. He also offers some suggestions as to its structure, but calls attention to the fact that experimental data for such a discussion is almost wholly wanting.

A short obituary notice of August Kekulé, who died July 13, 1896, is also contained in this number. J. ELLIOTT GILPIN.

SOCIETIES AND ACADEMIES.

THE AMERICAN CHEMICAL SOCIETY.

THE regular meeting of the American Chemical Society was held at the College of the City of New York on Friday evening, November 6th, Prof. William McMurtrie in the chair, and fifty-one members present.

The announcement was made that an invitation from Drs. Morton and Leeds to hold the next meeting (December 11th) at the Stevens Institute of Technology, Hoboken, had been received, duly acted upon and accepted by the Executive Committee. Dr. Morton will read a paper on 'Some Illustrations of the Phenomena of Fluorescence,' and Dr. Leeds will give an 'Exhibition of Appliances for the Quantitative Estimation of Micro-Organisms.'

Dr. Squibb reviewed in detail the method of Messrs. Robineau and Rollin for the 'Volumetric Determination of Aceton.' (Moniteur Scientifique, 1893.) This method consists in mixing acetone with a solution of potassium iodide and sodium hydroxide, and then transforming it into iodoform with a titrated solution of a hypochlorite. The end reaction is indicated by the appearance of a blue color when a drop of the liquid is touched with a drop of bicarbonated starch solution. From the volume of hypochlorite used the quantity of acetone is deduced. Dr. Squibb has introduced various modifications which shorten the work so as to render the process available in commercial work, the details of which require a perusal of the paper in full for their due appreciation.

Dr. Doremus gave an interesting sketch of the scientific meetings held in London and Paris last summer, and of the various English and Continental laboratories visited, not the least efficient of which were several connected with large manufacturing establishments. The expensive platinum apparatus used by Moissan in the isolation of fluorine, Dewars's apparatus for liquefaction of oxygen, and photographs of the spectrum of Argon, were among many extremely interesting landmarks in the progress of chemical science which were seen and described.

Mr. J. C. Boot exhibited and described a specific gravity bottle, designed to prevent the rapid alteration of the temperature of the liquid and consequent difficulty in making accurate weighings, when the temperature of the laboratory happens to be much above the standard temperature at which the liquid must be weighed. The essential point is the inclosure of an inner by an outer bottle, the space between being quite thoroughly exhausted. The non-conductivity of the vacuum permits of maintaining the temperature of the inner bottle stationary for as much as five minutes with a room difference of twenty-five or thirty degrees.

A paper by Mr. Heath, on the colorimetric determination of copper, described methods of preparing color standards, whereby a year's permanence is assured, and other modifications conducive of accuracy and rapidity. Mr. Heath insists on the absence of nitric acid in the standards of color comparison, as well as an excess of ammonia of uniform strength, and the standards should then be preserved in absolutely tight, glass-stoppered bottles, and not exposed to heat or direct sunlight.

He objects to the method involving the use of metallic aluminum, because of the danger of incomplete precipitation, or retention of copper by silica, and the additional time required to avoid or correct errors resulting in these ways. He advocates a double precipitation, by ammonia, of the iron and alumina, redissolving in sulphuric acid for the second precipitation. His standards enable him to read to 0.03 per cent., and check assays made by electrolytic method indicate a very small range of error. DURAND WOODMAN,
Secretary.

THE TORREY BOTANICAL CLUB.

At the meeting of October 28th two new members were elected. The reference in the last minutes to the occurrence of the Russian Thistle on Captain's Island was corrected, the plant proving to be *Salsola Kali.*

The paper by Mr. B. D. Gilbert, entitled 'A New Gymnogramme from Venezuela, with Remarks on other Venezuelan Ferns,' was presented by Prof. L. M. Underwood, the author not being present. It consisted of an exhibit of the ferns collected upon the lower Orinoco River last spring, by Messrs. Rusby and Squires. The more interesting species, besides the new one, were *Adiantum olivaceum* Baker, *Alsophila blechnoides* Hooker, *Hemitelia grandifolia* Spreng., *Hemitelia Guianenses Parkeri* Hooker, *Aspidium meniscioides* Willd. and *Antrophyum subsessile* Kze.

A discussion followed on the heterogeneous character of the elements at present included in the genus Gymnogramme, and it was agreed that the new species was naturally a Polypodium and that its necessary reference to Gymnogramme was due to artificial genus-limits.

Dr. H. H. Rusby described a new genus from Bolvia, in the family *Icacinaceæ*, illustrating by specimens and blackboard drawings. Its structural relations to the other groups of the family and to the associated genera were carefully pointed out. The communication was discussed by Dr. Britton.

A communication from Miss S. B. D. Lewis on the species of Nymphea found in Raquette Lake was beautifully illustrated by colored drawings. The form of *Pontederia cordate*, with cream flowers, was also reported by Miss Lewis. An animated discussion of the communication was participated in by Dr. Britton, Prof. Lloyd, Mr. Rydberg, Mrs. Britton and the Secretary.

Dr. Allen remarked on his collections and observations in the far North, and exhibited a number of interesting specimens.

H. H. Rusby,
Recording Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of November 2, 1896, Mr. Colton Russell spoke of 'what an entomologist can find of interest about St. Louis,' illustrating his remarks by numerous pinned specimens of insects, giving particular attention to the butterflies, and speaking at some length of the phenomena of periodicity, migration, polymorphism, etc., as illustrated by these insects, his paper embodying the result of a large amount of field work performed during the past ten years. Resolutions opposing the passage of the anti-vivisection bill now before the United States Senate were adopted. Three persons were elected to active membership.

Wm. Trelease,
Recording Secretary.

TEXAS ACADEMY OF SCIENCE.

At a meeting of the Texas Academy of Science, held at the University of Texas on October 2d, Dr. George Bruce Halsted gave an account of his recent travels in Russia. At a regular meeting of the same association, held on November 6th, Prof. T. U. Taylor, C. E., gave an abstract of a somewhat extended paper on Roads in the Black Waxy Lands of Texas, in which he discussed the best methods of construction, the cost of labor, results already attained, etc. Dr. Frederic W. Simonds also presented an important paper at this meeting, a tribute to his friend and teacher, Prof. Ch. Fred. Hartt, M. A., the first Professor of Geology at Cornell University, who died in 1878, when Chief of the Geological Commission of Brazil. This sketch will be published in full in one of the leading scientific journals.

NEW BOOKS.

The Cell in Development and Inheritance. Edmund B. Wilson. London and New York, The Macmillan Co. 1896. Pp. xvi + 371. $3.00.

The Survival of the Unlike. L. H. Bailey. New York and London, The Macmillan Co. 1896. Pp. 515. $2.50.

The American Commonwealth. (Abridged edition.) James Bryce. New York and London, The Macmillan Co. 1896. Pp. xiii + 547. $1.75.

The Story of the Mine. Charles Howard Shinn. New York, D. Appleton & Co. 1896. Pp. vii + 272. $1.50.

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THE NATIONAL ACADEMY OF SCIENCES.

A SCIENTIFIC session of the National Academy of Sciences was held at Columbia University, New York, on Tuesday and Wednesday, November 17th and 18th, and a business meeting was held on November 18th to consider the report of the President of the Academy to Congress. The President of the Academy, Prof. Wolcott Gibbs, was prevented by illness from being present, and the sessions were presided over by President F. A. Walker, the Vice-President of the Academy. The following members were present: Henry L. Abbot, J. A. Allen, George F. Barker, Carl Barus, John S. Billings, Henry P. Bowditch, William H. Brewer, Charles F. Chandler, Cyrus B. Comstock, Edward D. Cope, Edward S. Dana, Samuel F. Emmons, Benjamin A. Gould, Arnold Hague, Asaph Hall, Charles S. Hastings, George W. Hill, Joseph Le Conte, O. C. Marsh, Alfred M. Mayer, Richmond Mayo-Smith, T. C. Mendenhall, Arthur Michael, A. A. Michelson, S. Weir Mitchell, Simon Newcomb, A. S. Packard, Charles S. Pierce, Ira Remsen, Ogden N. Rood, Henry A. Rowland, Charles S. Sargent, A. E. Verrill, Francis A. Walker, William H. Welch, R. S. Woodward. There were thirty-six members in attendance, seven more than at the corresponding meeting a year ago at Philadelphia. The following papers were entered to be read:

1. *On Certain Positive-Negative Laws in their Relation to Organic Chemistry.* A. Michael.
2. *The Jurassic Formation on the Atlantic Coast.* O. C. Marsh.
3. *The Hydrolysis of Acid Amides.* Ira Remsen.
4. *The Isomeric Chlorides of Paranitroorthosulphobenzoic Acid.* Ira Remsen.
5. *The Equations of the Forces Acting in the Flotation of Disks and Rings of Metal, with Experiments showing the Floating of Loaded Disks and Rings of Metal on Water and on other Liquids.* Alfred M. Mayer.
6. *On the Geographical Distribution of Batrachia and Reptilia in the Medicolumbian Region.* E. D. Cope.
7. *On the Physical Causes of the Periodic Variations of Latitude.* S. Newcomb.
8. *On the Solar Motion as a Gauge of Stellar Distances.* S. Newcomb.
9. *Memoir of F. B. Meek.* C. A. White.
10. *The Evolution and Phylogeny of Gastropod Mollusca.* A. E. Verrill.
11. *On Flicker Photometers.* O. N. Rood.
12. *A New Type of Telescope Free from Secondary Color.* C. S. Hastings.
13. *A Graphical Method of Logic.* C. S. Peirce.
14. *Mathematical Infinity.* C. S. Peirce.

Prof. Willard Gibbs was requested to prepare a biographical notice of the late Prof. H. A. Newton, of Yale University, and Prof. S. P. Langley, a notice of the late Dr. G. Brown Goode. In addition to the serious loss the Academy has suffered in the deaths of Newton and Goode, three of the twenty-two foreign associates have died very recently, Hugo Gyldén, August Kekulé and F. F. Tisserand.

On the evening of Wednesday, November 18th, Mrs. Henry Draper gave a reception to the Academy and invited guests. In the laboratory at her house an exhibit was arranged as follows:

1. (*a*) Photograph of Delegates to the Kelvin Jubilee, June, 1896; (*b*) Radiographs, Normal and Pathological, taken by A. W. Goodspeed, Assistant Professor of Physics, University of Pennsylvania. G. F. Barker.
2. Plates of Vital Statistics of the 28 Great Cities of the United States. J. S. Billings.
3. Stereoscopic Telescope and Binocular Dissecting Microscope. H. P. Bowditch.
4. Optical Glass. Relief Plates in Color. C. F. Chandler.
5. Photographs of the new Flying Machine. S. P. Langley.
6. Views of the Lias Formation in the United States. O. C. Marsh.
7. Small Model of Interferometer. A. A. Michelson.
8. Photographs illustrating Recent Progress in the Henry Draper Memorial. E. C. Pickering.
9. Photographs showing the Effect of Pressure on the Spectrum. H. A. Rowland.
10. (*a*) Photographs and Transparencies; (*b*) Recent Geological Maps. C. D. Walcott.

RECENT ADVANCES IN MALACOLOGY.

During the past year some notable work has been published, including not only contributions to the natural history of groups, anatomy, material for monographs, etc., but also a certain number of studies which lead to a change in the point of view of whole series of evolutionary processes. As these things are too late for the latest text-books, and liable to be overlooked by teachers who are not specialists, a brief reference to some of the more important may be useful. A remarkable series of investigations by F. Bernard, on the development of hinge teeth in Lamellibranchs,* is among the most striking in the results which flow from the facts observed on the nepionic stages in many genera.

After the prodissoconch stage, when the primitive pellicle secreted by the embryonic shell gland is continuous between the valves and the ligament is simply its uncalcified median part, come the nepionic stages of which Bernard has recognized two types among the species examined. One, which is the most common, has the shell oval with an arched dorsal hingeline and convex umbones; the other has a straight hingeline, a more elongated shell and the umbones not projecting. To these might have been added the fresh water *glochidium* and *lasidium*, had species of *Naiades* or *Mutelæ* been among the forms studied. In

*Bull. Soc. Géol. de France, 3me Sér. XXIII., pp. 104–154, and XXIV., pp. 54–82, 412–449, 1896.

both the observed types there is practically no cardinal plate, the hingeline being thin, the ligament between (not outside of) its opposed edges and usually directed obliquely downward and backward. Toward the extremities of the cardinal border are found the feeble projections which indicate the beginnings, called by Bernard the *primitive lamellæ* of the permanent teeth, of which the anterior appear first. In the left valve one, and in the right valve two, of these appear, from which are developed ultimately the anterior lateral and the cardinal teeth. The posterior lamellæ give rise to the posterior laterals only.

The position of the ligament above described, and which seems to be general at this stage, is regarded by Bernard and at first sight would seem antagonistic to the dynamic hypothesis of Neumayer and others, which postulate an originally external ligament. A little reflection, however, shows that there is no real antagonism, for there is practically no mechanical distinction between inside and outside at this stage, and in the later stages it makes no essential difference, so far as the dynamics of the hinge are concerned, whether the movement which leads to a separation between ligament and resilium is upward and outward for the former, or downward and inward for the latter, the mechanics of the process being the same in either case. The ligament increases by additions from below, or at the posterior end. If these are in excess in the latter case the ligament tends to become elongated and external, in the former case short and internal ; while its edges of insertion, through the deposit of shell adjacent to them, in a ligament otherwise external are almost always situated in a channel of which the nymphæ are the thickened ventral border. The dynamic reaction of the form and mode of growth of the ligament upon the form of the valves is clearly set forth by Bernard, who thus supplies an interesting contribution to the data of dynamical evolution.

The most important and unexpected result of Bernard's studies is the discovery that, in the nepionic stage of all the *Prionodesmacea*, the first development of the hinge consists in the appearance, on each side of the ligament (except in *Ostrea*, where they are solely posterior), of a series of vertical crenulations, or taxodont denticles, which are entirely distinct from the permanent teeth of the adult shell. These had been observed in a few cases previously, but their widespread occurrence, not only in the order mentioned, but also in some species of the *Teleodesmacea*, had not been suspected ; while the discontinuity between them and the permanent teeth, even in such typically taxodont groups as *Nucula* and *Pectunculus*, is very remarkable. For this primitive hinge, as distinguished from the subsequently developed permanent cardinal mechanism, we may adopt the term *provinculum*. The character of the provinculum is that of two subsymmetrical areas of nearly vertical parallel ridges separated by subequal grooves, forming a taxodont apparatus similar to the permanent dental series of *Arca* and much resembling the hinge in some of the Paleoconcha illustrated by Neumayr. It is difficult to avoid the conclusion that we have in the provinculum a representative of the primitive hinge of the Protopelecypod, which was, perhaps, a free-swimming pelagic animal like *Planktomya*. The theory of Neumayr, which derives the dentition from the influence of external sculpture on the hinge margin, accentuated by natural selection, remains unshaken, but we have still to account for the gap which, in the forms yet examined, appears to intervene between the provinculum and the permanent teeth. It is probable that further researches will lead to the discovery of this missing link.

The second important fact brought out

by Bernard is that the so-called 'cardinal' teeth in the *Teleodesmacea* are genetically identical with the distal laminæ called in the adult shell 'lateral' teeth. The anterior primitive lamellæ grow, and, as they grow, curve and develop angular hooks at their proximal extremity. These hooks become detached from the main body of the lamella from which they originate and the distal part of which become 'lateral,' while the hook develops into a 'cardinal' tooth. In such a form as *Rangia* the hook remains permanently attached to the lower anterior lateral by cessation of development. The disunited portions of the hook may remain separate or, as in *Mactra*, unite with one another and so form /\-shaped teeth.

In general, the results of Bernard's work appear to confirm the unity of the groups of *Prionodesmacea* and *Teleodesmacea*, as formed by the writer, and to approximate to the latter the group of *Anomalodesmacea*, as already intimated by me. He has also in some details efficiently reinforced the dynamical doctrine as explanatory of many features in the growth and resulting form of the shell. The invalidity of Neumayr's *Desmodonta*, already fairly proven by Bittner and the writer, is confirmed, while the moribund order, *Septibranchia*, finds no support in the development of the hinge.

It has long been known that the gill of *Planorbis* is a flat lobe, not lamellose like most external molluscan breathing organs, and recently Pelseneer* has reviewed and added to our knowledge of this organ and analogous structures in several gastropod types. This gill plate is not homologous with the typical prosobranch ctenidium, but is an independent development accessory to the lung of the fresh water pulmonates. It occurs in one form or another in most of them, even *Limnæa* showing a rudiment in some cases. In our *Ameria scalaris* Jay, from Florida, the plate is large and smooth, as in *Planorbis*. In one of the Physiform planorboids from the southern hemisphere, which at one time were generally confounded with the true *Physidæ* in default of a knowledge of their anatomy, Pelseneer describes a further step in the evolution of this organ. In the *Ameria lamellata* Smith, of Madagascar, the plate is transversely folded into lamellæ, as in the great majority of molluscan gills, thus giving another example of the ease with which similar but non-homologous breathing organs are developed among mollusks, a feature which I have long insisted on. No cases of this kind have been known among Pelecypods hitherto, but recently Bernard* in an interesting paper on a new commensal bivalve mollusk, *Scioberetia australis*, has described a case where the reticulated true ctenidium is formed by the folding and subsequent perforation of a single plate, instead of the growth and subsequent concrescence of single filaments. The latter process has been supposed to be almost, if not quite, universal in the *Teleodesmacea* and Anisomyarian *Prionodesmacea*. Bernard suggests that the mode of development in some of these may really be similar to that of *Scioberetia*, and shows that the whole subject requires further study.

More recently still, Simroth,† in a valuable memoir on the Pelecypoda of the pelagic region, has described a new type, *Planktomya Henseni*, a minute and seemingly strictly pelagic bivalve, in which the true ctenidium has the simple lamellar form of the gill of *Planorbis*, without transverse plications or free filaments. So the evidence grows of how structurally similar breathing organs, whether strictly homologous or not, may be developed either as a orm of the true ctenidia, or elsewhere, in

* Arch. de Biologie, XIV., pp. 357–393, 1895.

* Bull. Scientifique de la France, XXVII., pp. 362–395, 1896.

† Die Acephalen der Plankton Expedition, Leipzig, 1896.

response to the needs of the organism. Even if *Planktomya* should eventually prove to be an immature Leptonoid, the fact of the mode of development of the ctenidium would remain of the greatest interest. The existence of this minute form, apparently confined to the open sea between the latitudes of Ascension Island and Bermuda, suggests that the earliest (Cambrian) bivalves may also have been pelagic, which would explain their rarity and minuteness. Of the various larval bivalves found in the Plankton, all are dimyarian and destitute of a pallial sinus, the oral palpi develop in advance of the gills, which appear either as a single lamella on each side or as a number of buds not exceeding ten, while the hinge is either edentulous or taxodont; in all these characters recalling the Paleoconcha.

Wm. H. Dall.

Smithsonian Institution.

A STUDY OF THE COLON BACILLUS GROUP, AND ESPECIALLY OF ITS VARIABILITY IN FERMENTING POWER UNDER DIFFERENT CONDITIONS.

A research on the colon bacillus group of bacteria has been in progress during the past two years in the Laboratory of Hygiene of the University of Pennsylvania, in accordance with a scheme prepared by Dr. Weir Mitchell and Dr. John S. Billings, the director of the laboratory, for an investigation on the variability of bacteria, under the auspices of the Bache fund. A resumé of the results of last year's work was published in this Journal under the title 'The Influence of Certain Agents in Destroying the Vitality of the Typhoid and the Colon Bacillus,' and the following article records the experiments made since that time. The organisms which, owing to certain common characteristics, are usually included in the group under examination, the colon bacillus group, have excited much interest during the past few years because of their resemblance to the bacillus of typhoid fever and the difficulty attending the differentiation of certain varieties of the colon bacillus from this organism; and also because of the importance ascribed in recent years to the bacillus coli communis, the type of this group, as a cause of inflammation and abscess in man. This organism first isolated by Escherich, in 1886, has been found to be constantly present in the intestinal canal of man, and als› in that of many of the lower animals. Different observers have noticed variations in the characteristics of cultures obtained from different sources, and some have been disposed to consider each of these varieties to be a separate species, but the similarity of many prominent features of these cultures finally led to a grouping of these organisms as varieties of a species. Different groups of colon bacilli have been described by several writers. Achard[1] and Renault in 1892 had observed five types of the colon bacillus, and Tavel[2] had isolated fifteen varieties. Stoeklin[3] distinguishes thirteen forms which he classifies by their motility and the number of flagella. Gilbert[4] finds five varieties. Fremlin[5] describes several varieties obtained from different animals. Refik[6] records five varieties found in water. But an article published by Dr. Th. Smith[7], entitled 'Notes on the Bacillus Coli Communis and its Related Forms,' in which several varieties of the colon bacillus and other similar organisms are tabulated, showing their differentiation by means of the fermentation test and also by the comparison of other distinguishing reactions, has been the means of making better known a number of the different varieties and of establishing a basis for further classification. Very little comparison can be made, however, between the varieties described by Smith and those by other writers because of the paucity of the tests recorded by the latter.

Cultures from the species designated by

Smith as the typical colon bacillus, the transitional forms of the colon bacillus, and the pseudo forms of the colon and the typhoid bacillus, having been furnished to Dr. Billings, and placed in the hands of the writer, these have been studied for the purpose of becoming able to identify the different members of the colon group met with in further research, and an effort has also been made to differentiate each species by the appearance of its colonies.

The colonies on gelatine plates were drawn at different stages of growth and compared as to variations in size, outline, color and surface-markings; but these differences were not found to be greater than have often been observed in the typical colon bacillus grown in an unfavorable medium, or at a low temperature, or under some other unusual condition. The atypical forms of the colon bacillus, found in water and sewage, may present changes in microscopic appearance due to their environment. Therefore this means has not been found to be of much positive value in determining a variety.

Cultures of each variety were then observed in an unfavorable medium. Bouillon containing subnitrate of bismuth in varying amounts, one per cent., one-half per cent., and one-tenth per cent., was first used. The bismuth subnitrate was rapidly reduced in the one-tenth solution; and more slowly in the others. After remaining for twenty days in this medium the colonies became irregular in shape, but this feature was not more prominent in any one variety than in another, and it is of constant occurrence whenever the bacillus is kept for a long time without change of medium, or in distilled water.

Salicylate of bismuth was also used in the same manner. The same grotesqueness in the shape of the colonies was observed in the one-tenth per cent. solution, which was the only one in which the cultures lived.

A study of the different members of this group in stroke cultures on the various media in general use showed this means of differentiation to be of less value than the appearance of the colonies on gelatine plates. On agar-agar the only variation observed in the different types was, that in some cultures the growth stained the medium a yellowish-brown color while in others no such staining occurred. On blood-serum the growth was scanty in every instance and there was a tendency to remain in distinctly separate colonies. On gelatine, every variety presented a tufted appearance to some degree. A slight clouding of the gelatine around the growth was seen in the most alkaline cultures. The so-called artificial potato made of Petermann's fluid, stiffened with rice powder, potato-starch and calcined magnesia was tried, but was found to be very unsatisfactory, because of its constant alteration in reaction, produced by the action of the acid on the phosphates and carbonates, which action continued until the composition of the substance was entirely changed.

The reaction of cultures of the colon bacillus group as found by testing a considerable number of each different type, is always alkaline in media which do not contain sugar. In sugar bouillon the reaction varies with the kind of sugar used. If the sugar is broken up by the ferment of the organism, enough acid may be formed to finally kill the culture, but if only a small amount of acid is formed, then the culture finally produces an alkaline reaction.

The indol reaction was found of much value in testing certain varieties of this group. Some difficulty was experienced in obtaining an accurate test in cultures in which only a slight trace was present. The well-known test as given by Kitasato was used. Notwithstanding the great care taken in testing, ten tests made upon each organism gave greatly varying results. The peptone used was then tested for indol, and of five bottles tested each gave a distinct indol reaction. Sargent's peptone was then substituted for Witte's and uniform results were obtained.

All of the different varieties of this group were found to be motile. Specimens were stained in order to compare these types with Stoeklin's groups of the colon bacillus, which are differentiated by the number of flagella. The writer was never able to attribute a certain number of flagella to any one variety, and each specimen showed a much greater number than was found by Stoeklin in the cultures forming his group.

From a study of these types of the colon bacillus group, it does not appear that any one or two characteristics can be relied upon to distinguish a variety ; for great variations have been found in all of the important functions of the specimens tested. One of the most marked types is that described as the pseudo-typhoid bacillus, which does not ferment sugars nor produce indol, two of the functions especially observed when determining the typical colon bacillus. Such widely varying characteristics seem to indicate the necessity of using all of the biological features for the differentiation of a member of this group.

The fermentation test as given by Smith was used by the writer as the initial step for distinguishing and classifying cultures obtained from many different sources. The greater proportion was taken from the dejections of patients or animals sick with intestinal diseases, and especially from typhoid dejections obtained from a number of patients.

Gelatine plates were made from the materials investigated and a series of cultures was taken from such colonies as seemed characteristic of the colon bacillus. Each series was carefully tested in regard to indol production, fermentation, motility, etc. The fermentation tests were made with dextrose, lactose and saccharose, in one per cent. solutions. Meat extract bouillon was used with glucose, but for lactose and saccharose a special medium free from muscle-sugar was required. An acid-albumin medium was found to be free from sugar and also from indol. This proteid solution was tested by Pére,[8] using muscle for its production, and was found to give a luxuriant growth of the colon bacillus. Ohlmacher[9] recommends peptone prepared from egg-albumin. The writer has prepared it as given in foot note.*

Two hundred cultures were tested regarding fermentation with the three varieties of sugar. The cultures obtained from typhoid dejections were found to give somewhat less gas with lactose and saccharose than the standard colon bacillus described by Smith, which gave with glucose a volume of one-half of the fermenting tube; with lactose the same amount; with saccharose two-thirds. No culture was obtained from human dejections in which there was complete absence of fermenting power for one or more of the sugars.

A series of cultures taken from the intestine of a dog with ulcerated intestines was quite typical in appearance and reaction.

Cultures taken from the intestine of a healthy rabbit gave only a small amount of gas with glucose, and none with saccharose. Fremlin found that the colon bacillus from rabbits varies from that found in man ; but his fermentation tests were decided by glucose alone.

The fermentation test was also applied to cultures of the colon bacillus obtained from specimens attenuated by growth under very

* The whites of two eggs are well-beaten and mixed with 500 c. cm. of distilled water acidified with 2 c. cm. of concentrated hydrochloric acid. Two and a-half grammes of scale pepsin are used for the digestion of this mixture, which is kept at a temperature of 40° C. for six hours. It is then neutralized, one-half per cent. each of peptone and salt are added, and enough water to make one litre, when it is boiled and filtered.

unfavorable conditions. Typhoid fæces were kept in the glass-stoppered bottles in which they were received, and plates made from time to time to ascertain whether the fermenting function of the colon bacillus is affected by prolonged residence in such a medium.

Of twenty series tested, three, covering a period of 126 days, are tabulated (see table).

Series A: This series consists of cultures from fresh typhoid fæces. The gas formation with glucose is typical, but with lactose and saccharose the amount is considerably diminished.

Series B: These cultures were made from the same specimen of fæces when it had been kept for thirty days. They show a great reduction in the amount of gas produced with each variety of sugar. No. 2 does not form gas with either form of sugar, and does not coagulate milk, yet in indol-formation, growth on potato, motility and macroscopic and microscopic appearance it is like the typical colon bacillus. Number 4 gives merely a bubble of gas with lactose and saccharose.

Series C: This series was obtained from plates made when the same specimen of fæces had been kept for 126 days. Growth was slower than usual, but the colonies finally presented the irregular outline, the translucent border and relief-map surface-markings which characterize the colon bacillus. The branching appearance of the stroke cultures on gelatine did not appear for several days. Growth on agar-agar was typical and the fæcal odor distinct. Milk was not coagulated by these cultures, even when it was boiled. The indol-reaction was distinct in every case. A microscopical examination showed a short, motile bacillus in pairs, or sometimes in chains of two or three, which in very young cultures might be mistaken for cocci in the stained specimens; but in the hanging drop the shape was easily seen and the motility was nearly as great as that of the typical colon bacillus. The fermenting function was entirely lost with all the sugars used. An acid reaction in every tube showed that the sugars were broken up into acids, to some extent.

These cultures, which after careful study are considered as true colon bacilli attenuated by prolonged dwelling in undiluted fæces, correspond very closely to those described by Villinger[10] in his investigations upon the changes produced in the colon bacillus by environment. A tested culture of the colon bacillus was so changed by different chemical and physical influences that nearly all of the characteristics by which it is differentiated from other organisms were lost. Some of these functions could be again revived by repeated changes in a favorable medium. The indol-formation, however, was never regained.

An attempt was made to attenuate a tested culture of the colon bacillus by inoculating it into diluted, sterilized, typhoid fæces. It was put into this medium on December 20, 1895, where it

GAS REACTION SHOWING THE TOTAL AMOUNT OF GAS FORMED IN THE FERMENTING TUBE.

Series A.	No. of Culture.	Dextrose.	Lactose.	Saccharose.	Series B.	No. of Culture.	Dextrose.	Lactose.	Saccharose.	Series C.	No. of Culture.	Dextrose.	Lactose.	Saccharose.
	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{7}$		1	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{6}$		1	0	0	0
	2	$\frac{1}{2}$	$\frac{7}{13}$	$\frac{1}{10}$		2	0	0	0		2	0	0	0
	3	$\frac{1}{2}$	$\frac{7}{13}$	$\frac{1}{6}$		3	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{1}{6}$		3	0	0	0
	4	$\frac{1}{2}$	$\frac{2}{9}$	bubble		4	$\frac{1}{3}$	bub.	bubble		4	0	0	0
	5	$\frac{1}{2}$	$\frac{1}{3}$	bubble		5	$\frac{1}{3}$	$\frac{8}{13}$	$\frac{1}{9}$		5	0	0	0
	6	$\frac{1}{2}$	$\frac{1}{5}$	bubble		6					6	0	0	0

has been kept at room temperature until the present time, April 12, 1896. Plates made on April 9th show as large and as characteristic colonies as from the original culture. The gas production of the original culture was, with glucose, one-half the fermentation tube; with lactose, one-half, and with saccharose two-thirds. After growing in the fæcal fluid for 110 days the gas production for glucose is one-third; for lactose, one-third; for saccharose, a bubble.

A culture was inoculated into the same fluid in a flattened test-tube, and exposed to the light and sun. It lived only thirty days, giving nearly the same reduction in gas production as the one which was kept in fæcal fluid for 110 days.

The effect of the insolation of cultures on agar-agar plates was also tested in regard to the fermenting power. Each culture was insolated for two hours and then incubated until the next morning. A series of cultures was made, consisting of removes from the original culture, which was the one used for inoculation of the fæcal fluid. The amount of gas produced after six removes was, with glucose, one-third; with lactose, one-quarter; with saccharose, a bubble.

The decrease in the fermenting function observed in the series of cultures taken from fresh typhoid fæces suggested that the colon bacillus may lose this function in some degree, because of the change in the nature and amount of proteid materials in the contents of the intestine, resulting from the throwing off of cellular products from the intestinal walls.

Pére[8] found that the colon bacillus gave great variation in the amount of lactic acid formed in fluids containing different proportions of proteid materials. With 10 grammes of glucose and 6 grammes of peptone in 250 c. cm. of fluid, the colon bacillus gave 2.37 gr. of lactic acid; but with the same amount of glucose and 6 grammes of peptones only 1.170 gr. was formed.

A tested culture was therefore inoculated intraperitoneally into a guinea pig, recovered again, and the cultures tested in sugar bouillon. The gas production was considerably diminished by one passage through an animal, as will be seen in the first series of the following table. These cultures were taken from the spleen of the guinea pig. In the second series the cultures were taken from the typhoid spleen of man, in which the typhoid bacillus was also very plentiful. The escape of the colon bacillus through the ulcerated intestinal wall into the organs of the body has been especially noted by Wathelet,[12] who considers that it is frequently found in the spleen.

TOTAL AMOUNT OF GAS IN FERMENTING TUBE.

Series 1.	Dextrose.	Lactose.	Saccharose.	Series 2.	Dextrose.	Lactose.	Saccharose.
Original Culture.	$\frac{1}{2}$	$\frac{7}{13}$	$\frac{1}{2}$				
a	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{8}$	a	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{7}$
b	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{9}$	b	$\frac{2}{7}$	$\frac{1}{4}$	$\frac{1}{5}$
c	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{10}$	c	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{7}$
d	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{9}$	d	$\frac{1}{4}$	$\frac{2}{7}$	$\frac{1}{6}$

It seems, therefore, that the fermenting power of the colon bacillus may be easily decreased, not only by unfavorable conditions of growth, but also by conditions which do not injure its growth and which may be favorable for and increase some of its other functions.

The colon bacillus, deprived of its fermenting power, would be difficult to differentiate in sewage waters; but it is probably killed in those waters, by exposure to sunlight, before this power is entirely lost. The members of the colon bacillus group which have been obtained by the writer from contaminated waters have rarely possessed the fermenting power which is found in cultures obtained from the normal intestines of man; they may be in a 'transitional' state.

The greater loss of fermenting power with saccharose than with other sugars, may be attributed to the nature of the sugar, which is not directly fermentable, but must first be inverted by a ferment, dextrose and levulose being formed, in which the process of fermentation is easily carried on. The duration of the fermenting process of the colon bacillus with saccharose is much longer than with other sugars.

The diminution in fermenting power noted in cultures obtained from organs undergoing inflammation will be further studied in connection with the influence of proteid materials on the colon bacillus.

My thanks are due to Dr. J. S. Billings and Dr. A. C. Abbott for direction in this work, and assistance in obtaining cultures; and also to Dr. Henry W. Cattell, who has furnished me with much valuable material.

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SUPERHEATED STEAM IN STEAM ENGINES.

The writer has been, for many years, much interested in the now century-old problem of the application of superheated steam to use in the steam-engine with a view to the extinction of those internal thermal wastes which have, from the days of Watt, been recognized more or less clearly as the most formidable obstacles in the way of improvement of the efficiency of the steam-engine, as in fact, of all known heat-motors. The material which has been meantime collecting was recently collated and abstracted, and finally published in a paper read before the American Society of Mechanical Engineers at its St. Louis meeting of 1896.* The subject has more of scientific than practical interest at the moment; but it is not impossible that the resuscitation of this once accepted and now comparatively little-used process may yet prove to be the means, and the only practicable means, of continuing indefinitely the improvement of the steam-engine begun by Watt a century ago. The alternative seems, at the present time, to be the discovery of some commercially practicable method of

* Superheated steam; facts, data and principles relating to the problem. Trans. A. S. M. E., 1896, Vol. XVII.

producing a non-conducting working cylinder and thus of approximating the real to the ideal thermodynamic machine, a method discussed by the writer at some length in a recent issue of the Transactions of the U. S. Naval Institute.

The following is a summary of the conclusions presented before the American Society of Mechanical Engineers:

*   *   *   *

Opinion seems substantially unanimous, and all testimony confirms the conclusion that superheat may effect large net economies. Collating the results of about fifty authentic and well-conducted experiments, it is found that the gain in fuel, by the introduction of superheating, ranges from ten to fifty per cent. of the fuel used with wet steam; that about 100 degrees superheat, on the Fahrenheit scale, gives usually complete extinction of initial condensation; that even fifteen or twenty degrees will make an important gain in reduction of internal wastes; that every application of this system, discreetly effected, returns several times—actually from two to ten times—its cost in heat expended; that the largest returns are secured by the smallest quantities of superheating; and that the indications are, so far as we can to-day judge from earlier and contemporary practice, good engineering in this direction pays, and pays well; the limit being found at that point, continually becoming more remote and at a higher and higher temperature, at which excess of temperature begins to cause rapid destruction of the superheating apparatus, and consequent expense and danger in such degree as to become a large and more than counterbalancing element. The average of fifty-two cases observed by the writer gives a gain of twenty-six per cent. with a superheat of 105 degrees Fahr. The average gain with compound engines examined is twenty per cent. with a lower but uncertain amount of superheating, in a majority of the cases reported the superheat not having been measured. In cases averaging about fifty degrees superheat, the gain was twenty per cent., and this is probably not far from the average for all.

*   *   *   *

Thus, one thermal unit, one pound of steam or of fuel, or one dollar, expended in reduction of this internal waste, returns three; and a profit of three hundred per cent. pays, in turn, the excess of cost of maintenance of superheating apparatus and incidental costs and repairs at engine and at boiler.

Where the gain by use of superheating is less, the proportion of profit to expenditure is, as a rule, greater, since the effect of the first few degrees of elevation of temperature and of superheat is by far the most effective in reduction of initial condensation.

The conclusions of the writer are the following:

(1) Superheated steam, as hitherto employed in the steam-engine, has absolutely no purely thermodynamic value. It neither raises the upper limit of temperature nor depresses the lower; it gives no increased range of temperature of the cycle; the value of the maximum measure of ideal efficiency, $(T_1 - T_2)/T_1$, is in no manner altered by its introduction into the system.

On the other hand, it is evident, from a study of the physics and thermodynamics of the case, that, could any way be found of practically working superheated steam, safely and with economy in its production, it would permit a thermodynamic gain only limited by the extent to which the range $T_1 - T_2$ could be thus expanded.

(2) Superheating has for its sole purpose and result, in the steam-engine to-day, the extinction or reduction of the internal thermal wastes of the engine, consequent upon the phenomenon known as initial or 'cylinder condensation.' Here it is extraordinarily effective, and a small quantity of

heat expended in superheating the entering steam effects a comparatively large reduction in the expenditure of steam in the engine; each thermal unit thus employed saving several thermal units otherwise wasted. The process is one, mainly, at least, of prevention rather than of cure of that fault; and prevention is, as usual, here found to be vastly more effective than attempted cure.

(3) Superheating is superior to any other known means of reduction of internal waste. Jacketing ordinarily suppresses but a fraction of that waste, and the multiple-cylinder engine has also its limitations; while superheating may not only extinguish it, but may also check wastes due the resistance to flow of the denser, wet steam through steam and exhaust ports, and may sensibly improve the vacuum attainable in the condenser, with corresponding reduction of back pressure, of the quantity of condensing water demanded, and of the load on the air pump.

Superheating even a few degrees improves considerably the performance of the engine, and, in the average case, superheating one hundred degrees Fahrenheit will entirely extinguish that waste.

(4) The hitherto unconquered obstructions to the use of superheated steam in the engine have been those resulting from destruction of packing and decomposition of lubricants, with consequent friction and 'cutting' of the rubbing surfaces. The introduction of metallic packings and of high-test lubricants has now enormously reduced the difficulties of application of superheating. No trouble need now be found at the engine with sufficient superheating, under usual conditions of operation, to annihilate cylinder condensation. It seems not at all improbable that even this limit may be ere long safely, and perhaps even largely, overpassed, with resulting improvement of thermodynamic efficiency.

(5) The obstruction at the boiler has been, and still remains, difficulty of construction of a superheater, or of a superheating system, which will be at once effective, safe and durable.

The comparatively low temperatures at which modern boilers discharge their gases into the uptake, while reducing these difficulties largely, introduces the complementary one of increased necessary area of superheating surface, and consequent volume, weight and cost of the superheaters. The real difficulty is to-day found at this point, and the production of a superheater which will safely withstand the effects of high temperature of flue gases, will effectively transfer heat from gas to steam, and will have a satisfactorily long life, still challenges the engineer as one of his most serious, yet attractive and important problems.

(6) The more wasteful the engine, the larger the promise of gain by superheating, and small engines will profit by it more than large, slow engines more than fast, and simple engines more than the multiple-cylinder systems, which latter require such auxiliaries less as their cascade action is the greater and its steps more numerous.

(7) The larger the waste to be checked in the engine, the farther should the superheating be carried. That degree which would serve every purpose in the simple, slow, small mill engine would be entirely too high for safe use, and quite inexpedient, in the high-speed compound of large size, while that which would be ample for the latter would be entirely insufficient for the former.

(8) The extent of superheating should be adjustable—not only to the particular size and type of engine in view, but also in the same engine—to the extent to which expansion is carried.

A perfectly satisfactory system of superheating should be adjustable in this respect with the load on the engine, and still free from danger of burning out at light loads, while giving suitable action at heavy loads. In the one case it must supply a small amount of highly superheated steam to the engine, in the other a larger quantity with less superheat.

This presents the engineer with a problem not yet really attacked.

(9) The average simple engine may be said, under such conditions as we are most familiar with, to demand a quantity of fuel annually, about equal in value to its own first cost. In such cases it is obvious that under these conditions, and with the above return of five dollars in saving to each dollar paid to thus reduce waste, it will pay to annually expend the full equivalent of the interest on the price of the engine in maintaining a good superheating system. When, however, as has usually hitherto happened, this account includes such large interest and wear-and-tear accounts as cause the total annual expense to exceed this financial limit, the engineer will wisely decline to thus invest capital.

Studying the results of experiments to date determining the magnitude of the internal wastes which superheating is expected to reduce, we shall find that the following may be taken as, roughly, the measure of those wastes, the relative quantities of heat gained by their complete extinction and the extent of the necessary superheat:

GAIN BY SUPERHEATING.

ENGINE.	Steam pressure, pounds per square inch.	Percentage steam condensed, without superheating.	Relative gain by superheating.	Degrees Fahr. superheat.
Simple	50 to 100	50 to 30	5 to 1	100
Compound.....	75 to 125	30 to 20	3 to 1	75
Triple..........	125 to 180	20 to 10	2 to 1	50

(10) Given a safe and durable and efficient superheater, and the engineer will have the power to adjust his temperatures and pressures of working fluid to any limit that may be sent by the character of his materials in boiler and engine, and to secure the best adjustment of the thermal to the dynamic limit.

In other words, he may produce a working fluid having at once the high temperature and wide range of adiabatic expansion requisite for maximum thermodynamic efficiency, and the high initial and mean effective pressures needed to insure maximum dynamic efficiency or efficiency of the mechanism of the engine ; the two combined thus giving the maximum total efficiency obtainable by any means whatever. The high thermodynamic efficiency of the gas engine and the peculiarly high 'efficiency of machine' characteristic of the steam-engine would be both secured, and the steam-engine once more placed beyond rivalry among all the heat-engines.

(11) This is, to-day, the greatest of all the problems presented the designing and constructing engineer, with the possible exception of that of finding a system of effectually rendering the interior of the working cylinder non-conducting, in such manner as to prevent entirely the occurrence of initial condensation, thus conforming the 'ideal case' to the real, and making the steam engine a purely thermodynamic machine.*

The above are the main points of the paper, so far as especially interesting from a scientific point of view. It includes, in a monograph of some seventy pages, a collection of facts, data, and results of experience and of direct experimental tests of engines and boilers, as well as opinions of distinguished authorities and practitioners, which, while valuable as a basis for its deductions and final conclusions, would be out of place here. But even these omitted sixty pages constitute but a fraction of all

* 'The Final Improvement of the Steam Engine,' R. H. Thurston. *Transactions United States Naval Institute*, 1891 ; *Sibley Journal of Engineering*, 1892.

the material accummulated, having value to the expert engineer and corroboratory of those conclusions. In the opinion of the writer, the latter may be accepted as thoroughly well-established.

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ON CERTAIN PHYSICAL DIFFICULTIES IN THE CONSTRUCTION OF LARGE GUNS.

THE substitution of forged steel for cast iron in gun construction has resulted in the universal adoption of the built-up gun. About the year 1855 the Englishman, Blakely, and the American, Treadwell, independently discovered and demonstrated the value of the principle of initial tension as a means of increasing the strength and economizing the material of a gun. What this means can be briefly shown.

Assume a tube of perfectly annealed metal with given tenacity and elasticity. If a powerful stress be applied, there is no reason why one part should be more capable of resisting it than another. Let the tube be closed at one end, and let the stress originate from within near this end, as in the explosion of a charge of gunpowder. Under this condition it was shown by Treadwell that if we assume the tube to be made up of a large number of uniform, cylindrical, concentric layers of metal, then the resistance of each layer to the exploding force will vary inversely as the square of the diameter. The stress in its effect upon the metal decreases at a rate quite similar to that of the radiation of heat or light. If the wall of the tube be under no initial stress its inner surface may be stretched even to its elastic limit, while the stretching of the outer surface is comparatively slight. The metal's property of elastic resistance is hence not utilized to the best advantage in the outer layer, while in the inner layer it may be utilized to an extent inconsistent with safety.

Treadwell therefore proposed a plan of gun construction which has since been universally adopted. The modern gun consists of a steel tube which is reenforced by one or more concentric hoops or tubes, the number and position of these being adjusted to the variation of pressure from within as the hot exploding gas finds vent at the muzzle. The ordinates of the pressure curve are greatest at the origin, this being taken as the middle of the seat of the powder charge in the chamber. They decrease rapidly with approach to the muzzle. The reenforcement of the tube should therefore be greatest around the breech. A tubular jacket is shrunk on around the main tube, covering the breech and often as much as two-thirds of the entire length. Around the jacket is a series of compressing hoops, and around this there may be a second or outer series of supplementary hoops. Originally the interior diameter of the jacket is a little less than the exterior diameter of the tube. By heating the jacket sufficiently it is made to expand until large enough to be slipped into place over the cold tube. This becomes enormously compressed by the subsequent cooling of the jacket. In like manner the first hoop is too small to be slipped over the cold jacket until sufficiently heated for this purpose. The same remark applies to the relation between the second and first hoops. The final result is that the diameters of the tube, both external and internal, are permanently decreased by the compression of the jacket, while those of the hoops are permanently increased. Their contractile force is not enough to compress the jacket into smaller space, for this itself is pushed outward by the powerful reacting force of the compressed tube within. The hoops, therefore, serve to reenforce the jacket by their own tendency to contract. Having been put on in an expanded condition and prevented from recovering their normal dimensions, they continue in a permanent condition of tension.

Steel is the only metal that combines elasticity and tenacity in such high degree as to warrant its advantageous use in the manner just described. For gun metal the material should be manganese steel, made from the purest wrought iron attainable, with a very small percentage of carbon, indeed not more than one per cent. This should be so uniformly diffused as to secure the closest possible approach to absolute homogeneity. The elastic limit should not be reached for any stress under 50,000 pounds per square inch, nor should the ultimate strength be less than 100,000 pounds per square inch. Such steel withstands a high temperature without softening, resists erosion well, and permits but little set under shock beyond the elastic limit. The preparation of such metal is a severe test of skill for the metallurgist. The most conspicuously successful gunmaker in the world, Friedrich Krupp, of Essen, Germany, uses crucible steel exclusively for this purpose. This firm, founded by the grandfather of its present head, has made a specialty of steel and its applications in manufacture during the last eighty-five years. Bessemer, open-hearth, and crucible steel plants are all included in its outfit. Much the most expensive product among these is crucible steel. In its manufacture the skill of the fathers has been given to their sons; and doubtless grandsons and great-grandsons will continue to apply the secrets of their special art in the same place. With the staid conservatism of the laboring classes in Germany the development of heredity in artisan skill is not uncommon. In America so restless, impatient and ambitious are our laborers that the son rarely ever lives in the same place or works at the same occupation with his father.

So highly developed is the crucible steel industry at Essen that ingots of this metal weighing each as much as seventy tons have been repeatedly cast, and with these the forgings are made from which Krupp constructs his monster guns. Many visitors at the Columbian Exposition looked with astonishment at the great gun weighing one hundred and twenty tons, which was only one of several of the same size due to this firm. In other parts of the world crucible steel is abundantly produced for cutlery, and for small articles generally where the finest quality is demanded. But nowhere else than in Essen has the highest grade of crucible steel been made thus far in quantities sufficient for the largest forgings. In England, in France, and in America gun metal is at present made by the open hearth process. While this product is greatly superior to Bessemer steel the method of production is such as to forbid the attainment of such nearly perfect homogeneity as can be secured by the more expensive crucible method.

The open hearth steel used for our largest American guns is produced for the most part, if not entirely, at Midvale and Bethlehem in Pennsylvania. Before actual use test specimens are required to manifest tensile strengths from 75,000 to 125,000 pounds, and elastic limits from 40,000 to 70,000 pounds, per square inch, according to the calibre of the gun and the special parts of this for which the metal is intended. For tubes, jackets and hoops the maximum tensile strength demanded is 93,000, and the maximum elastic limit, 53,000 pounds per square inch.

Up to ten years ago American fortifications were for the most part supplied with nothing superior to the Rodman cast-iron smooth-bore columbiad and Parrott rifle, the latter being made of cast iron but reenforced with a wrought-iron hoop. During this interval Congress has appropriated about $20,000,000 for the modernizing of our navy and our seacoast defences. For the latter the largest built up steel rifle thus far constructed has been one of 12-inch caliber, 40 calibers in length, weighing 57 tons. This is not yet ready for use. A 16-inch rifle, very nearly as massive as the great Krupp gun, has been ordered and will probably be finished within the next two or three years. A number of 12-inch 34-caliber guns have been finished, tested and mounted.

In assembling the parts of the large 40-caliber gun, at the Watervliet Arsenal gun shop a few months ago, an unfortunate mishap occurred. After the tube had been reenforced near its forward end with a series of hoops it was prepared for the more formidable work of shrinking on the large jacket. It was stood up vertically upon the breech end, and the heated jacket was let down into position. The heating proved to be insufficient to secure all the expansion needed, and as a result the cooling jacket gripped the tube before quite reaching the final position intended. An interesting problem was now presented, that of separating the tube and jacket after they had become thoroughly cool, and completing the process which had been so unexpectedly interrupted.

After due consideration the plan which seemed most promising of success was to introduce the cold gun, with breech downward, as suddenly as possible into a furnace, protecting the exposed part of the tube below the jacket from the heat by enclosing it in a bag of asbestos cloth through which a strong blast of cold air should be propelled. The jacket being thus heated first, while the tube within was comparatively cool, it was hoped that expansion enough might be attained to ensure separation. In order to keep the greatest possible difference of temperature between jacket and tube, a flow of cold water through this was set up immediately after its emplacement within the furnace. The breech had been closed water-tight. A pipe occupying the axis of the bore was coupled at the top with hose from an elevated tank full of ice water, and this was carried thus to the bottom. After it had filled the tube it was carried off by an overflow pipe. The jacket, or certainly its lower part, was quickly raised to a temperature estimated to be about 1100° F. The temperature gradients from outer to inner surface would obviously be curves, at first sharply concave upward, but gradually approaching straight lines as the heating continued. It was hoped that, before the equilibrium expressed by the straightening of these gradients should set in, the jacket would become expanded enough to settle down by its own weight into the desired final position.

But this hope was doomed to disappointment. The external heating and internal cooling was continued nearly eight hours on January 27th, the flow of ice water being kept quite uniformly forty cubic feet per minute. Its temperature was raised from 34° to 40° F. in transit, with but little variation after the first two hours. The water was then discontinued and the supply of heat kept up through the night. On the following day the experiment was renewed, but varied by trying the effect of sudden cooling from within. On admitting the supply of ice water there was naturally much steam produced at first, but within fifteen minutes the temperature difference between inflow and outflow fell to 36°. At the end of two hours it had fallen to 9°, and during the remaining six hours it continued quite uniformly about 8°. This difference was in excess of that of the previous day, as it had been found necessary to reduce the rate of water supply. This experiment being unsuccessful, the gun was removed from the furnace and allowed to cool.

The furnace had been originally constructed of such dimensions as to permit of heating the longest jacket, but not an entire gun. Since the breech and unjacketed part of the gun under present conditions had to occupy space within the furnace, an extension of this at the top had to be improvised to enclose the upper part of the jacket. Soon after the experiment began it was observed that the heating was by no means uniform, and by no supplementary efforts could uniformity be secured.

Measurement upon the cooled gun revealed the fact that the jacket had changed its position nearly half an inch, but this was only one-twentieth of the shifting needed. It was not surprising also to find that the whole assemblage was perceptibly warped.

The method, applied on so large a scale and under conditions which had precluded the possibility of uniform heating, had failed. But theoretically it seemed unassailable. It was decided to test it again under more favorable conditions. The construction of a new large gun for this test would obviously involve an unwarranted expense; for the cost of a completed 12-inch gun of this type is not much less than $60,000. A short 'dummy' gun was therefore constructed, of 8-inch bore and 3 feet in length. This was provided with hoop and jacket, which were shrunk on tightly into position, a special furnace being built for the purpose of the experiment. The piece was inserted into the hot furnace, the water turned on to the interior, and at the end of 3 minutes the jacket suddenly dropped 4 inches. It continued then creeping downward at a moderately uniform rate, and dropped entirely off from the tube at the end of 42 min. 30 sec. The temperature of the inflowing water was 58° F. and that of the outflow 67° F., no attempt being made to secure artificial cooling by use of ice.

The success of this experiment, which was made on the 31st of March, caused the decision to make another trial with the large gun. This was started on May 11th, extra precautions being taken to secure uniformity of heating. An auxiliary grate had been prepared for the furnace extension above, and with a view to securing the highest heat as close to the jacket as possible baskets of heavy wire netting were filled with charcoal, inserted in the furnace and brought close up around the gun after its insertion. At the same time water at a temperature of 68° F. was turned on, as it had been found impossible to secure a sufficiently rapid supply of ice. The elevation of temperature in transit was at first 5° F., and this rose in time to 11° F. At the end of 22 h. 30 min. the jacket having remained immovable, the fire was drawn from the furnace, while the water supply was continued 15 hours longer, until the gun was thoroughly cooled.

It is but due to say that, although this experiment has proved an instructive failure, the gun is not lost to the ordnance department of the government. The unjacketed part of the breech will be cut off, and the final outcome will be simply a gun somewhat shorter than provided for in the original specifications.

But the question may be asked, will this gun be so reliable as it would have been without passing through so many fiery ordeals? After each furnace trial it was carried back to the shop and the degree of warp ascertained by measurement. Its exact condition between the locking of the jacket and the first attempt to move this is not known. The present warp of the axis between the breech end and the support near the muzzle end of jacket is 0.1855 inch, and from here to the muzzle end of the gun, 0.1561 inch in the opposite direction but in the same plane. Between the first and second attempts at removal there was no noticeable variation of result. The interior diameter of the bore within the jacket has been decreased as might be expected; but this decrease is quite irregular, reaching a maximum of 0.064 inch about two feet from the upper, or muzzle, end of the jacket, while at the other end of the jacket it is 0.017 inch. The diminution of bore extends to the extremity of the breech beyond the region of compression due to the jacket.

The only hypothesis upon which these irregularities can be even tentatively explained is lack of homogeneity in open-hearth steel. The better the steel the more nearly perfectly does it recover from strain after the removal of stress. Irregularity in heating during the first attempt would have produced warping in any metal whatever. Perfectly homogeneous steel would have recovered completely when the temperature became uniform, but any lack of homogeneity implies a permanent set. Assuming such lack, the larger the scale of experiment the more difficult it is to secure uniformity of temperature. The steel may satisfy completely the demands of preliminary test experiments on elastic limit and tensile strength, yet it may fail to meet the requirements of accurate fitting and complete recovery after wide variation of temperature. Krupp, with his admirably homogeneous but high priced crucible steel, has already been successful in assembling the parts of guns twice as massive as the recent subject of experiment at Watervliet. It remains to be seen whether equal success will be possible by the use of open-hearth steel in connection with the 16-inch gun yet to be constructed. In the light of recent difficulties the approaching work will be watched with interest.

The publication of these observations in the present form would not have been possible but for the friendly courtesy of Major Isaac Arnold, Jr., the commandant of the Watervliet Arsenal, who has granted me the utmost freedom of access to the gun shops and who kindly invited my interest and cooperation in the attempt to solve the problem of the unmanageable jacket.

W. LeConte Stevens.
Rensselaer Polytechnic Institute, Troy, N. Y.

ONTOGENIC AND PHYLOGENIC VARIATION.

In an article published in 1894, in Merckel u. Bonnet's *Ergebnisse der Anatomie u. Entwicklungsgeschichte*, the writer proposed the distinction which forms the title of this article. This subject was further elaborated in three papers before the Biological Section of the New York Academy, in March, April and May, 1896. As Prof. C. Lloyd Morgan and Prof. J. Mark Baldwin have quite independently reached somewhat similar conclusions, it seems of interest to publish the second and third papers, above referred to, in their original form as they were mailed to the Secretary of the Academy. These papers, by an unfortunate oversight, were never sent to the printers. The first paper was published in the *Transactions* and abstracted in Science.

The title of the paper of April 13th was 'A Mode of Evolution requiring neither Natural Selection nor the Inheritance of Acquired Characters.' It was discussed by Prof. Baldwin and Prof. Cattell. "I present a continuation of the subject of Ontogenic and Phylogenic Variation, discussed at the last meeting of the Biological Section. The latest papers upon selection are significant because they show that the hypothesis of evolution purely by the selection of fortuitous variations is losing ground. Definite or determinate variation is now admitted by nearly all writers except Wallace. If we assume the transmission of acquired characters the explanation of definite variation becomes simple enough, but in this contribution I propose a view of the facts which does not assume the transmission of acquired characters nor the immediate action of natural selection. It is thus a phase of evolution without either natural selection or the transmission of acquired characters. I have no new facts to bring forward, but wish to present certain well-known facts in a new aspect which has a very direct bearing upon the theories of Spencer and Cope, as well as of Weismann. The recent papers of James Mark Baldwin contain something very similar under the term Social Heredity. It involves what the botanist, George Henslow, has been calling 'Self-adaptation.' In personal conversation Lloyd Morgan has recently expressed to me very similar views.*

The matter rests upon well-known biological principles which may be expressed in the following formula:

$$\left(\begin{array}{c}\text{Adult Or-}\\\text{ganism.}\end{array}\right)=\left(\begin{array}{c}\text{Congenital, Con-}\\\text{stitutional or}\\\text{Stirp.}\end{array}\right)\times\left(\begin{array}{c}\text{Conditions of Envi-}\\\text{ronment through-}\\\text{out whole Period}\\\text{of Development.}\end{array}\right)$$

Every adult organism, therefore, has a single set of characters, but each of these characters has a double origin due to the adjustments and readjustments of its internal and external relations in course of growth. To sharply distinguish these two origins, I some time ago proposed the terms phylogenic and ontogenic, as in the following table:

VARIATIONS.

ONTOGENIC.	PHYLOGENIC.
Arising in course of development from chemico-physical, motor, psychical (social and imitative) causes.	Variations within the phylum, part of which were originally ontogenic.

Thus the really superficial or transient differences between organisms are upon the ontogenic side. The fundamental differences are phylogenic. The importance of the discrimination between these origins becomes apparent only when we realize what profound modification occurs in the course of ontogeny and how very generally these modifications are confused with those which really belong within the phylum.

When we fully grasp the possibilities of ontogenic variation it appears that ontogenic evolution must be a leading, progressive, guiding process, and is so far in advance of phylogenic evolution that in many cases it gives rise to characters which we use to separate species and even genera. There is thus an individual evolution which progresses under the following well-known laws: (1) When the environment changes, the adult individual changes, without necessarily involving any alteration of the stirp. (2) These ontogenic changes may be progressive or retrogressive, and reach a term which we would give specific or generic rank, as in the transformation of *Artemia* or *Saturnia*. (3) A limited, if not complete, *internal adaptation* must occur, because the growth of every part of the organism depends upon the nutritive materials supplied to it as well as upon the stimuli which the environment arouses. As shown in experimental embryology, a series of readjustments of an adaptive character always occur if the stimulus is not too profound. (4) As to the external adaptation of the organism to its surroundings in the struggle for existence, it is apparent that chemical and physical changes do not *necessarily* fit the organism. (5) Yet such purely physical changes may be followed by associated adaptations. Thus an animal shut off from the action of light exhibits ontogenic degeneration of pigment and of vision, and, in general, of all organs which represent a response to light. This degeneration is compensated by an increased sensitiveness of the other sense organs of smell, touch and hearing. (6) The most definite adaptations arise as a result of new habits, motions, etc.

This principle of the ontogenic adaptive influence of habit is so well known, it is surprising that more allowance for

*See SCIENCE, Nov. 20th.

it has not been made in the study of adult characteristics. In the anatomy of the different races of man, for example, it is demonstrated that many features are fundamental race characters, while others are merely the expression of certain habits, such as modes of walking, climbing, squatting, etc. The studies of Lane upon the anatomy of laboring men of different trades prove that entirely new structures, such as articulations and facets, may be developed. This has an important bearing upon the scope of the 'predisposition' principle. New facets do not arise because there is a predisposition at a certain point to form a facet, but because the local tissue reactions at that point under stimulus result in a facet.

Such ontogenic variations may extend over an enormously long period of time, and it is very obvious that they anticipate the future course of evolution, so far, at least, as all parts of the body are concerned which are directly modified by stimuli. Thus, whether these ontogenic variations are inherited or not, they predetermine the course of evolution. They set a groove, as it were, along which evolution must take its course.

These variations, further, are of so perfect a character that they have been by nearly all observers misinterpreted. They have been wrongly considered as representing phylogenic evolution, but such evolution is a matter of constitutional or stirp variation, as shown by the well-known examples of the pigmentation of the lower side of the flounder and of the entire body of the colorless Proteus when exposed to light. If these animals are contrasted with an albino type, such as the albino breed of Amblystoma, the real difference becomes apparent.

Thus the case appears to be established that ontogenic evolution parallels, and in many parts of the body anticipates, phylogenic evolution by enormously long periods of time. We have in these facts a partial explanation, at least, of *determinate variation*. The straight lines which certain characters follow are simply guided by ontogeny. In many structures the inherent adaptive power of the organism is so great that it can conform sufficiently to its new environment without any change in the stirp.

Two questions remain: (1) whether such evolution is accumulative; (2) what relation it bears to phylogenic evolution. These will be discussed at the next meeting of the Section."

This meeting was held upon May 8th.

"Continuing the subject discussed at the last two meetings, it has been questioned whether this ontogenic evolution can properly be considered evolution at all. It appears, so far as all those characters are concerned which are adaptively plastic, that the first stages of their true evolution must be ontogenic. Subsequently, the same changes become phylogenic, but the passage from one to the other is so gradual and insensible that they must all be considered part of the same process. Ontogenic evolution, then, represents the extreme changes in organisms possible during individual development; changes in color, hair texture, plumage, scales, and the greater or less ossification of the skeleton; in the forms of the joints and articular surfaces; in the development of the nervous centers and the muscular system; in short, every change which does not involve a change of stirp.

The chief question remains whether such evolution is accumulative. It is obviously accumulative if the change of environment becomes more intense and so far as new habits in successive generations become accumulative by practice and imitation. In the case of plants exposed through several generations to the same environment there is observed a marked loss of *stability*; thus the ontogenic variations are more marked in each successive generation.

But certainly the crucial point is what

relation do these ontogenic changes bear to the stirp. It is demonstrated that characters of this class finally become hereditary, because we ultimately find them in the organism at a stage preceding either exposure to external conditions, use or exercise. It would appear extremely difficult to determine whether this inheritance is due to Lamarck's principle or to the gradual *selection* of congenital predispositions. In the latter case we have a valid explanation of orthogenic, determinate or definite variation, so far as a very large class of characters are concerned, for it is obvious that ontogenic evolution works on all individuals practically alike. It gives a definite trend to evolution and it does away with the selection of fortuitous variations. This, however, is not a complete explanation of definite variation, because we find the same definite principle operating in the evolution of the teeth, which are not, so far as we know, subject to ontogenic variation. The only explanation which we can offer of definite variation in the teeth is that all animals which arise from a similar stem form seem to have their new characters constitutionally predetermined. Thus each new character will arise at a certain point, and in nearly the same order in all animals which are derived from a similar stem. Thus we may say that adaptive evolution is not confined to organs in which individual reaction or ontogenic evolution is operative."*

HENRY F. OSBORN.

COLUMBIA UNIVERSITY.

*Prof. Morgan has proposed the term 'Modification' for the change here defined as 'Ontogenetic Variation.' The term 'Phylogenic Variation' was first used by Nägeli; it is equivalent to the term 'Mutation' as employed by Wagner and Scott. Prof. Baldwin, in April, 1895, proposed the term 'Organic Selection' for the processes of ontogenic evolution substantially similar to those here described. As pointed out by Prof. Morgan in last week's SCIENCE, this principle was also clearly stated in Weismann's Romanes' Lecture. These matters will be discussed in a later number of SCIENCE.

CURRENT NOTES ON ANTHROPOLOGY.

THE PARIS SCHOOL OF ANTHROPOLOGY.

THE program of this school for 1896–7 has been issued. About two hours a day are devoted to lectures. They embrace the following topics:

1. Prehistoric Anthropology: Prof. A. de Mortillet on prehistoric times.
2. Pathological Anthropology: Prof. Capitan on disorders of nutrition in their influence on races, etc.
3. Ethnography and Linguistics: Prof. Lefèvre on the Middle Ages and times.
4. Ethnology: Prof. Hervé on the accessary ethnic elements of France.
5. Biological Anthropology: Prof. Laborde on the senses of sight and hearing in race studies.
6. Zoological Anthropology: Prof. Mahoudeau on heredity and transformation in relation to man.
7. Geographical Anthropology: Prof. Schrader on the relations of earth to man in Asia.
8. Physiological Anthropology: Prof. Manouvrier on the elements of character.
9. Sociology: Prof. Letourneau on certain features in the history of civilization.
10. Comparative Ethnography: Prof. A. de Mortillet on the worship of the dead and burial ceremonies among primitive peoples.

This program will give a good idea of the scope of instruction in this, the oldest school of anthropology. It is now in the twenty-first year of its existence.

AN ARCHÆOLOGICAL MAP OF OHIO.

THE Ohio State Archæological and Historical Society for the past three years has been hard at work upon a large map of the State, which is to show all the prehistoric monuments and sites, according to town-ships. The work is only about one-third complete and up to the first of November there were 2,100 marks upon the map, representing between 5,500 and 5,600 remains.

Some interesting facts have been brought to light; that the mounds, earthworks, village sites, etc., generally follow the stream, that, in the Sciota valley there are very few stone monuments, but that, in the Muskingum valley, along the Ohio river and in Brush Creek valley (Adams county), stone monuments predominate over those of earth. Seven counties in the State show a total of 918 monuments. Those in the northern and eastern portion average about five or six mounds and village sites each. It does not appear from this that there is a county in the State in which there are less than 15 or 20 ancient remains, but the observations of these counties are only partially complete. Most of the marks were secured by personal visits, the State having been quite thoroughly traveled by students of the Ohio State University and by the Curator, Mr. Moorehead, on bicycles. Several hundred mounds were secured from the report of the Bureau of Ethnology and the Smithsonian Institution.

The number of recorded monuments will reach probably eight thousand. This is a praiseworthy undertaking and it is to be hoped will be carried to completion.

D. G. Brinton.

University of Pennsylvania.

ASTRONOMICAL NOTES.

In our issue of October 23d we called attention to Dr. See's announcement of his rediscovery of the companion of Sirius at the Lowell Observatory. Observations of this star were subsequently made at the Lick Observatory. The observations of both observatories disagreed with the published ephemeris of Dr. Auwers, and in our issue of November 20th we called attention to this fact. From a recent letter of Prof. Holden we learn that the Lick observations are certainly correct. This would throw upon the Lowell observations an error of 31°, and upon the ephemeris of Dr. Auwers an error of about 13°. No doubt observations with some of the other large telescopes of this country and Europe will soon be published, and thus any doubts as to the correction required by Dr. Auwers's ephemeris will be set at rest.

Prof. Schaeberle, at the Lick Observatory, has also examined Procyon, with the result of finding that this star also has a visible companion. It was possible to make observations in both positions of the telescope, the means obtained being 319° for the position angle and 4″59 for the distance. The magnitude of the companion was estimated as 13, and the seeing was unusually fine.

H. J.

NOTES ON INORGANIC CHEMISTRY.

The discovery of a supposed new element, Lucium, in monazite sand has already been reported in these columns. The discoverer Barrière of Paris has now patented the element! The specifications cover the use of the element alone or in mixtures for incandescent gas lighting, the progress of obtaining the element and the element itself.

The rotation of polarized light in crystals has heretofore been studied exclusively in natural crystals or in such as have been cut in plates. In the last Berichte, Landolt describes an investigation carried out on finely powdered crystals, suspended in a liquid medium of the same refractive power. The object was to see if the rotation remained unchanged, or disappeared when the particles became sufficiently minute. The crystals used were sodium chlorate and the liquid in which they were suspended was a mixture of alcohol and carbon bisulfid. Experiments were made with a powder in which the particles averaged

0.03 mm. in diameter, and another of 0.008 mm. The rotation was found to be unchanged, and the conclusion reached is that particles of sodium chlorate down to 0.004 mm. in diameter possess completely the crystalline structure which is necessary for circular polarization. In solution, however, sodium chlorate is perfectly inactive.

THE late determinations of the atomic weight of tungsten by E. F. Smith have given a number close to 184.9. More recently (J. Prakt. Chem. 53: 288) Schneider has repeated his earlier work which gave the number 184.12 and now finds the atomic weight to be 184.01. Schneider proved his tungsten to be free from molybdenum, but he used the same material as in his former determinations. He attributes the larger figure of Smith and others to the use of too small quantities, thereby involving relatively large errors.

LOBRY DE BRUYN has succeeded in completely dehydrating hydrazin-hydrate by means of barium oxid, a method unsuccessfully used by Curtius, and in the Rev. Trav. Chim. Pays–Bas 15 : 174 describes the properties of the free hydrazin, N_2H_4. Hydrazin is a solid, melting at 1.4°C and boiling at 113.5°C at 761.5 mm. It is soluble in alcohols, but only slightly so in other organic solvents. It dissolves many inorganic salts as sodium and potassium chlorids and nitrates. It is a stronger base than ammonia, liberating the latter from its salts. It reacts energetically with chlorin, bromin, iodin, sulfur and phosphorus, and oxidizes slowly in the air. It is noteworthy that the boiling point of free hydrazin, 113°, is very close to that of hydrazin-hydrate, 119°.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

INVITATIONS have been sent for the opening of the new halls of ethnology and vertebrate paleontology of the American Museum of Natural History, New York. The reception will be held from two to three o'clock on November 30th.

WE learn from *Nature* that the Royal Society's medals have this year been adjudicated by the President and Council as follows: The Copley medal to Prof. Carl Gegenbaur, For.Mem.R.S., for his researches in comparative anatomy, and especially in the history of the vertebrate skeleton; the Rumford medal to Prof. Philipp Lenard, and also to Prof. Wilhelm Conrad Röntgen, for their investigation of the phenomena produced outside a highly exhausted vacuum tube through which electrical discharge is taking place; a Royal medal to Sir Archibald Geikie, F.R.S., on account of the great value and importance of his many original contributions to geology; a Royal medal to Prof. Charles Vernon Boys, F.R.S., for his invention of quartz fibres and investigation of their properties, his improvement of the radiomicrometer and investigations with it, for developments in the art of instantaneous photography, and for his determination of the value of the constant of attraction; The Davy medal to Prof. Henri Moissan (of Paris), for the isolation of fluorine and the use of the electric furnace in the preparation of refractory metals; the Darwin medal to Prof. Giovanbattista Grassi (of Rome), for his most important discoveries, especially on matters directly related to Darwin's speculations. Her Majesty has signified her approval of the award of the Royal medals.

THE Secretary of the Permanent Committee of the International Zoological Congress announces the subjects for the two prizes, to be awarded at the next Congress. These are: 'A study of the ruminants of Central Asia, from the points of view of zoology and geography' and 'An anatomical and zoological monograph on some groups of marine invertebrates.' The papers, which may be in manuscript or printed since September, 1895, must be presented before May 1, 1898. They must be written in French, which seems to be contrary to the spirit of an international congress. It is in any case doubtful whether many men of science will care to compete for such prizes. We are somewhat vaguely informed that 'Les prix consisteront, au choix des lauréats, soit en une somme d'argent, soit en une médaille de valeur égale.' The committee of award consists of MM. A. Milne-Edwards (Paris), President; R. Blanchard (Paris), Secretary; Sir Wm. Flower (London), F. A. Jentink (Leyden), R. B. Sharpe (London), Th. Studer (Berne) and N. Zograf (Moscow).

The German Fisheries' Association has offered, according to *Nature*, a prize of 600 M. for the best essay on the history of development and the vital conditions of *Leptomitus lacteus*, with especial reference to its appearance and disappearance in impure water. The essays are to be sent in to Prof. Weigelt, 90–91 Zimmerstrasse, Berlin, S. W., by May 1, 1897.

At a meeting of the Royal College of Physicians, on November 6th, it was decided that the sum of £1,000, given by Captain E. Wilmot Williams, in memory of Dr. Bisset Hawkins, should be devoted to the establishment of a gold medal, to be awarded by the College every three years to some duly qualified medical practitioner who is a British subject, and who has, during the preceding ten years, done such work in advancing sanitary science, or in promoting public health, as in the opinion of the College deserves special recognition.

According to *Garden and Forest* an agricultural experiment station has been established at Usambara, in German East Africa, for the purpose of investigating the agricultural character of that region and discovering its adaptability to various crops. Both native and introduced tropical plants are now under test at different altitudes to decide which ones are best suited to cultivation, and when these points have been determined both the plants and seeds will be supplied in commercial quantities to settlers.

It is reported in the daily papers that Dr. Lauterbach, Dr. Keruting and Herr Tappenbeck, who conducted an exploring expedition into the interior of New Guinea, returned to the coast at the end of October. The expedition discovered, at the foot of the great Bismarck Mountain, a navigable stream of considerable size, which flows through a fruitful, thickly populated plain well adapted for cultivation. This plain was explored for a distance of two hundred miles.

News has also been received from two scientific expeditions now in Central Asia, under the auspices of the Russian Imperial Geographical Society. M. Clementz has been exploring Mongolia and the Hangai range of mountains. Dr. Swen Heding has been exploring the neighborhood of Khotan, where he has discovered the ruins of two ancient towns.

The courses of lectures annually given by Columbia University, in cooperation with the American Museum of Natural History, have been arranged for the present season. There will be four courses as follows: 'Mountain Ranges of Western North America,' by Prof. J. F. Kemp, Dr. C. Willard Hays, Mr. Bailey Willis and Mr. H. M. Wilson. 'Anthropology and Ethnology,' by Dr. Daniel G. Brinton, Dr. Otis T. Mason, Dr. Franz Boas, Dr. Livingston Farrand and Dr. William Z. Ripley. 'Alcohol and Alcoholic Beverages,' by Mr. C. E. Pellew. 'Botanical Studies,' by Prof. Lucien M. Underwood and Prof. Smith Ely Jeliffe. The lectures are given at the Museum of Natural History on Saturday evenings, beginning on December 6th.

The Berlin Academy of Sciences has awarded its gold medal to Dr. Auwers.

The Germam Electro-Chemical Society has awarded its annual prizes in recognition of contributions to the advancement of electro-chemistry to Prof. Hans Jahn, of Berlin, and Prof. Max LeBlanc, of Frankfort-on-Main.

Dr. Edward S. Holden, Director of the Lick Observatory, has received the decoration of Knight of the Royal Order of the Dannebrog of Denmark. This ancient order was founded in A. D. 1219, as a mark of military distinction, but is also conferred, as in the present instance, for services to science.

Sir Joseph Lister and Prof. Michael Foster have been elected honorary members of the Asiatic Society of Bengal, in the place of Huxley and Pasteur.

It is stated in *Natural Science* that Mr. William Whitaker retired from the Geological Survey of Great Britain on October 22d. Mr. Whitaker, who is senior officer, was appointed on April 1, 1857, and has therefore held service for nearly forty years.

PROF. MAX VON PETTENKOFER has consented to fill the chair at the Academy of Science of Bavaria and to act as Keeper of the State Scientific Collection for a further term of three years.

Nature, quoting the *Kew Bulletin*, announces that the government of Zanzibar have decided to appoint a Director, and have selected Mr. Robert N. Lyne for the post. The object of the government in creating the post is to improve, where possible, the methods under which the agriculture of the country is now carried on, and to endeavor by experiment to discover some new product that may to a certain extent take the place of cloves. The government desire that the work so admirably begun by Sir John Kirk when he was Consul-General there, and since interrupted, may be continued.

SIR BENJAMIN WARD RICHARDSON, M.D., F.R.S., died on November 21st, aged sixty-eight years. He had made important investigations on the effects of anæsthetics, having discovered the use of ether spray for the abolition of pain in local surgical operations. He was the author of many articles and books treating especially of the subjects of public health and social reform.

THE death is announced of Admiral Sir George Henry Richards. He had conducted important nautical surveys and was in command of one of the vessels of the Franklin research expedition. He was a member of a number of learned societies, including the Paris Academy of Science.

WE regret to announce the deaths of Dr. Möller, professor of astronomy at Lund, on October 26th, at the age of 66 years; of Dr. Ernst Wenzel, associate professor of anatomy at Leipzig, on October 25th, at the age of 56 years; and of Dr. Eugen Bauman, professor of physiological chemistry, in the University at Freiburg in Breisgau, on November 3d, at the age of 50 years.

AT midnight on November 15th the electric power generated at Niagara Falls was transmitted to Buffalo where it will be used to operate the trolley cars of the street railway.

PROF. E. MACH has prepared an important work entitled *Die Principien der Wärmelehre*, treated from a historical and critical point of view. It is published by J. E. Barth, of Leipzig, and includes 105 figures and six portraits. The same publishers announce the second issue of the *Jahrbuch der organische Chemie* for the year 1894, edited by Dr. Gaetano Minunni.

A MONTHLY *Hypnotic Magazine* has begun publication in Chicago, under the editorship of Mr. Sidney Flower. The journal will, we fear, find it somewhat difficult to maintain a satisfactory scientific standard.

The Illine, the weekly paper published at the University of Illinois, contains in the issue of November 6th an account of the fresh water biological station of the University, by Mr. C. A. Kofoid. The biological station at Havana is said to be unique in having for its basis of work the fauna and flora of a river, while there are numerous lakes and marshes in the neighborhood. The station was opened in the spring of 1894, and this year a floating laboratory was launched. This is 60x20 feet and contains three rooms, a small office and library, a general laboratory provided with aquaria, etc., and a cabin for the attendant. The boat is said to be free from tremor. In addition to the director, Professor Forbes, and other teachers, there were seventeen students in attendance during the past summer.

IT was provided by an Act of Congress passed early last year that the Superintendent of Documents should, at the close of each regular session of Congress, prepare and publish a comprehensive index of public documents. Mr. F. A. Crandall has, in spite of the short time and other difficulties, prepared the catalogue of the public documents of the fifty-third Congress and of all departments of the government for the period from March 4, 1893, to June 30, 1895, it being thus continuous with *The Ames Comprehensive Index*. The catalogue, which contains 638 large pages, will be of value to men of science, as perhaps one-half of the entries are on scientific subjects. Indeed, it is of much interest to note how largely the publications of the government are taken up with scientific subjects and the great importance of a majority of these. An alphabetical catalogue such as this will add much to the usefulness of the publications and to convenience in finding them.

We learn from *Nature* that arrangements are being made to commemorate the sixtieth year of the reign of Queen Victoria by an exhibition at the Crystal Palace, to be opened on May 24, 1897. It is proposed to illustrate by models and practical examples the famous inventions in arts and industries during the past sixty years, and also the progress of other sides of national development. As a sort of prologue to this exhibition, a series of popular lectures, dealing with the advancements in science made during Her Majesty's reign, will be delivered during March and April next.

UNIVERSITY AND EDUCATIONAL NEWS.

The Pope has appointed the Rev. Dr. Thomas J. Conaty, rector of the Church of the Sacred Heart, Worcester, Mass., to succeed Bishop John J. Keane as rector of the Catholic University at Washington. Dr. Conaty is a native of Ireland and is supposed to be more conservative than his predecessor.

Prof. William M. Sloane, of Princeton University, has been elected to the Seth Low professorship of American history in Columbia University.

Haverford College will soon come into possession of property valued at nearly $500,000, bequeathed by Jacob P. Jones in 1885, subject to a life estate for his wife, who died a few days ago.

Colonel C. S. Venable, for thirty-one years professor of mathematics in the University of Virginia, has retired.

According to the *Academische Rundschau*, the additional yearly appropriations granted to the French universities under the new laws, to take effect January 1, 1898, will be approximately as follows: Lyons, 130,000 fr.; Bordeaux, 100,000 fr.; Toulouse, 80,000 fr. The remaining universities will receive sums varying from 20,000 to 50,000 frs. The amount of the appropriation to the University of Paris has not yet been decided, but it is expected that the five Paris Faculties, with their large number of students, will receive four or five times the amount appropriated to the Faculty at Lyons.

The following foreign appointments are announced: Professor Lenard, director of the physical laboratory, Polytechnic Institute, at Aachen, has been called to the University of Heidelberg; Dr. Czapek, Privatdocent at the University at Vienna, has been made associate professor of botany in the Polytechnic Institute in Prague; Dr. Seeliger, Privatdocent in zoology at Berlin, and Dr. Karl Mez, Privatdocent in botany at Breslau, have been promoted to professorships.

DISCUSSION AND CORRESPONDENCE.

AN OPTICAL ILLUSION.

To the Editor of Science: I reproduce, in one of the accompanying diagrams (A), the arrangement used in a research published in the *Psychological Review* (II., May, 1895, p. 244), and reprinted in the *Princeton Contributions to Psychology* (No. 2, Sept., 1895), the result of which was to show that the judgment, *i. e.*, of the midpoint between two such squares as those of Fig. A, is subject to illusion. The actual midpoint, marked by the short line on the line of connection between the squares, is regularly judged to be too far toward the larger square, the real midpoint being judged farther toward the smaller. I should like to gather further results by the use of the Figures A and B, and your readers may be willing to assist as follows:

Ask people of both sexes, but recording the difference of sex, the following questions strictly in the order named, first of Fig. A. They should be entirely ignorant of the experiment and its results.

Question 1. Holding the figure before the eyes with *the bottom of the page down*, is the line connecting the squares bisected by the short line or not, and if not, is the real midpoint further to the right (R) or to the left (L)?

Question 2. Holding the page with *the bottom of it turned to the right hand*, ask whether the midpoint is marked by the line or whether it is farther up (U) or farther down (D).

Question 3. Holding the figure with *the bottom of the page upwards*, ask as in question 1.

Question 4. Holding the figure with *the bottom of the page toward the left hand*, ask as in question 2.

Then taking figure B., ask *the same questions in the same order*, being careful to have the person still altogether uninstructed as to the results of the first series and also to connect the

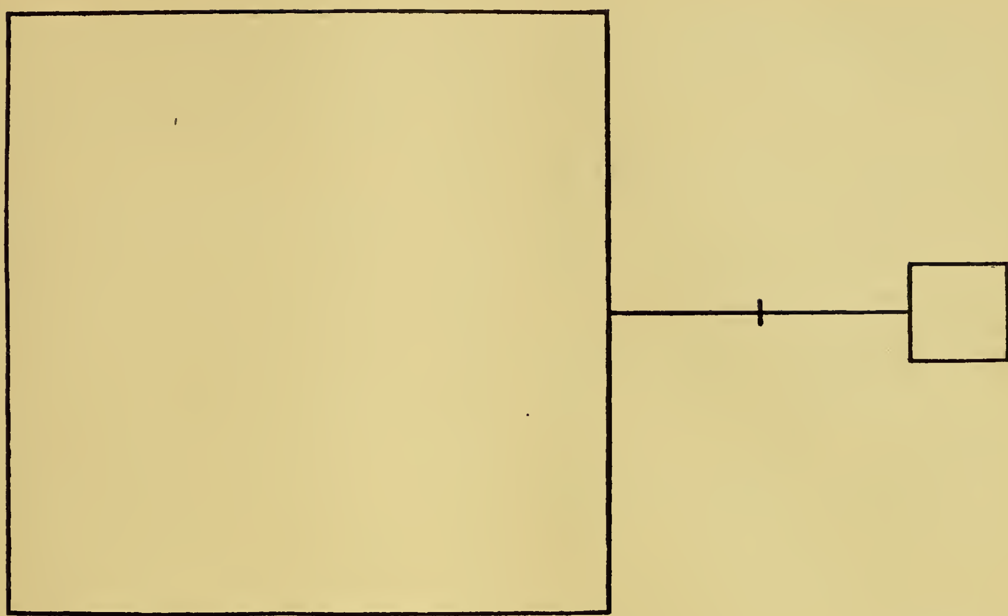

Fig. A.

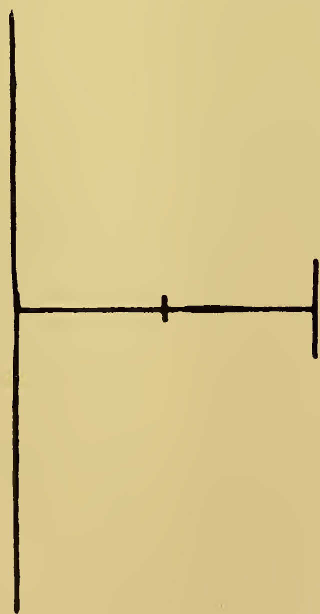

Fig. B.

two series, carefully distinguished, with the same person by name or initials.

When using one figure, *the other should be covered.*

The results, whether from one person or from many, may be sent to the undersigned, who will receive them with thanks. Results from those who know what the illusion is and what to expect need not be sent, *except in cases of persons who do not get the illusion at all, or who only get it for one of the figures.*

Any known defects of eye-sight should be reported; also indications of tastes or pursuits, as of architects, artists, etc., likely to modify the results.

I should also be glad to be referred to any literature which seems to touch upon this illusion. J. Mark Baldwin.

Princeton, N. J., October 7, 1896.

LE CONTE'S ELEMENTS OF GEOLOGY.

To the Editor of Science: I read with great interest Mr. Gilbert's review of Le Conte's Elements of Geology, in Science, No. 95. Having used the book in the classroom I can heartily approve every word of commendation in that review. It is therefore not in the spirit of captious criticism that I venture to point out two or three weaknesses in the book which experience brought to my attention. I do this because Le Conte's Elements is 'a Textbook,' and, if Prof. Simonds' calculations* be correct, only a portion of the teachers of geology are investigators who would detect from their own researches either the strong points or the weak ones of the book. It may be urged that geographical considerations have much weight in my case; yet no more weight with me than would naturally be felt with any other teacher of geology between Lake Huron and the Rocky Mountains north of the 40th parallel.

I desire to call attention only to the following points:

1. Artesian wells are discussed within the limits of a single page (p. 76). Several wells are named, bored in widely separated localities, and the depth reached in each is stated. As the examples given are among the deepest borings in the world the natural inference is that an abundant flow can be found if the contractor only bore deep enough. Such an inference is not only wholly wrong in its practical aspects, but it is not the result of good geological reasoning.

In many portions of the country, notably in the northern belt of states from Ohio to the Rocky Mountains, much attention is given to the subject of Artesian water supply for domestic uses, power and irrigation. Its geology is important. Qualifying conditions must always be weighed and understood. The character of the water is an important factor, since within certain limits its chemical composition determines its usefulness. Within this area the geological character of the formations penetrated have become pretty well known to the depth of half a mile. Yet with all this scientific and economic interest within so large a portion of the United States, there is no aid in Le Conte's Elements for the teacher in the presence of a class anxious to take away something practical, or for the general reader seeking information as to where and how he shall proceed to obtain artesian water, although he is told with much detail how to find the epicentrum and focus of an earthquake.

2. In the subject of historical geology two or three points command attention. The Archean era and system are first to be noted. As the classification on page 295 is compared with that of working geologists, the labors of the last 22 years within the field of Pre-Cambrian geology receive but little recognition. In 1874, in his 2d edition of the Manual, Dana recognizes the 'Primordial or Cambrian,' and places beneath it the Archean with its sub-divisions, Laurentian and Huronian. In 1896 LeConte does the same. Teachers and general readers in geology would receive much more help from the conclusions of the Geological Conference in Washington, January, 1889, in which conference Mr. Gilbert was himself a leading figure, had its results touching these basal formations been used by Professor LeConte.

The Lake Superior basin, with its southerly borders, has been for years the center of interest to students of petrographic and historical geology. The work of Irving, Van Hise and

* Geology in the Colleges and Universities of the United States. Frederic W. Simonds, Science, Oct. 2, 1896, p. 497.

others, in developing this region along the lines of classification marked out by the Conference of 1889, are too well known to require specific attention. That basin portion of the continent is disclosing in striking characters and in magnificent array the successive and continuous steps of progress through the great time gap between the Archean complex and the fully developed faunal conditions of the early Combrian, in which gap, it is believed, lies one-half the geologic history of the globe. The Algonkian seems to be a fact, and a large one too, in North American geology; yet this period is not mentioned save in a single footnote (p. 296). In the four and one-half pages devoted to the Archean, ten lines are given to the rocks of the period, of which 'there is nothing very characteristic, * * * * * except their extreme and universal metamorphism.' The word Huronian does not occur in these pages.

Perhaps a word of caution should be spoken against the impression given by Figs. 264 and 265, that iron ore is interstratified with its associated rocks and hence may reach through to the bottom of the earth's crust. Investigations show that iron ore of the Lake Superior type does not occur as interstratified formations and does not appear to any workable extent in the Archean of North America, as the term Archean is understood among working geologists. In giving 34 per cent. of his Archean space to evidences of life the author says of the leading type that its 'organic origin is not now generally admitted.'

To the writer it would seem that had fewer pages been devoted to geysers and earthquakes, topics of no great geologic significance so far as past researches reveal, and more been given to the subjects enumerated above, geologic science would have been aided in its appeal to the instincts of American students of geology.

3. Finally, from a pedagogical standpoint, this book is to be judged because the author calls it a text-book for colleges. From this standpoint it chief defect lies in the multiplicity of theories advanced and discussed. A text-book should be the exponent of a doctrine. It should be constructed on the definite and positive plan best adapted, in the mind of the author, to expound his body of principles. When several theories are presented and the student practically told to take his choice (p. 100 et seq.), or when he is told that all are true (p. 65), the function of the text-book disappears. The book in so far becomes a compilation of opinions. So far as the development of geologic science goes, the reader is in the dark as to what to believe, unless he assumes that the chronological order of the opinions expressed represents such development. Geology is a science; it has passed the stage of assumption. While much remains to be discovered, worked out and established in geology, still the body of facts and well-understood phenomena now clustering around the subject is sufficient to fill a book. By the presentation of these facts and phenomena the student who leans upon a text-book subjects himself to the inspiration of positive ideas and, in his intellectual processes, acquires that habit of decision so essential to practical success.

C. W. HALL.

THE UNIVERSITY OF MINNESOTA.

SCIENTIFIC LITERATURE.

Die Morphologie und Physiologie des Pflanzlichen Zellkernes, eine kritische Litteratur. Studie von PROF. DR. A. ZIMMERMANN. Jena, Verlag von G. Fischer. 1896. Pp. viii + 133.

This collection of literature and critical review of the numerous scattered investigations and comparatively few extended studies which have been made upon the nucleus in plant cells is very welcome to all plant cytologists. It is indeed, an excellent and well prepared summary, and avoids the errors of classification, which to some extent impaired the usefulness of the 'Botanisches Mikrotechnik' by the same author.

The work is divided into a general part and a special part. In the former, under the following chapter heads, research methods, nomenclature and general considerations, chemical structure, morphological differentiation of the resting nucleus, nuclear division, nuclear fusion and nuclear physiology, the various observations of a large number of investigators are collected. In this part the two most interesting and useful chapters are those on karyokinesis, in which Zimmermann's views upon the nucleolus and upon the mechanics of the process are succinctly stated again, but with due regard to his critics, and on the physiology of the nucleus in which the somewhat divergent views upon nuclear function are balanced, and much useful information brought together regarding the influence upon the nucleus of such environmental forces as gravity, light, electricity, mechanical pressure, heat, etc. In discussing the mechanics of karyokinesis, Zimmermann uses considerable illustrative material from the field of zoocytology, but, while quoting the interesting results of Henneguy, does not seem to have known the opposite view supported by Watasi from his studies of cephalopods. Nor is his account of the center zone in plants altogether abreast of present knowledge, while the discussion of fragmentation is itself rather too fragmentary.

The second part of the work, the special part, takes up in detail researches upon the nuclei in Angiosperms, Gymnosperms, Pterodophytes, Bryophytes, Fungi, Algæ and Schizophyta. Here a large amount of special literature is indexed, and on the whole this is the most useful part of the volume. Several of the recent papers of American investigators receive proper consideration, which is a gratifying departure from the methods of too many of the European writers.

A bibliography including nearly six hundred titles and two indices, one a 'Sachregister' and the other to the names of plants, complete the volume.

In the light of modern study and his own added experience in book-making, it would be very helpful if Dr. Zimmermann could find time to revise and rewrite his older work on the plant cell. Certainly this paper is of the greatest value, but needs a better handling than was given it in the Schenk's *Handbuch.*

CONWAY MACMILLAN.

UNIVERSITY OF MINNESOTA.

The Myths of the New World: By DANIEL G. BRINTON, A.M., M.D., LL.D., D.Sc., Professor of American Archæology and Linguistics in the University of Pennsylvania. Third Edition revised. David McKay, Philadelphia. 1896.

The appearance, in 1868, of Dr. D. G. Brinton's 'Treatise on the Symbolism and Mythology of the Red Race of America' marked an epoch in the study of the 'Myths of the New World.' Although prior to this date able scholars had made valuable researches among various groups of American aboriginees, in this volume the first attempt was made to mass this scattered information, and to present in a clear and concise form whatever contribution might be offered by the natives of this western continent, in answer to the general inquiry as to 'man's earliest ideas of a soul and a God, and of his own origin and destiny.'

In the recent rapid growth of our knowledge of the red race, it is not easy to appreciate the difficulties encountered thirty years ago, and the courage requisite to accomplish the task undertaken by the author. A new claim was set up by him for the natives of America, a claim which was no less than the right to be heard in the general discussion of the upbuilding of the intellectual life of the human family. The issue of a revised third edition of 'The Myths of the New World,' in which much of the text has been rewritten, and some fifty pages of new material added, brings forward the arguments offered in 1868, reinforced with additional evidence gathered from the recent work of students who have opened new fields of research or gleaned in those already known.

The title might imply to those unfamiliar with former editions that the volume contained a collection of myths, whereas myths are only referred to by the author as he seeks to trace the intellectual history and to ascertain the 'laws of religious growth of the red race.' For this purpose he treats the race as a "unit, regarding its religion as the development of ideas common to all its members, and its myths as the garb thrown around these ideas by imaginations more or less fertile, but seeking everywhere to embody the same notions."

The author attacks his theme with directness and force, accepting at the opening of his first chapter the unity of the human family, and granting that the aim of man is to find out God, the cause of all. Natural religions are therefore 'the effort of the reason struggling to define the infinite.' Concerning the birth of religion we read: "The idea of God does not and cannot proceed from the external world but nevertheless it finds its *historic* origin (as art, science and government do) in the desperate struggle for life, in the satisfaction of the animal wants and passions, in those vulgar aims and notions which possessed the mind of primitive man to the exclusion of everything else." Religion, however, does not 'begin and develop under the operation of inflexible laws;' these 'potently incline; they do not coerce.' Symbols and myths originate "in dealing with matters beyond the cognizance of the senses; the mind is forced to express its meaning in terms transferred from sensuous perception, or under symbols borrowed from the material world." Therefore to understand these transfers, and to reach the 'real meaning of the myth,' we are told: "With delicate ear the faint whispers of thought must be apprehended" (by the student) "which prompt the intellect when it names the immaterial from the material; when it has to seek amid its concrete conceptions for those suited to convey its abstract intuitions."

These general statements precede a rapid but clear presentation of the physical and intellectual peculiarities of the red race, wherein their language, mnemonics and written records are reviewed, and the probable migrations of its chief families indicated, and their location given when they were first known historically.

In chapters 2 to 9, inclusive, the author treats broadly and suggestively, the Idea of God; the Origin and Application of the Sacred Number; the Symbol of the Bird and the Serpent; the Myth of Water, Fire and the Thunder-storm; the Supreme Gods of the Red Race; the Myth of the Creation, the Deluge, the Epochs of Nature and the Last Day; the Origin of Man; the Soul and its Destiny; the Native Priesthood; and the Influence of the Native Religion on the Moral and Social Life of the Race. An index in which over three hundred and fifty authorities are cited, and another of the subjects touched upon, closes the volume of 360 pages.

It is impossible within this brief notice to even outline the arguments and evidence presented by our author; he has brought wide learning and careful thinking to bear upon his theme, and has established a thesis that it will be difficult to successfully assail.

It is true that there are students who do not fully share the insistance of the author for the complete isolation of the American race, an isolation which insured an indigenous growth of its culture. While recognizing American characteristics, some are inclined to consider contact with the Old World during the centuries as more or less probable, and point to certain similarities and parallelisms as possible evidence of the fact. 'Those analogies and identities' * * 'whether in myth, folklore or technical details,' our author attributes 'wholly and only to the uniform development of human culture under similar conditions,' and deprecates 'contact and transference' as affording an adequate explanation.

The points of difference between the author and other students upon this and a few minor matters are not radical and do not invalidate the gist of the argument found in the volume, namely, the psychical solidarity of mankind. There can be no question of the efficient service which has been rendered by the author in this book toward the establishment of this great truth, the far-reaching influence of the acceptance of which is being felt in a broader and deeper religious faith, and in the growth of higher international and, one might say, interracial ethics.

ALICE C. FLETCHER.

SCIENTIFIC JOURNALS.

THE ASTROPHYSICAL JOURNAL, OCTOBER, 1896.

The effect of Pressure on Wave-length: By J. F. MOHLER. A continuation of the investigations of W. J. Humphreys and J. F. Mohler on the *Effect of Pressure on the Wave-length of Lines in the Arc-spectra of Certain Elements.* The latter investigation was carried on with pressures exceeding one atmosphere. The present paper deals with pressure below one atmosphere. Special attention was given to the spectrum of cadmium, with the hope that the light might be thrown upon the matter of discrepancy between the absolute measurements of cadmium wave-lengths by Michelson, and the determinations of the same lines by Rowland upon the foundation of Bell's work. Unhappily, the hoped-for illumination was not eminently satisfactory. In general, the results of the previous work were found to be capable of extrapolation to low pressures. With some exceptions, the shift of a line for any given element was approximately proportional to the product of the atmospheric pressure to which the arc was subjected into the wave-length of the line in question. The law that the shift is also proportional to the absolute temperature of the melting point of the element was not verified.

Solar Observations Made at the Royal Observatory of the Roman College During the First Half of 1896: By P. Tacchini. A tabulation of results showing the distribution of spots, faculæ, and prominences upon the sun's surface throughout the half-year.

Résumé of Solar Observations Made at the Astrophysical Observatory at Catalona in 1895: By A. Mascari. A tabulation similar in form to the preceding, but with more extended discussion.

Certain Considerations Concerning the Accuracy of Eye-Estimates of Magnitudes by the Method of Sequences: By Alex. W. Roberts. Prof. Pickering having spoken deprecatingly of the estimation of stellar magnitudes by the unaided eye, the article appears as a defense of such determinations. In the method pursued by the author stars of the magnitudes 6.8 and 9.3 were determined, being respectively on the limit of visibility of the naked eye and a one-inch telescope. The magnitudes of certain comparison stars were determined by interpolation between these values, and with these the star suspected of variability was compared. Measurements of the variable L 5861 show the mean discrepancies of a single observation to be less than 0.04 mag. The relative position of two stars in the field of view is shown to have an important effect upon the estimation of their relative brightness. This personal error is eliminated by using successively direct vision and reversing eye-pieces. The final conclusion is that eye-estimates are as trustworthy as any that are being made photometrically.

On the Level of Sun-spots: By Edwin B. Frost. A review of the various sun-spot theories in the light of recent investigations. After a respectful consideration of the hypothesis of Wilson, that sun-spots are depressions in the photosphere, Prof. Frost points out that there is very little to substantiate it. The existence of the apparent effects of perspective on the so-called penumbra, upon which the theory mainly rests, is doubted by many of the most careful observers. Measurements of the relative thermal radiation of spots and contiguous portions of the photosphere show an increase in favor of the spots as they approach the limb of the sun. But the radiation of the spot compared with that from the center of the disc decreases as the spot approaches the limb. This would apparently be the case if the spot were composed of radiating matter at a height above the photosphere, since in that case its heat would not be so subject to the absorption of the atmosphere on the sun's limb. Again, the velocities of rotation upon the sun's surface are in the following ascending order: velocity of iron vapor, of spots, of faculæ. It would appear from this that the elevation of the spots might reasonably be supposed to be intermediate between that of the absorbing iron vapor and faculæ, and therefore above the photosphere. This opinion is supported by the investigations of Wilczynski.

Researches upon the Arc-spectra of the Metals. II. The Spectrum of Titanium. II. (Continued from Aug. Ap. J.): By B. Hasselberg. A tabulation of the Titanium lines from λ 3477 to λ 5900. The presence of titanium in the sun is proven, and the lines compared with other determinations. A chart of the spectrum accompanies the article.

Minor Contributions and Notes, Harvard college circulars 10 and 11; notices.

Review of *The Equipment of the Astrophysical Observatory of the Future. G. Johnstone Stoney, A. M., etc.:* By F. L. O. Wadsworth. Bibliography of recent astrophysical literature.

THE AMERICAN GEOLOGIST, NOVEMBER.

An iron meteorite weighing 19¾ pounds, found near Arlington, Minn., is described by N. H. Winchell.

H. W. Fairbanks discusses the age of the California Coast Ranges. Considerable antiquity for these mountains is claimed, and a number of profound oscillations are noted, beginning with the Jurassic and continuing down to the present.

M. E. Wadsworth makes a strong plea for the introduction of the elective system in engineering colleges, based upon practical experience in the Michigan Mining School.

Orotaxis; A method of geologic correlation: C. R. Keyes. This may be defined as a systematic arrangement of mountains, or orotaxis, in which the cycles of elevation and degradation, together with the consequent unconformities in the sediments of separate cycles, are made the basis of geological chronology. The method has had its greatest use in pre-Cambrian and other nonfossiliferous series. The author claims that it may serve equally reliable and serviceable ends in the correlation of even richly fossiliferous horizons.

Human relics in the drift of Ohio: E. W. Claypole. The principal specimen, and the one on which the main argument rests, is a small grooved axe found at a depth of 22 feet in boulder clay. All the collateral evidence, such as the oxydized condition of the axe and the circumstances of the find, points to the genuine antiquity of this relic.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

The 51st meeting of the Geological Society, the first of the winter season of 1896, was held in Washington on November 11th. Mr. J. E. Spurr briefly described the reconnaissance of the gold resources of the Yukon region of Alaska, from which he has just returned. The Geological Survey party in his charge crossed the Chilkoot Pass, about the middle of June, to the headquarters of the Yukon, and proceeded down the river to the chief gold-bearing localities. The principal producing districts, those of Forty-Mile Creek and Birch Creek, were thoroughly explored, as well as other less important localities. The party then continued down the Yukon, examining the younger sedimentaries which overlie the gold-bearing formation, as far as Nulato. At this point passage was taken by steamer to St. Michael's, and the homeward journey begun.

One of the principal results of the expedition was the recognition of the gold-bearing rocks from which the gold in the river gravels is derived. These gold-bearing rocks constitute a distinct broad belt, running northwest into Alaska from British territory. They are in their lower portions schists and gneisses, with intrusive rocks, and in their upper portion somewhat altered sedimentaries. They are all older than Carboniferous, for the Carboniferous and younger rocks overlie them on both sides of the gold-bearing belt. In this belt the gold occurs partly in quartz veins, partly in deposits formed along shear-zones; in both occurrences it is contained in pyrite, and becomes free on weathering. The quartz veins are distinctly older than the shear-zone deposits, and were formed before the alteration of the enclosing rock to a schist; they have, therefore, partaken of this shearing, and have been broken and sheared so that they are typically non-persistent. The deposits along shear-zones are, however, of later date than the shearing, and can be continuously followed.

The younger beds which overlie the gold-bearing belt consist in part of conglomerates, and some of these conglomerates are fossil placers, which give promise of being productive.

Mr. S. F. Emmons, of the United States Geological Survey, gave a brief description of the gold deposits of the northern end of the Black Hills of South Dakota. The geological structure of the region is that of a series of steeply upturned Algonkian slates, on the basset edges of which rest nearly horizontal beds of Cambrian, Silurian and Carboniferous age. All these rocks are abundantly intersected in the mineral-bearing region by dikes and intrusive sheets of various porphyritic rocks, mostly of acid types. Erosion has removed the later rocks and included porphyry sheets from the valleys, but portions of them remain in the higher ridges and peaks. There are three types of gold deposits: The Homestake type of deposit, the siliceous gold ores of the Cambrian and the placer deposits. The first occur in sheets often several hundred feet wide along a mineral bearing zone, which is mostly controlled by the Homestake Company, and is now worked to a vertical depth of 800 feet. The placer deposits are partly ancient or fossil placers at the base of the Cambrian (Middle Cambrian, and not Potsdam sandstone, as it has hitherto been called), and modern placers along present stream beds, resulting in part from the disintegration of the older placers. The so-called siliceous gold ores occur in the remnants of Cambrian beds and included porphyry bodies in the elevated region around Grey's Peak and Bald Mountain, to the west of the Homestake belt. The ore bodies are siliceous replacements of certain beds in the upper and lower parts of the formation near eruptive sheets or dikes, which have been mineralized from certain north and south cracks or fissures—locally called 'verticals'—which traverse both sedimentary beds and eruptive sheets. The ores are finely disseminated pyrite, generally oxidized with gold, either free or combined with tellurium. The ore bodies are of great longitudinal extent, having been traced continuously in the Golden Reward mine for many thousand feet; in some cases they are twelve feet thick and more than a hundred feet wide. They give promise of important future developments.

Wm. F. Morsell.

ENTOMOLOGICAL SOCIETY OF WASHINGTON NOVEMBER 12, 1896.

Mr. Ashmead exhibited specimens of *Proclytis grandis*, a European species, which had been collected by Mrs. Slosson, at Franconia, N. H. Some discussion ensued on the occurrence of European species in North America.

Mr. Schwarz exhibited two European beetles recently found in North America, viz., *Attagenus schaefferi* from Wyoming, and *Lathridus hirtus* from Montana. He also showed the Madeiran *Cartodere watsoni*, which now occurs at Washington, D. C.

Mr. Howard exhibited specimens of *Coccophagus orientalis*, originally described from Ceylon, but now occurring in Louisiana.

Mr. O. F. Cook exhibited specimens of two new American species of Japyx, one from Alabama, and the other from Ventura County, California. He also showed a specimen of Casey's genus *Gastrotheus*, originally described as a possible coleopterous larva, but which the speaker considered a genus of true Thysanura, distinct, however, from recognized families by the presence of two pairs of several-jointed abdominal legs, acting as supporters to the abdomen. He thought it necessary, in consequence, to admit at least a new sub-order, which he would call Gastrotheoidea. The same speaker also exhibited two specimens of an African insect closely related to or identical with *Dyscritina* Westwood. He also showed a specimen of Walker's remarkable genus *Hemimerus*, collected in Liberia, but not on a rat, the supposed habitat of *Hemimerus*. He also showed a specimen collected in Liberia, under rotting wood, which will possibly form a new order of insects of the Orthopterous series. He also showed a specimen of *Cryptostemma* Westwood, an African Arachnid, now recognized as the type of a distinct order originally based on a fossil genus and now known by Thorell's name of *Meridogastra*. Finally he exhibited a small Arachnid collected under stones at Muhlenberg Mission, Liberia. It has an 11-jointed abdomen distinct by a constriction from the cephalothorax, which has an evident transverse suture. The palpi are not chelate nor modified for prehension, as in the Pedipalpi. The genus has been named *Artacarus* and will probably constitute a family distinct from the Schizonotidæ and also serve as the type of a distinct order of Arachnida, which may be known as *Artacarida*, although this name should not be supposed to carry an implication of especial affinity with the mites.

Mr. W. G. Johnson presented a paper entitled 'Notes on the Morelos Orange Fruit-worm,' in which he recounted rearing *Trypeta ludens* from maggots found in oranges purchased at Chicago, Ill., last February. He traced these oranges through a Chicago dealer to Mexico. He described the different stages of the insect, and concluded that the establishment of the species in orange growing regions in the United States is probable.

Mr. Howard, in discussion, called attention to the peculiar present danger of such establishment, owing to the fact that the failure of the orange crop in Florida has induced extensive importation of Mexican oranges.

Mr. Schwarz read a paper upon a new cave beetle, reviewing the subject of recent additions to the Coleopterous cave fauna of North America, and referring particularly to a new species which he will call *Ptomaphagus cavernicola*, collected by Dr. C. Hart Merriam, in Stone Cave, Mo.

The general subject of cave animals was discussed by Messrs. Gill, Ashmead, Cook and Schwarz.

Mr. Howard presented some notes on the parasites of *Orgyia leucostigma*, which was followed by a general discussion of parasitism in insects, in which Messrs. Schwarz, Fernow, Swingle, Dr. Otto Lugger and Prof. W. B. Alwood took part.

L. O. HOWARD,
Secretary.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, OCTOBER 27.

CHARLES MORRIS read a paper on 'The Primeval Ocean.' While evaporation takes place at 212 degrees Fahrenheit under one atmosphere of pressure, if the ocean temperature were raised to 212 degrees the increased atmospheric moisture would greatly increase the pressure, and the resulting loss of oceanic water would consequently be small. The highest limit of evaporation under pressure known experimentally is about 440 degrees, producing a pressure of about twenty-five atmospheres, and if the ocean were raised to this temperature there would probably be not more than one-twelfth of the water evaporated. But as the energy of evaporation increases more rapidly, with increased temperature, than that of pressure, all the water would probably be evaporated at between 600 and 800 degrees, and at this temperature the atmospheric pressure would reach 300 to 350 atmospheres, equal to from 4,500 to 5,200 pounds to the square inch, a pressure which would probably prevent seismic action on the earth's surface, and tend to condense gaseous and liquid materials into solids.

These conditions must have been attended with great chemical activity, and this was possibly the era, in the world's history, of inorganic chemistry; which was succeeded by organic chemistry when the water cooled to 212 degrees. Hence the great period of inorganic chemism was prior to that of organic chemism; as the former is largely a process of oxidation it practically exhausted itself when all the materials were oxidized; while the latter, being in the main a process of deoxidation, may continue indefinitely while temperature conditions permit.

As to the derivation of organic from inorganic chemism, it probably occurred during the perion in question, when, owing to its great chemical activity and increased solvent power, the water may have been so charged with foreign matter so as to be nearly jelly-like in consistency. Under present conditions organic chemical material could not be reproduced should it be swept away; at the same time the conditions are favorable to its continuance, having once been produced.

Papers under the following titles were presented for publicatton: 'New Species of Fresh-water Mollusks from South America,' by Henry A. Pilsbry. 'Geology of the Mussel-bearing Clays of Fish-House, N. J,' by Henry A. Pilsbry.

Biological Section, November 2d: Dr. M. V. Ball, Recorder. Dr. A. H. Stewart made a communication on the effects of rattlesnake poison on the blood. The snakes in captivity are fed only once or twice in six months. The venom is obtained by engaging the head of the snake in a leather loop and then making pressure on the glands while the fangs are protruded. The color of the venom varies from a light lemon to a rich straw or even orange. When the fluid evaporates yellow crystals are formed.

When a drop of the venom is injected under the skin of a rabbit death will result in four hours. The dried poison is fatal to a rabbit in a dose of four milligrammes in from ten to twelve hours. The venom becomes less poisonous the more frequently it is taken from the snake; the quantity is also much lessened.

From the point of entrance of the fangs subdermal hemorrhages occur; the parts become almost black; the peritoneum appears gangrenous. The blood passes through the vessels freely, producing an extensive œdema, while the internal organs—the kidneys, liver and lungs—are almost bloodless. The blood remains fluid for a long time after death. The corpuscles are reduced in size and seem to be stuck together by the edges. They retain their shape for weeks and the blood of the snake itself is affected in the same way by its own venom. Pure venom is not as speedily fatal as when mixed with normal salt solution. The oval corpuscles of the frog's blood are rendered more circular and the nucleus is thrown out. When fed by the mouth there is no action from the poison. Immunity had been produced in rabbits against ten times the lethal dose.

NOVEMBER 10, 1896.

Dr. Harrison Allen presented a paper for publication on *Tarsius fuscomanus*. In a verbal synopsis he exhibited the undissected half of this curious little creature from the eastern Malayan Islands, pointing out its anatomical peculiarities. In referring to the muscular structure, he called attention particularly to the large muscle on the fore part of the thigh, which in the human subject, it is claimed, is necessary to maintain the erect position, but *Tarsius*, in which animal this muscle is greatly developed upon a relatively very long thigh, is unable to assume an erect position, the leg being flexed against the thigh and the possible divarication slight. He referred to the species *Tarsius spectrum*, lately the subject of investigation by Hubrecht. Dr. Allen pointed out some differences between Burmeister's description of the same species and those of *T. fuscomanus*, the result of his own dissection. The upper molars of *T. fuscomanus* exhibit meta-conules and para-conules. These are absent in *Anaptomorphus*. Dr. Allen claimed that Burmeister and Specht were in error in representing the hind foot as having a transverse grasp. The foot has a longitudinal grasp, as correctly delineated by Cuvier. *Tarsius*, he said, though generally classed with the lemurs, in the opinion of some naturalists, should be classed separately next to the apes.

Dr. Calvert stated that while at Utrecht the past summer he had the pleasure of meeting Prof. Hubrecht, and with him examining his specimens of *Tarsius*, which included both anatomical and embryological preparations. He also referred to the contention that the line of descent to man was from the lemurs or the Eocene representative of *Tarsius*, *Anaptomorphus*, and through the man-like apes, to man, leaving the other Old and New World monkeys as side branches.

Mr. Vaux reported that the fossil tree at Lindenwold, N. J., is a conifer completely silicified, measuring 26 feet in length and $7\frac{1}{2}$ feet in diameter at the base, tapering to 5 feet 12 feet up, where it branched. It was, however, so fragile that it was impossible to get a section of it for the Academy.

Edw. J. Nolan,
Recording Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis on the evening of November 16, 1896, Dr. Charles R. Keyes, the State Geologist of Missouri, read a paper entitled 'How shall we subdivide the Carboniferous?' and Prof. J. H. Kinealy exhibited a chart for determining the number of square feet of low pressure steam heating surface required to keep a room at 70° F., and gave a description of the method of making the chart.

Two active members and one life member of of the Academy were elected.

William Trelease,
Recording Secretary.

NEW BOOKS.

Electro-physiology. W. Biedermann. Translated by Frances A. Welby. London and New York, The Macmillan Co. 1896. Vol. I. Pp. xii+517. $5.50.

Grasses of North America. W. J. Beal. New York, Henry Holt & Co. 1896. Vol. II. Pp. viii.+706. $5.00, net.

Allgemeine Erdkunde. J. Hann, Ed. Brückner and A. Kirchhoff. 5th Edition, 1st part. Die Erde als Ganzes, ihre Atmosphäre und Hydrosphäre, Dr. J. Hahn. Prag, Wien, Leipzig, F. Temsky. 1896. Pp. 336. M. 10.

Versuch einer Philosophischen Selektions Theorie. Johannes Unbehaun. Jena, Gustav Fischer. 1896. Pp. 150.

Erratum: In the last paragraph of the review by C. S. M., on page 764, the quotation marks should include the last four words, making the paragraph read:

The note of personal exultation predominates in the pamphlet, and the author closes with the following words: "All the things mentioned above, and many more, are in agreement with the view of an antithetic alteration as underlying Metazoon development and—where are the *facts* that are opposed to it? And echo answers—'where?'"

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SCIENCE

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SCIENCE

Friday, December 4, 1896.

CONTENTS:

*THE JURASSIC FORMATION ON THE ATLANTIC COAST.**

The absence of all Jurassic strata in the eastern part of the United States has been generally regarded as a settled point in geology for half a century or more. The reason for this vacancy has also been one of the problems geologists have had to deal with, since the formations above and below are well represented. Until a comparatively modern date, this supposed absence of Jurassic deposits was thought to be true, also, for the rest of this country. I well remember the parting advice given me by an eminent professor of geology with whom I studied in Germany:† "The first thing you should do on your return to America is—look for the Jurassic formation. I am sure it is there, full of fossils." This advice I followed, and on my first visit to the Rocky Mountains, in 1868, I found this formation near Lake Como, Wyoming, well developed, and containing an abundance of typical fossils. As this locality is now a famous one, I have brought here a colored drawing that shows the characteristic variegated strata of the Como Bluff, from which so many remains of

* Abstract of Communication made to the National Academy of Sciences, New York meeting, November 18, 1896.

† Ferdinand Roemer, whose researches here had already added much to our knowledge of the geology and paleontology of this country.

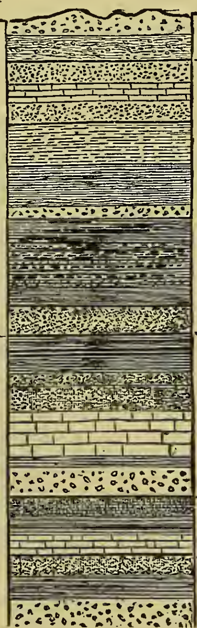
Jurassic vertebrates have been taken during my long explorations there.

The base of this section is a red sandstone, apparently of Triassic age. Next above are Jurassic marine beds, with many invertebrate fossils and a few remains of reptiles. Over these beds is a series of peculiar, highly colored clays of fresh-water origin and considerable thickness, rich in vertebrate fossils. Crowning all is the characteristic Dakota sandstone, generally considered of Cretaceous age. The position of this series of strata in the geological scale is shown in the section below, which represents especially the succession of vertebrate life in the West during Mesozoic and Cenozoic time.

in 1870, near the Green River in Utah, and since then at various other points. These strata I have named the Baptanodon beds, from a genus of large swimming reptiles entombed in them.

THE ATLANTOSAURUS BEDS.

The extensive fresh-water deposits of Jurassic age that lie over the marine strata at Como, I have called the Atlantosaurus beds, from a gigantic Dinosaur especially characteristic of the horizon. Other Dinosaurs, large and small, and a great number and variety of vertebrate fossils—mammals, birds, reptiles and fishes—I have likewise secured from this locality and at several other points in the same horizon, chiefly in



CENOZOIC.	Recent. Quaternary.			Tapir, Peccary, Bison. *Bos, Equus, Tapirus, Dicotyles, Megatherium, Mylodon.*
	Tertiary	Pliocene.	Equus Beds.	*Equus, Tapirus, Elephas.*
			Pliohippus Beds.	*Pliohippus, Tapiravus, Mastodon, Procamelus, Aceratherium, Bos, Morotherium, Platygonus.*
		Miocene.	Miohippus Beds.	*Miohippus, Diceratherium, Thinohyus, Protoceras.*
			Oreodon Beds.	*Oreodon, Eporeodon, Hyænodon, Moropus, Ictops, Hyracodon, Agriochœrus, Colodon, Leptochœrus.*
			Brontotherium Beds	*Brontotherium, Brontops, Allops, Titanops, Titanotherium, Mesohippus, Ancodus, Entelodon.*
		Eocene.	Diplacodon Beds.	*Diplacodon, Epihippus, Amynodon, Eomeryx.*
			Dinoceras Beds.	*Dinoceras, Tinoceras, Uintatherium, Palæosyops, Orohippus, Hyrachyus, Colonoceras, Homacodon.*
			Heliobatis Beds.	*Heliobatis, Amia, Lepidosteus, Asineops, Clupea.*
			Coryphodon Beds.	*Coryphodon, Eohippus, Eohyus, Hyracops, Parahyus* Lemurs, Ungulates, Tillodonts, Rodents, Serpents.
MESOZOIC.	Cretaceous.		Ceratops Beds of Laramie Series.	*Ceratops, Triceratops, Claosaurus, Ornithomimus.* Mammals, *Cimolomys, Dipriodon, Selenacodon, Nanomyops, Stagodon.* Birds, *Cimolopteryx.*
			Fox Hills Group.	.
			Colorado Series, or Pteranodon Beds.	Birds with Teeth, *Hesperornis, Ichthyornis, Apatornis.* Mosasaurs, *Edestosaurus, Lestosaurus, Tylosaurus.* Pterodactyls, *Pteranodon.* Plesiosaurs, Turtles.
			Dakota Group.	
	Jurassic.		Atlantosaurus Beds Baptanodon Beds. Hallopus Beds.	Dinosaurs, *Brontosaurus, Morosaurus, Diplodocus, Stegosaurus, Camptosaurus, Ceratosaurus.* Mammals, *Dryolestes, Stylacodon, Tinodon, Ctenacodon.*
	Triassic.		Otozoum, or Conn. River, Beds.	First Mammals, *Dromatherium.* First Dinosaurs, *Anchisaurus, Ammosaurus, Bathygnathus, Clepsysaurus.* Many footprints. Crocodiles, *Belodon.* Fishes, *Catopterus, Ischypterus, Ptycholepis.*

FIGURE 1.—Geological Horizons of Vertebrate Fossils.

THE BAPTANODON BEDS.

The same marine beds that constitute the base of the Como Jurassic series, Meek had previously identified near the Black Hills, by means of invertebrate fossils (Proc. Acad. Nat. Sci., Phila., Vol. X., pp. 41–59, 1859). I found these deposits again

Wyoming and Colorado. Among these extinct forms, the gigantic *Sauropoda*, the largest of all land animals, are the most wonderful, and are known only from the Jurassic. They are therefore of special value as evidence of geological age.

The main physical features of the Jurassic strata in the West, especially the variegated fresh-water deposits, are so striking that, once seen, they will not soon be forgotten. As these physical characters may be used as one means of readily identifying this horizon, I have brought here, besides the colored drawing of the Como section in Wyoming, two others illustrating sections in Colorado. One is from Morrison, near Denver, and the other one hundred miles farther south, near Cañon City, both representing, in the Atlantosaurus beds, localities famous for the vertebrate fossils they have furnished. I know of no other geological horizon in the West marked by such striking and characteristic physical features.

THE PLEUROCŒLUS BEDS.

In the East, the strata most resembling the Atlantosaurus beds in physical characters are the Potomac clays and sands so conspicuous between Washington and Baltimore, and known to extend, also, both to the north and south. Although fifteen hundred miles to the eastward, these Maryland strata so strongly recalled those I had explored at the base of the Rocky Mountains, I felt reasonably sure, even before I had examined them, that this series would turn out to be essentially the same age as the Atlantosaurus beds of the West. This proved to be the case. Although the Potomac beds have been generally regarded as Cretaceous, I can now safely say that the vertebrate fossils I have secured from them, especially the *Sauropoda*, demonstrate their Jurassic age beyond reasonable doubt. I stated this conclusion in my first description of Potomac fossils, and it is now fully confirmed by more recent discoveries.*

The fact that the *Sauropoda* of the Potomac beds are all of diminutive size, in comparison with the western forms, is a point of some importance in estimating the age of the strata that contain them. It is a rule almost without exception, that the earlier members of an order of ancient vertebrate animals are small, while the last survivors before extinction are the largest. The gigantic forms of every such group left no successors. Hence the small *Pleurocœlidæ* of the East may possibly be the ancestors of of the huge western *Atlantosauridæ*, but can hardly be their descendants. The other vertebrate fossils from the Potomac of Maryland, although fragmentary, all appear to be Jurassic in type.

It cannot, of course, be positively asserted at present that the entire series now known as Potomac is all Jurassic, or represents the whole Jurassic. The Lias appears to be wanting, and some of the upper strata may possibly prove to belong to the Dakota.

The latter formation in the West often lies apparently conformably on the Atlantosaurus beds, and besides its many fossil plants contains fragments of bones, but these may have washed out of the Jurassic clays below. Footprints resembling those of birds have also been found.

THE POTOMAC FORMATION.

The Maryland Potomac, as we know it to-day, is the keystone to the arch. If this is Jurassic, as now seems certain, it is a fair conclusion that the same series of deposits, north and south, are essentially of the same age. The only region along this line of a thousand miles or more where a systematic search for vertebrate fossils has been made is in Maryland, and here a rich fauna has been found. Doubtless in many outcrops of this formation, animal remains may be rare or absent, as they appear to be in the Triassic below, but vertebrate life we know was abundant during the Jurassic, and characteristic remains will sooner or later come to light.

Taking, then, the Potomac formation as it is developed in Maryland as an eastern

* *American Journal of Science*, Vol. XXXV., p. 90, 1888. See also, Sixteenth Annual Report U. S. Geol. Survey, Part I., p. 183, 1896.

representative of the Jurassic, let us see what follows. The authorities on this formation—McGee, Ward, Fontaine, Uhler and others—agree that it extends south along the Atlantic border as far as North Carolina, holding the same relative position and the same general characteristics. That it also extends west around the Gulf border has been asserted by those most familiar with its southern development, but on this point I cannot speak from personal observation.

From the Potomac River northward, however, I have made sufficient explorations along its outcrops through Maryland, Delaware and Pennsylvania, to the Delaware River, to ascertain its distinctive features, essentially the same throughout, with its geological position still maintained. In New Jersey I have likewise followed its equivalent strata across the State in the great series of variegated plastic clays, to the Raritan River, and again in their exposure on Staten Island, everywhere seemingly the same series of strata and of the same age. The position is a definite one, always along the line where the Jurassic must lie, if present.

Along the northern shore of Long Island, the same formation extends, and at many outcrops it may be seen with its characteristic features well displayed. I have recently examined these exposures at many points, and all tell the same story. At Montauk Point and on Gardiner's Island I found apparently the same deposits, but with local variations that need not now be discussed.

Block Island, evidently once a part of Long Island, I have also examined. Its basal clays agree in most respects with the above representatives of the same horizon, as I have shown elsewhere.*

**American Journal of Science*, Vol. II., p. 295, October, and p. 375, November, 1896. In the second paper will be found an abstract of the more important literature.

GAY HEAD.

By far the finest exhibition of the great formation in question may be seen on Martha's Vineyard, especially at Gay Head, which for a century has attracted the attention of geologists, who have tried in vain to solve its mysteries. My first visit to this classic region was in September last, and I know of no point on the Atlantic coast, from Nova Scotia to Florida, of more interest to geologists. The striking resemblance between the variegated cliffs at Gay Head, the Potomac hills in Maryland, and Como bluffs in Wyoming, will impress everyone who has seen them. That all three are of essentially the same geological age, I have good reason to believe. Two of them are certainly Jurassic, as demonstrated by typical vertebrate fossils, and I hope soon to prove that Gay Head, so similar in all other respects, also contains the same characteristic vertebrate fauna that marks the Jurassic—the long missing formation on the Atlantic coast.

It has already been shown that the vertebrate fossils of the Potomac in Maryland prove its age there to be Jurassic, especially when taken in connection with the rich fauna of the Atlantosaurus beds of the West. In determining the age of the whole series, every aid that paleontology can render should be brought to bear upon the question, but a discrimination greater than has hitherto been shown is necessary to secure the best results.

In addition, then, to the evidence of vertebrate fossils as to the age of this eastern formation, the testimony of the invertebrates and plants should also be considered. The invertebrates known from these strata are few in number, but some of the mollusks among them point to the Jurassic age, as Whitfield has shown.* Nearly all, however, were estuary or fresh-water forms, which are now generally admitted to be of

* Monograph IX., U. S. Geol. Survey, p. 23, 1885.

slight value as witnesses of geological changes.

EVIDENCE OF FOSSIL PLANTS.

Remains of plants are numerous, but usually fragmentary, and these have been collected at many localities, and studied by botanists of much experience in such investigations. The verdict they have rendered has not been a unanimous one, but is especially interesting, as it coincides at one point with the decisions some of their predecessors have rendered as to the age of other geological horizons in the succeeding formations of the West.

The horizons I especially refer to are in the Dakota, Laramie and Eocene, all essentially of lacustrine origin, and now well known. Fossil plants in good preservation have been collected in each of these in turn, and pronounced by eminent botanists to be Miocene. Other paleobotanists of equal eminence have reviewed the evidence and made the age somewhat older, but, as a rule, the conclusion reached made the deposits in question at least one period later than the animal remains indicated. To explain this discordance, it was in one case gravely asserted that a Cretaceous vertebrate fauna lived in the midst of a Tertiary flora. A larger knowledge of the facts has since led to revision of the first opinions on this point, and the Cretaceous age of both is now admitted.

It seems to me extremely probable that in the Potomac formation we again have an analogous case. The botanists have pronounced the plants Cretaceous, while the vertebrates are certainly Jurassic. Change the botanical scale one notch, as was done in the horizons above, and the flora and fauna agree, while the Jurassic formation, so long missing, is in its proper place on the Atlantic coast as it is in the West. The North American botanical timepiece was originally set by the European clock, which was one period too slow, as many facts now indicate. Sooner or later, an adjustment must be made.

AGE OF THE WEALDEN.

To illustrate this, I may mention, as the latest change in the European time-standard, the Wealden formation, the Cretaceous age of which has long been considered a settled point. I had studied this formation at many localities in England and on the Continent, as it contained a reptilian fauna similar to one I had found in the Rocky Mountains and regarded as Jurassic. A further study of the Wealden reptiles caused me to question their Cretaceous age, and a comparison of these with allied forms from the Rocky Mountains led me to the conclusion that both series were Jurassic.

At the meeting of the British Association, at Ipswich, last year, I read a paper on European Dinosaurs, including two from the Wealden, and thus the question of their geological age came up for determination. The facts I presented, based mainly upon the reptilian fauna, strongly indicated the Jurassic age of the Wealden, and I urged a re-examination of the question by English geologists.* The subject has since been taken up by Smith Woodward, with special reference to the fossil fishes, on which he is high authority. In the *Geological Magazine* for February, 1896, he gives the main results of his investigation, which prove that the fishes, also, of the Wealden are of Jurassic types, thus placing the geological age of this formation beyond reasonable doubt.

The same conclusion, based upon a review of the Wealden plants, has recently been reached by A. C. Seward, likewise an eminent authority, who states the case as follows: "The evidence of paleobotany

* Report British Association for the Advancement of Science, p. 688, 1895; and *American Journal of Science*, Vol. L., p. 412, November, 1895.

certainly favors the inclusion of the Wealden rocks in the Jurassic series."*

AGE OF THE LARAMIE.

The problem before us to-day has a strong family resemblance to another with which geologists were face to face twenty years ago; namely, the geological age of the great lignite series of the West. Then, as now, the plants and the animal remains seemed to tell a different story, and I was thus led to investigate the question with considerable care. It may perhaps aid in solving the present problem if I repeat what I then said so far as it relates to the value of different kinds of fossils as evidence of geological age. In an address before the American Association for the Advancement of Science, in 1877,† I stated the case as follows:

"The boundary line between the Cretaceous and Tertiary in the region of the Rocky Mountains has been much in dispute during the last few years, mainly in consequence of the uncertain geological bearings of the fossil plants found near this horizon. The accompanying invertebrate fossils have thrown little light on the question, which is essentially whether the great Lignite series of the West is uppermost Cretaceous or lowest Eocene. The evidence of the numerous vertebrate remains is, in my judgment, decisive, and in favor of the former view.

RELATIVE IMPORTANCE OF FOSSILS.

"This brings up an important point in paleontology, one to which my attention was drawn several years since; namely, the comparative value of different groups of fossils in marking geological time. In examining the subject with some care, I found that, for this purpose, plants, as their nature indicates, are most unsatisfactory witnesses; that invertebrate animals are much better; and that vertebrates afford the most reliable evidence of climatic and other geological changes. The subdivisions of the latter group, moreover, and in fact all forms of animal life, are of value in this respect, mainly according to the perfection of their organization or zoological rank. Fishes, for example, are but slightly affected by changes that would destroy reptiles or birds, and the higher mammals succumb under influences that the lower forms pass through in safety. The more special applications of this general law, and its value in geology, will readily suggest themselves."

In the statement I have quoted I had no intention of reflecting in the slightest degree on the work of the conscientious paleobotanists who had endeavored to solve the problem with the best means at their command. I merely meant to suggest that the means then at their command were not adequate to the solution.

It so happened that the most renowned of European botanists, Sir Joseph Hooker, was then in this country, and to him I personally submitted the question as to the value of fossil plants as witnesses in determining the geological age of formations. The answer he made fully confirmed the conclusions I had stated in my address. Quoting from that, in his annual address as President of the Royal Society, he added his own views on the same question.* His words of caution should be borne in mind by all who use fossil plants in determining questions of geological age, and they are especially applicable to the problem now before us—the age of the Potomac formation.

The scientific investigation of fossil plants is an important branch of botany, however fragmentary the specimens may be. To at-

* Catalogue British Museum, Wealden Flora, p. 290, 1895.

† *American Journal of Science*, Vol. XIV., pp. 338–378, November, 1877.

* Proceedings Royal Society of London, Vol. XXVI., pp. 441, 443, 1877.

tempt to make out the age of formations by the use of such material is too often labor lost and must necessarily be so. As a faithful pupil of Goeppert, one of the fathers of fossil botany, I may perhaps be allowed to say this, especially as it was from his instruction that I first learned to doubt the value of fossil plants as indices of the past history of the world. Such specimens may indeed aid in marking the continuity of a particular stratum or horizon, but without the reinforcement of higher forms of life can do little to determine the age.

The paleobotanists have certainly failed repeatedly in the past in attempting to define geological horizons by fossil plants alone. Although they have this record as a guide, some of them are still using the same methods, the same material, with the same confidence, that formerly misled their predecessors. In view of this, and of the great importance of the present question, is it too much to ask them to reconsider their verdict as to the age of the Potomac formation?

Were the fossil plants of the Potomac the plants alone cannot finally decide the age.

POSITION OF JURASSIC STRATA.

In the geological section, Figure 1, on page 806, the relative position of the Jurassic deposits of the West is designated, and this will hold good for all the strata of that age in known localities on both flanks of the Rocky Mountains. In the East the position of the deposits here regarded as Jurassic is equally definite, and corresponds strictly to that of the western horizon in its most essential features. A reference to the section in Figure 2, below, will make this clear. This typical section is based on one by G. H. Cook, in the Geology of New Jersey,* and represents the successive Mesozoic and more recent formations, from New Brunswick, New Jersey, on a line southeast, through Lower Squankum to the Atlantic. The relative proportions and inclination of the various divisions cannot, of course, be given accurately in so small a figure. The distance represented by this section is about forty miles.

a *b* *c* *d*

Figure 2.—Geological Section in New Jersey.
a, Triassic; *b*, Jurassic; *c*, Cretaceous; *d*, Tertiary; T, tide level.

that have been pronounced Cretaceous unknown, the Jurassic age of this extensive series would have been accepted as a matter of course long ago. The strata themselves lie exactly in the position the Jurassic should occupy. They agree in physical characters more closely with the shallow fresh-water shales and sandstones of the Trias below than with the deep-sea Cretaceous beds above. Still more important, the animal remains taken together, invertebrates and vertebrates, indicate one fauna, the Jurassic. Under these circumstances

In this section, the red Triassic shales and sandstones are shown on the left, highly inclined. Resting on their eroded surface are the well-known variegated plastic clays, also of fresh-water origin. These strata are nearly horizontal, having a slight inclination toward the ocean. The top of these peculiar clay beds is not defined, but is marked by a change from lacustrine to marine conditions, which clearly indicate deposition in water of increasing depth, and finally deep-sea glauconite strata. These

*Geological Map, Cretaceous Section 3, 1868.

greensand deposits continued with some interruptions throughout the remaining Cretaceous time, and even into the early Tertiary, the third, or upper, marl bed being Eocene. Over these are strata of Miocene age, the Ammodon beds, and still more modern deposits form the shore of the Atlantic.

ATLANTIC BARRIERS.

The change from the fresh-water plastic clays of New Jersey to the marine beds containing greensand over them proves not only the breaking down of the eastern barrier which protected the former strata from the Atlantic, but a great subsidence also, since glauconite, as a rule, is only deposited in the deep, still waters of the ocean.

The Miocene greensand surmounting the Gay Head clay cliffs on Martha's Vineyard also means the same thing, and a still greater lapse of time, as the whole Cretaceous and Eocene strata are here apparently absent. The present height of these Miocene strata indicates indirectly the minimum of elevation, the depth of the sea in which they were deposited being at present one of the unknown elements. It has been suggested by some geologists that the eastern barrier was composed of granitic rocks, and thus furnished the materials for the New Jersey and other clays.* Many known facts support this view.

The western, or inner, barrier of this great fresh-water border lake is still well marked. In the New England region, the present rock-bound coast line indicates its approximate position, and retains in its bays and inlets remnants of the deposits then laid down. Away from the coast, I know of only a single locality that seems to have preserved these beds, and that is near Brandon, Vermont. This basin I explored long ago, and, if my memory serves me rightly, I saw there the typical clays, lignites, and iron ores, that mark the horizon now under consideration. South of New England, the inner barrier is equally well defined by the Triassic and older rocks to the Potomac River, but beyond that point I have not carefully examined it.

*Geology of New Jersey, Report on Clays, p. 30, 1878.

PHYSICAL CHARACTERS OF THE JURASSIC.

The strong resemblance in their physical characters between the fresh-water deposits here regarded as Jurassic and those long known to be such in the Rocky Mountain region is largely dependent on the materials of which they are formed, and the conditions under which they were deposited. The close correspondence in this respect between the beds of the two regions should have some value in estimating their age.

The most striking feature in these deposits is the variety of colors in the plastic clays. Brilliant red, green, and yellow tints are especially prominent, yet the white and black shades are equally noticeable. While these colors are often seen in great masses, marking definite strata in fresh exposures, they blend one with another from the effects of weathering, where the original colors wash over each other. In the Rocky Mountain region the brilliant hues of the Jurassic strata may be seen for miles on the face of the high bluffs. This is especially remarkable in the cliffs at Como, Wyoming, a representation of which is before you. Still more brilliant effects may be seen in the canyons on the west side of the Green River, in eastern Utah.

East of the Rocky Mountains the same color scheme is well illustrated around the Black Hills, in South Dakota. Again in the foot-hills west of Denver, near Morrison, Colorado, a similar exhibition is to be seen, as represented in the second drawing. This is repeated on a much larger scale further south, near Cañon City, Colorado, as likewise shown in still another sketch, but none of these colored drawings does justice to the natural scenery.

On the Atlantic coast the same combination of colors, although less brilliant, may be seen in the Potomac outcrops in Maryland, now proved by vertebrate fossils to be likewise Jurassic. Further north the reds predominate in this horizon across Delaware and Pennsylvania, but in the plastic clays of New Jersey the strong, distinct colors, usually in horizontal bands, are dominant. On Staten Island and at various outcrops along the northern shore of Long Island, as well as on Block Island, the same horizon is distinctly marked by variegated patches, while still further east, at Gay Head, on Martha's Vineyard, the most startling color display of the whole Atlantic coast forms a flaming beacon that mariners and geologists alike have for a century held in high esteem. I know of no other horizon of equal extent so readily distinguished from all others by its physical features.

EARLY INVESTIGATIONS.

In the early days of American geology the pioneers here, as in other branches of science, attempted to refer everything to European standards. In this way, strata of various ages, as we now know, were called by European names and were supposed to represent equivalents. In this general way, the terms Lias, Oolite, etc., were applied to strata on the Atlantic coast. It was soon found, however, by the actual workers in the field, that our geological sequence had only a general correspondence with that of Europe or of other parts of the world, yet some geologists still endeavor to harmonize the time tables, but with only moderate success. It is, however, now becoming known that this continent had its own law of development, and that its fauna and flora must be studied by themselves to disclose their full significance. The time ratios of America certainly do not coincide with those of Europe. The long periods of Mesozoic time represented in Europe by great deposition of many series of strata were marked here by other means as well. The rich fauna and flora that then lived here do not have their exact counterparts elsewhere.

The apparent absence on the Atlantic coast of the Jurassic as known in Europe naturally led the early geologists to seek its equivalent strata. The first supposed identification seems to have been recorded by W. B. Rogers, who called the eastern Virginia coal beds Oolitic.* These beds are now regarded as Triassic.

This eminent geologist also referred to the Jurassic certain silicious, argillaceous, and pebbly beds in Virginia and further north, as possibly 'a passage-group analogous to the Wealden of British geology.'† P. T. Tyson in 1860 referred the Maryland clays to the Cretaceous, and later to the Jurassic.‡

Long before this, in 1835, H. D. Rogers, in his sketch of the geology of North America, clearly recognized what is here regarded as Jurassic as pertaining to one great formation. He described this as extending along the tide-water plain of the Atlantic, from the Carolinas through Virginia, Maryland, Delaware, Pennsylvania, and New Jersey, and also as continuing on through Long Island to Martha's Vineyard and Nantucket. He gave it the name of 'Ancient Alluvium,' but included in it the plastic clay formation and part of the Gay Head deposits, the latter of which he considered Cretaceous.§

* Transactions Association American Geologists and Naturalists, Vol. I., p. 300, 1843.

† Proceedings Boston Society, Vol. XVIII., pp. 104, 105, 1875.

‡ 1st Report State Chemist, Maryland, p. 41, 1860; 2d Report, p. 54, 1862.

§ Report British Association, Edinburgh Meeting, pp. 1-66, 1835.

The next noteworthy description of the Jurassic as here defined was given by J. C. Booth in his report on the Geological Survey of Delaware, 1841. He described the variegated plastic clays of that state, and gave to them the name of 'Red Clay Formation,' which he regarded as belonging to the Upper Secondary. The more recent publications on this Atlantic Coast formation are well known, and need not be cited here.

Among the early explorers who contributed to our knowledge of the Jurassic of the Rocky Mountains and Pacific coast region were J. Marcou, in New Mexico, 1853; C. King, in California, 1863; and, in the same State, W. Gabb, 1864, and F. B. Meek, 1865.

The earliest discovery of the Jurassic in the Arctic region of this country was by Sir E. Belcher, in 1852, who found remains of *Ichthyosaurus* on Exmouth Island. The latest information in regard to the Jurassic comes also from the Arctic region, where Nansen has found this formation containing many fossils, near Franz Josef Land.

JURA-TRIAS.

The term Jura-Trias, now in use, is in reality a confession of ignorance, excusable, perhaps, a quarter of a century ago, but unpardonable now in those whose duty it is to map or define the formations of this country. Yet this term is still sometimes used for so clean-cut a Triassic horizon as the Connecticut River sandstone. It is true that in early days of New England geology this formation was in part referred to the Jurassic, but at the present time no one at all familiar with the evidence of the abundant vertebrate life found in it could make such a mistake. This is equally true of the southern extension of the same formation along the Atlantic coast, where it is everywhere quite distinct from the Jurassic. In the West the dividing line is less marked in some regions, but I believe that even there careful explorations alone are required to separate these two allied formations.

VERTEBRATE FAUNA OF THE JURASSIC.

The Jurassic age of the Atlantosaurus beds of the West has now been demonstrated beyond question by the presence of a rich fauna of mammals, birds, reptiles, and fishes. Among these the *Sauropoda* were dominant and the other Dinosaurs well represented.

In the Potomac beds of Maryland the same Jurassic vertebrate fauna is present, as shown by the remains of five different orders of reptiles already discovered in them. Among the Dinosaurs are the *Sauropoda*, the *Theropoda* and the *Predentata*, the first group represented by several genera and a great number of individuals. One of these genera is *Pleurocœlus*, which has also been found in the Jurassic of the West. Besides the Dinosaurs, characteristic remains of *Crocodilia* and *Testudinata* are not uncommon, and various fishes have been found. The remains of these six groups already known are amply sufficient to determine the age of the formation, and still more important discoveries doubtless await careful exploration.

The discovery of vertebrate fossils further east is merely a question of systematic work. That they are there, all experience in this horizon clearly indicates. In 1870 I passed over miles of similar strata on the eastern flanks of the Uinta Mountains, with every man of my expedition on the lookout for fossils, prompted both by zeal for science and a special reward for the first specimen, but also on the alert for the hostile Ute Indians around us, yet not a fossil was seen. Ascending a few hundred feet, I found the sides of a narrow canyon full of fossils, vertebrate and invertebrate, all of Jurassic forms. The stratum once established, the supposed barren clays soon furnished rich localities.

The similar Potomac clays were formerly pronounced quite destitute of animal remains by geologists of eminence, but hard work disclosed their treasures. The coast east of the Hudson has an abundance of the same strata, and offers still greater rewards to explorers. The Gay Head Indians are not hostile, but will be found active assistants in the good work, while holding fast to the traditions of their ancestors as to the volcanic origin of their narrow sea-scourged home.

LONG ISLAND SOUND.

It is evident that we know the remnants only of the great formation we are now discussing, for the larger part of it has long since been swept away, and much of the remainder is covered up or obscured by later deposits. The origin of this formation is a great question in itself, while its gradual destruction offers still larger problems to the geologist. One of these only I have time now to touch upon, and that has special interest for me, as day by day from my study window I look across the Sound to Long Island.

The origin of Long Island Sound was doubtless largely dependent upon the soft Jurassic clays that once filled its bed. The barrier on the north was the rock-bound New England coast essentially as it is to-day. The outer barrier, now removed or beneath the ocean, was perhaps of less durable material, and, as the coast subsided, gradually succumbed to the assaults of Atlantic waves. The great terminal moraine at the close of the glacial period proved a second barrier, and the waters from the melting ice and the larger rivers sought an outlet to the sea, both east and west, and thus a channel was formed in the soft clays and sands that the strong ocean currents gradually enlarged to its present size.

CONCLUSION.

The problem now before us is the presence or absence, on the Atlantic coast, of strata of Jurassic age. The exact position where such deposits should be found, if present, is well known to all geologists familiar with our eastern border. The fresh-water Triassic beds below this position and the extensive marine Cretaceous above have long been carefully studied and their exact limits defined.

For many hundred miles, along the line where the Jurassic should occur, there is a well-marked series of fresh-water clays and sands quite distinct from anything else on the coast, and the question is,—are these beds of Jurassic or Cretaceous age? The prevailing opinion hitherto has been strongly in favor of the latter, although this view separated two allied fresh-water formations, and still left out the great Jura, so well represented in other parts of the world, and especially in our own Rocky Mountain region.

How difficult it is to lay aside preconceived opinions, everyone knows. The long supposed absence of the Jurassic on the Atlantic coast seems to have blinded those who had the formation under their feet. The evidence to-day in favor of its presence, if not conclusive at every point, is vastly greater than the opposing testimony. Moreover, its acceptance explains at once a mystery of long standing—why the records of Jurassic time were not preserved here in their true place.

To call this peculiar Atlantic formation Cretaceous in its various eastern outcrops, when the western expansion of the same characteristic deposits has been proved Jurassic, is certainly not scientific. To do this in the light of present testimony, including the animal remains, vertebrate and invertebrate, the unique structure and materials of the strata themselves, and especially their definite position where the Jura should be, is to violate the laws of evidence.

No geologist familiar with the facts will deny that the variegated Potomac clays in Maryland are continuous with those in Delaware, Pennsylvania, and New Jersey, and that the similar basal clays on Long Island, and the other islands to the eastward as far as Nantucket, are part and parcel of the same series. There is now positive proof that the southern end of this series is Jurassic, and it is certainly a fair conclusion that the remainder is of the same age. The burden of proof will rest upon those who hold to the contrary.

To place the strata in question in the Jurassic section of the Atlantic coast at once removes many difficulties that have hitherto perplexed students of the Mesozoic of this region. It completes the series, and shows in part, at least, what was done in deposition during that long interval between the end of Triassic and the beginning of Cretaceous time, when the great barrier was broken down, which, from the Devonian to the Cretaceous, shut out the waters of the Atlantic.

I must leave it to others with leisure at their command to work out the details of this well-marked series, and its relation to those above and below. I have no time to devote to the surface geology of this belt or to the earlier deposits of Tertiary time. Just now the Mesozoic interests me most of all, especially its middle section, the Jurassic, as I believe great injustice has been done, since this has been denied its rightful place, and a name not its own stamped upon it.

In a later communication I hope to discuss this question further, and especially the Jurassic beds south of the Potomac River. O. C. Marsh.

Yale University, New Haven, Conn.

VOLCANIC ASH IN SOUTHWESTERN NEBRASKA.

In the summer of 1894 I spent two days in southwestern Nebraska in the examination of certain deposits of volcanic ash. These deposits were seen at three localities, viz: 1° near Ingham, Lincoln county; 2° near Edison, Furnas county, about forty-five miles southwest of Ingham; and 3° near Orleans, Harlan county, about twenty miles southeast of Edison. At all of these localities there are several more or less closely associated exposures of the ash. In all cases it appears in the side or near the head of a canyon-like ravine. In the ravines where it occurs it is to be seen only where the walls are essentially vertical, and in all places it is capped by loess. It is probable that the failure of the ash to appear at many points on the sides of the ravines in which it occurs is due to the fact that the loess from above has slumped down, concealing it.

The deposits near Ingham. The volcanic ash near Ingham is exposed at four or five points, the most widely separated of which are less than a mile apart. The first suggestion of the exposures was that the ash formed a continuous layer beneath the loess, and that it failed to appear continuously in the wall of the ravine only because it was locally concealed by the slumping of the loess above it. Further examination, however, showed that this was probably not the fact, for at one point a layer of ash was seen to thin out promptly from a thickness of twenty-two feet to a thickness of four or five.

The ash at this point varies in color from nearly white to a yellow-cream color, on the one hand, and to a light gray, on the other. It varies in grain from the grade of coarse sand to that of fine flour. These grades of coarseness do not appear to be the result of admixture with foreign substances, for no such materials could be detected on the ground, and microscopic examination confirmed the field conclusion. The ash is more or less affected by streaks or pockets of loess which appear to represent the filling of holes made by burrowing animals or by the roots of trees. In places there are thin sheets of lime carbonate, which have been concentrated by water from the loess above and deposited in the cracks in the ash.

Deposits near Edison. The ash of this region is four or five miles south of the station. The exposures are but two in number, but much larger than those near Ingham. Their general relations are the same. Where the wall of the valley is steep or vertical the ash appears, but where the slope is gentle, as where the loess has slidden down from above, it was not exposed. The larger of the two exposures near Edison extends along the side of the valley for a distance of several hundred yards, interrupted here and there by a mass of loess which has slumped, locally concealing it. The thickness of the bed is in places more than twenty feet. The ash is more uniform in texture than that near Ingham, there being none so coarse as the coarsest at that point. It seemed to be equally free from foreign matter. A re-entrant in the side of the ravine in which the main exposure occurs, shows that the ash runs back from the wall of the ravine where the main exposure occurs, in undiminished thickness.

The second exposure near Edison is about a-half mile from the first and in another valley. The exposure is much less extensive than the first laterally, though nearly as thick. It is very probable that the ash is continuous between the two ravines in which it is exposed.

Deposits near Orleans. The best of the exposures in this locality is near the head of a small ravine tributary to the valley of the Republican river. Its general relations are identical with those of the ash at the other localities. As there, it is covered by loess, and as there, it appears only where the valley slopes are steep and where the loess has not slumped. The exposed part of the deposit here varies in thickness from five to twelve feet, and the ash is very fine and white.

Ash in lesser quantities was seen at several points in the vicinity. In some cases, especially where thin, it is more or less mixed with earthy matter.

At most of these places the ash showed more or less evidence of stratification; but in the faces exposed in 1894, the stratification was not of such a character as to make it altogether certain that the ash was deposited in water. If deposited in water, it must have been at a time when this region was covered with a lake, presumably a late Tertiary lake, to which the wind brought the ash. So far as the relationships of the ash were seen, it was only clear that the ash was deposited, and probably somewhat eroded, before the deposition of the loess, and that the loess was deposited before the valleys in the banks of which the ash is exposed were excavated.

It has long been known that volcanic ash exists in other localities in Nebraska. Some of these were noted long since by Prof. Todd and Mr. Merrill, but, so far as I am aware, no publication has been made of the ash at the localities here mentioned. It may be of interest to add that the volcanic ash from this region has already become an important article of commerce, under the name of pumice. It has been found to be available for all the various uses to which pulverized pumice is put.

Rollin D. Salisbury.

University of Chicago.

THE MODERN VERSION OF THE LAW OF SUPPLY AND DEMAND.

A most interesting illustration of what the writer has called 'The Modern Version of the Law of Supply and Demand' is seen in recently published statistics of the copper production of Lake Superior, given out by Mr. Stanton, Treasurer of the old Central Mine. This mine has been in operation many years and has continuously supplied the market, in competition with the Calumet & Hecla and other more favored mines, with almost uniform profit; notwithstanding all the fluctuations of business during its now long life. The statistics are published in *The Iron Age*, in a late issue, and may be there consulted for details. The general facts are that, in the words of the 'modern version,' above mentioned, "increase of demand has been accompanied by the decreased costs, due to increased supply and improved methods."

The older version reads: "Increased demand produced increased prices; increased supply gives lower prices." The fact has come to be, in all the great fields of industry in which, as now, ample capital can always be secured for any legitimate enterprise, and especially in those in which invention and the mechanic arts play any large part, that "*Increased demand and an enlarged market, like inventions and discoveries and improved methods, by permitting more economical operation of the system of production, decrease prices.*"

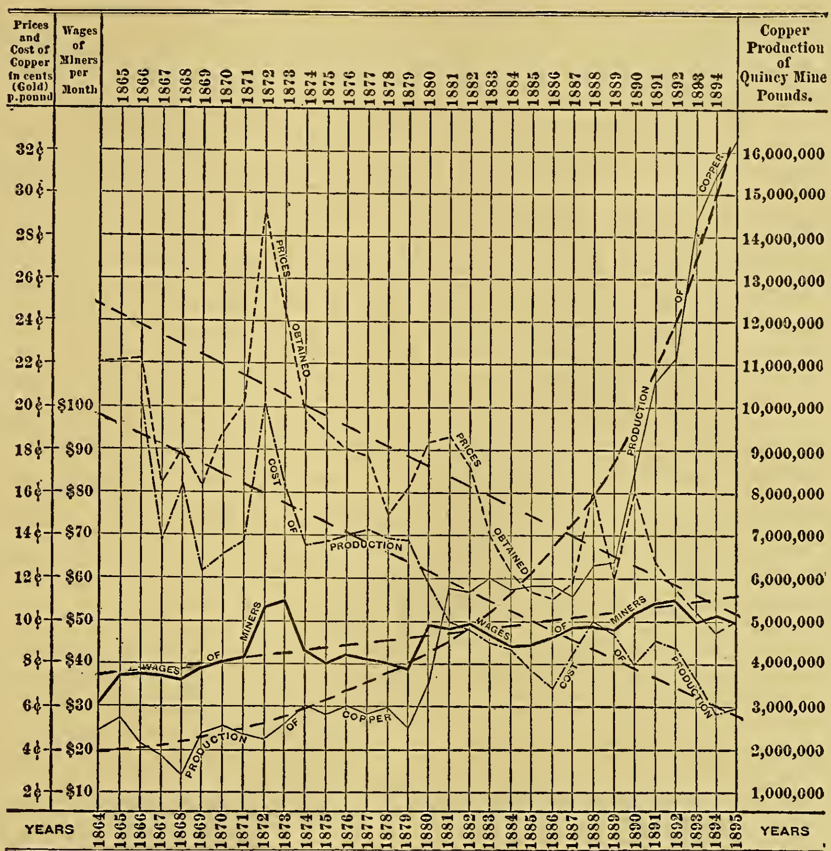
A contract for ten newly invented sewing machines could only be filled to-day, with profit, at a price, we will say, of $100 each; a contract for 10,000 could be filled probably at $10 each. A mine raising 100,000 tons of ore annually must charge more per ton, or accept lower profits, than if its production were a half-million tons, the office and general expenses being then assessed upon the smaller quantity. The fact above stated with reference to copper is true of silver, of gold in less degree, of iron, and of, in fact, all the products of mine and factory, and even of the soil in the long run.

The most generally illustrated action of the law of supply and demand, in recent times, would seem to be the following: Decreasing cost of production gives larger demand and stored capital permits larger supply. This reduced cost is also an element of the change in the case of copper production, which is more influential in causing the curious and interesting economic results observed, as above, in the case of copper, silver and other metals, than is any other. By improved processes and recent inventions the cost of production of the metal has been brought down to about one-half the figures of a generation ago, while the productiveness, and therefore the market value, of the labor engaged in this more efficient production is at the same time increased.

These facts are also shown in the accompanying diagram, which is reduced from the figures of the Quincy mine. It is seen that the introduction of improvements of methods and economics in various directions has produced a constant and a fairly steady diminution of prices in the copper market, while the resultant increasing demand has been met by a steady increase of supply—both measured by the production curve. Meantime the wages paid have been increasing as steadily throughout the period observed.

Prices are made in the general market and indicate the progress of the average of all mines in reduction of costs; for the market price, in all open business, is costs plus, in the long run, a fair business profit. Costs are determined by the conditions of the particular case, the progress of improvements and the influence of new inventions and discoveries. If the costs are not so far below the market price as to permit a fair profit to be in the long run made, the business languishes or expires. If the profits are abnormally large, more capital at once goes into production and reduces the excess by increasing supply, widening the market at a lower price.

During the past generation, and particularly the twenty years preceding the com-



Relations between wages, prices, costs and quantity.
[*From The Iron Age.*]

mencement of the existing crisis, costs have been on the average, in the copper producing industry, steadily and rapidly diminished by the use of rock drills and high explosives, as well as by diminishing costs of transportation and handling. The reduced costs have permitted reduced prices, which, in turn, have stimulated demand. The enormous quantity of free capital now existing has permitted immediate response to the demand and corresponding increase of supply. And thus, in consequence of the greater influence of invention and improvements in the arts, and especially of the increase of the amount of available capital in these later years, we see what may be termed a reversal of the customary statement of the law of supply and demand, and 'increasing demand produces decreased prices.'

Commenting upon these figures, *The Iron Age* says:

"We need hardly add that these bald figures, eloquent though they be, do not tell the whole tale of the wonderful improvement in the condition of the workingman, when instituting a comparison between the days before the war and those of the last decades. Only he who knows the life of a young mining location in the woods, and of the condition of the communities of the Lake copper region at the present day, can grasp all its significance."

Invention, discovery and general improvement in all the useful arts now control substantially all economic phenomena, and determine costs, which in turn determine the demand, and the demand now always meets the supply at a price which gives fair business returns on capital.

R. H. Thurston.

IN MEMORIAM: JOHN GREGORY BOURKE.

In 1892 the country was startled by the announcement in the papers that Captain John Gregory Bourke, of the Third Cavalry, United States Army, had been assassinated in broad day and in a thronged court-room in Texas, by some friends of the bandit Garza, against whom the Captain was testifying and whose forces he had defeated on the Rio Grande frontier. The grief and indignation in the army were intense, and many tears were shed by eyes unused to weeping, for there was no man in the military service who had friends more numerous and sincere than those of Captain Bourke. But after some days of mourning, our joy returned on learning that the item in the papers was false, that no coward shot had been fired as reported, and that Captain Bourke still remained a terror to the marauders of the Rio Grande.

Four years passed, and again we were shocked with the sudden and unexpected tidings of his death. But on this occasion the tidings were, alas! true. Now they came from a hospital in his native city of Philadelphia, where, on June 8th, he had succumbed to the sequelæ of a surgical operation performed with a hope of saving his life. At the time it was not generally known that he was ill or stood in need of an operation. Such was the ending of a hero who had a hundred times faced death on the field of battle before the bullet of the civilized foe, and, literally, like the Baron Rudiger, ‘ Before the Paynim spear.’

Captain Bourke was a soldier by nature and knew no other profession than that of arms. At the early age of 19, while our Civil War was in progress, he volunteered as a private soldier (August, 1862), and served in that capacity until the close of the war. He so distinguished himself in this part of his career that he was appointed to the National Military Academy, upon the recommendation of his illustrious commander, General George H. Thomas, at the close of the war. After the usual course of four years at West Point, he was graduated in June, 1869, and received a commission in the Third Calvalry, with which regiment he remained until the time of his death.

During the seventeen years following his graduation he was doing duty on our Western frontiers, in lonely and isolated garrisons, where so many of our soldiers, in days past, have worn out years of miserable existence, and in active campaigns against hostile Indians.

After five years of work in Washington City, where he was ordered on special duty, connected with his ethnographic researches, he returned again to service with his regiment—not to a dull garrison life, but to the active, warlike service which seemed to be his usual lot. This time he fought, not the the civilized foe or the savage enemy, but the elusive outlaw of the Mexican border. How well he succeded is a matter fresh in the minds of all.

In 1893 he had another brief respite from his military duties, when we all met him in charge of the rare collection in the mimic convent of La Rabida, at the World's Columbian Exposition. When his work there closed he returned to his regiment and assumed command of his troop at Fort Riley, Kansas. But he had not rested long until he was called again to Chicago, but by a sterner duty than that which called him there before. He came to quell the rioters of 1894 and to protect the United States mails. He discharged his difficult duties on this occasion, as usual, with credit to himself and profit to his country.

At length, after its long and arduous service in the far West, the valiant regiment to which he belonged was given the merited reward of a pleasant and peaceful station in the East. It came to the newly constructed post of Fort Ethan Allen, on the shores of Lake Champlain. Here we hoped our friend might long remain to enjoy his well-earned repose before he went on another campaign, but here it was destined that his earthly campaigns should end forever.

"A courageous man," says Webster, "is ready for battle, a brave man courts it, a gallant man dashes into the midst of the conflict." To the class of gallant men, Captain Bourke distinctly belonged, and he represented the highest type of the American soldier. In his boyhood he won a medal of honor—that decoration of the Republic which none but the bravest may wear—for gallantry in the memorable battle of Stone River, in Tennessee. For gallantry during Indian campaigns he was tendered two brevet commissions, that of captain and that of major, but both of these he modestly declined.

Some idea of the fierce battles which he fought on the frontier may be gleaned from his writings; but in these, while fullest justice is done to the bravery of his comrades, his own heroic part is modestly suppressed. It is enough to say that, for years, he served on the staff of that distinguished warrior, General George Crook, for none who had not 'A frame of adamant, a soul of fire' found favor in his eyes or could long follow the severe labors which he demanded of his soldiers.

So much for the military career of our subject, over which we would gladly linger, but which we must dismiss with brief words, and proceed to consider his claims on our attention as an ethnologist—the claims which most interest the members of this meeting.

Like a true soldier, he honored a brave foe. If the Indian found him a deadly enemy in time of war, he found also a true friend and advocate in time of peace. At an early time in his career he became interested in the customs and languages of the Indians and began to note these. He gained the confidence and respect of Indian allies and was afforded rare opportunities for investigation. The notes made from his original observations form the basis of most of his works; but he found means also for enriching his fund of knowledge by means of comparative studies.

In 1886 he was ordered to Washington to compile his ethnographic notes. He remained at the Capital about five years, and during this period spent most of his time in the great libraries reading the works of early explorers and ethnographers and makings copious notes. How well he collated and how wisely he compared is evinced by his excellent works on the 'Medicine-men of the Apaches' and the 'Scatalogic Rites of all Nations.' Had he lived longer we have no doubt he would have drawn further from his ample store of notes.

Of his published contributions to ethnography, which were numerous, perhaps the most noteworthy was his 'Snake Dance of the Moquis of Arizona.' In this he set an early example to students in the too long neglected study of ceremony and showed how minute and careful the observations of ceremonials might be made. The existence of this wonderful rite was known to few when he first witnessed it, but his work spread the fame of the Mokis and their ophiolatry over the world. To-day the biennial rite attracts visitors from every quarter, and the high pueblo walls that overhang the sacred rock are thronged with hundreds of white faces, mingled with the dusky ones that look down upon the awful rite below. His work stimulated the efforts of other investigators. Many scholars have, since his book was written, made the long pilgrimage to the desert mesa to witness the ceremony, and some have spent years in studying the rite without yet learning all that there is to be known.

In 1895 Captain Bourke received two well earned tokens of the recognition of his work. He was elected Secretary of the Section of Anthropology of the American Association for the Advancement of Science and President of the American Folk-Lore Society.

As a writer, Captain Bourke displayed great power. In his scientific treatises he was clear and concise; in his popular works, entertaining, witty, and, to a high degree, graphic. His pictures of early days in Arizona and of wild life on the Western frontier have, in their way, not been excelled; while some of his descriptions of Indian campaigns and battles stand unrivalled in the literature of modern warfare.

Captain Bourke was only 53 years of age when he died—an age when men are often in the fullest exercise of their intellectual powers. Only a few months before his death he told the writer, in a letter, that he hoped soon to get retired from active duty, on account of length of service; to make Washington his home and to devote the remainder of his life to the study of American Ethnology. What a hope was here held out for Science! What a pleasant anticipation to the writer, who looked forward to frequent association, in congenial pursuits, with his valued friend! "Oh Death! Where is thy sting?" It is here. In our hearts we feel it. It will abide with us forever.

Our loss is irreparable. Some say that the loss of no man is irreparable and that where one falls, another as good takes his place; but with our subject such is not the case. The life he experienced, the scenes he witnessed, many of the customs which he had studied and had not described to the world are part of an irrevocable past. The 'sea of change' sweeps as a tidal wave over all that belongs to our aborigines. Many reminiscences stored in his memory are buried with him.

But while the world of science may mourn in its formal way, it is to the intimate friends of Captain Bourke that his loss is deeply painful. He was a man of the most charming personality. In his serious moods his conversation was wise and instructive, while, for his gayer moments, his wide experience and close observation had given him an inexhaustible fund of narrative. He was an excellent mimic and always told his story to the best advantage. He was not only a humorist, but a decided wit, and he had the rare faculty, when uttering his wittiest sayings, of assuming a sad expression of face which might put to shame 'The Knight of the Sorrowful Countenance.'

A gallant soldier, a chivalrous gentleman, a scholar of rare acumen, a faithful friend, a dutiful son, a loving husband, a devoted father; such was the comrade over whose grave the bugle has sounded 'taps' on the Heights of Arlington.

WASHINGTON MATTHEWS.

THE BOTANICAL SEMINAR OF THE UNIVERSITY OF NEBRASKA.

THE Botanical Seminar of the University of Nebraska celebrated its decennial on October 10th. The Seminar was founded on October 11, 1886, as a quasi-fraternal organization of seven students in the botanical department. It soon grew into a serious botanical society, and since 1888 has been maintained as such by graduate students in botany in the University. It is a unique example of a society without constitution, by-laws, or written rules of any sort. No election has ever been held, no motion has ever been made and no formal vote has ever been had upon any subject at its meetings. But the society has developed a traditional constitution of some complexity that is closely followed. Although it now exists solely as a scientific society connected with the botanical department of the University, many traces of its original character remain, such as the seal, the designations of the officers and the method of determining them, certain ceremonies of initiation, etc.

The decennial exercises were begun by a public meeting in the afternoon. At this meeting, announcements were made of five public meetings for the reading of papers to be held during the year, and two 'symposia,' or oral discussions of certain subjects under the leadership of one member. It was also announced that Dr. William Trelease would deliver the annual address before the Seminar in May next. Prof. Bessey read a paper entitled 'The Evolution of a Botanical Journal,' which is published in the *American Naturalist* for December. Mr. Clements read a paper on 'The Plant-formation as an Element.' Mr. Pound read a 'Report on the Work of the Seminar 1886–1896.' The following items are taken from this report:

The Seminar maintains four grades of membership, two for graduates and two for undergraduates, known as socii, ordinarii, novitii and candidati. Since the reorganization of the Seminar, all but socii have been required to submit to an oral and a written examination for each grade by examiners appointed by the Seminar. Fourteen examinations have been held and seven members have been admitted under this system. The subjects examined upon have been Anatomy and Morphology of Anthophyta and Pteridophyta, Physiology, Morphology and Development of the Lower Plants, Embryology of the Anthophyta, Taxonomy, Bibliography, History of Botany, Nomenclature, the Flora of Nebraska and Spencer's Principles of Biology. Twenty members have taken part in the work of the Seminar since its organization, of whom eight are now resident. Two students are now preparing for examination.

Since 1888 forty-five meetings have been held for reading papers, at which one hundred and fifteen papers have been read. About twenty-five of these have been published in various scientific periodicals. The titles of the papers read show great improvement since the Seminar began to hold such meetings. Among the title of papers read the first year are: 'The present Status of the Algo-Lichen Hypothesis,' 'History of the Classification on Fungi,' 'Buchloë and its Relatives,' 'The Homologies of the Uredineae.' In 1894–95 some titles are: 'Some Observations on Transpiration,' 'Sketch of a Revision of the Mucoraceæ,' 'The Derivatives of the Apical Cell in Beta vulgaris,' 'Recent Discoveries as to Cell-division.' In 1895–96 among the papers read are: 'The Phytogeography of the Little Blue Valley,' 'The Muciferous Canals in the Laminariaceæ,' 'The Position of the Ovule in Ranunculus.'

In 1895 the custom of an annual address by a botanist of note was established. Dr. Coulter delivered the first of the series. Professor MacMillan followed in May, 1896, and in May, 1897, Dr. Trelease will deliver the address. In addition, short talks have been made to the Seminar by Dr. Coulter, Dr. Burrill, Professor A. S. Hitchcock and Professor MacMillan.

In 1892 the Seminar undertook the Botanical Survey of Nebraska. When Dr. Bessey came to Nebraska, in 1884, no proper work had been done upon the flora of the State. An extensive and pretentious catalogue and several pretentious lists had been put out, but they were based on conjecture as to what should be in the State rather than on observation and collection, and were entirely unreliable. In 1886 the members of the Seminar began to take up the work of investigating the flora of the State, and in 1890 Mr. Webber, one of the original members, put forth a catalogue enumerating 1890 species. The next year he published an appendix containing 432 additions chiefly made by members of the Seminar, and, hard on the heels of this appendix, Dr. Bessey issued a supplement raising the number of reported species to 2492. To keep up this work and to give it system, the Survey was organized. This Survey is conducted and directed by the Seminar and is maintained entirely by the individual members without public assistance of any sort. Its fruits are four reports in which the reported flora of Nebraska is raised to 3196 species, a herbarium of 7500 specimens representing the flora of the State, and five important expeditions which have made possible an exact phytogeographical districting of the State. In consequence, Nebraska has come to be recognized as one of the best known States botanically in the country. The Seminar now has in preparation an elaborate report on the phytogeography of the State for which it has been gathering materials for many years.

A more ambitious undertaking has been the publication of the Flora of Nebraska, of which three parts have now been issued and two more are under way. The Flora has been fairly successful financially, and in other respects its success is unquestioned. In addition to the Flora and the Reports of the Survey, the Seminar has published two addresses delivered before it.

Of the eleven who have taken part in the work of the Seminar as ordinarii, four are now employed in the United States Department of Agriculture, namely, Mr. Smith, Mr. Webber, Mr. Williams and Mr. Woods; another is professor of Botany in a State Agricultural College, and another holds the botanical fellowship at Columbia University. All of them have become known through their published work, and they are all busily engaged upon other publications of importance.

At the close of the public meeting, Mr. Ernst A. Bessey was initiated as a novitius, having taken the required examinations. Letters were next read from absent members and friends of the Seminar and also letters which had been received from botanists and scientific men. Thereafter a 'symposium' was held, led by Dr. Bessey, upon the subject of the Laboratory Method. By way of introduction, Dr. Bessey spoke of the history and the development of botanical laboratories in the United States, and the present differentiation into histological and physiological laboratories. The future of botanical laboratories was then discussed, Dr. Bessey, Dr. Ward, Professor Bruner, Mr. Pound and Mr. Clements taking principal parts in the discussion.

In the evening, Dr. H. B. Ward delivered the anniversary discourse, before the Seminar and invited guests. His subject was 'Tendencies in Biological Investigation.' It would not be possible to do justice to the discourse by such a synopsis as could be given here.

At the close of the discourse the Seminar and its guests sat down to a collation served in the histological laboratory, which had been suitably fitted up for the occasion. Mr. Roscoe Pound, who acted as toastmaster, spoke for the 'Original Seven,' the founders of the Seminar. Mr. Clements responded for the 'Epigoni.' Professor Bruner responded to 'Canis Pie,' the emblem of the Society, and explained its appropriateness. Dr. H. K. Wolfe, in speaking on 'Philosophia Botanica,' said that the history of botany differed from that of most other sciences in that its progress had been uninterrupted by convulsions or catastrophes and it had kept moving. He had wondered if this might be due to the fact that Aristotle's work on plants was lost, so that the grasp of antiquity was less strong than elsewhere. "In spite of this constant growth," he continued, "there have appeared few great generalizations in botany, and so it is not absolutely correct to speak either of a botanical philosophy or of a philosophical botany. In common with all branches of biological science, botany must rest content with details and small excursions into neighboring fields of common interests. This is the fate of all modern investigation."

Dr. Bessey responded to 'How I manage the Boys.' He said that the fact was the boys managed him. He was like the prudent driver of a team, who, when he saw it was about to stop, pulled the reins and cried 'whoa,' or like the man who 'manages' his household, or like the meteorologist who manages the weather. As to the relation of the Seminar to his department, he said it must be remembered that the Seminar had grown up as an independent society and was not a part of the department. It was an ally—a close friend. Its help was like the help that a good wife is to a man, and the same kind of 'management' existed in each case. He had always adhered to Joseph Henry's rule; he let the boys work, and let them take up any line they would without restraint.

Responses were made by Dean Sherman, of the chair of English literature, who commented favorably upon the fraternization of scientific savants and literary scholars, who aforetime were too much inclined to fall upon each other by the way, and by the Chancellor of the University, who saw in the present occasion the beginning of a closer union of the workers in the different fields of science in the University, as well as the promise of higher and broader work such as should be found among scholars; "the work of the Seminar is true university work, and the spirit it fosters is that which is the peculiar feature of the genuine university."

*FOURTEENTH ANNUAL REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.**

THE Committee on Indexing Chemical Literature presents to the Chemical Section its fourteenth annual report. During the year ending August, 1896, there has been exhibited much activity in chemical bibliography and indexing; several valuable works have been completed and many important undertakings have been begun.

WORKS PUBLISHED.

A Dictionary of Chemical Solubilities. Inorganic. By ARTHUR MESSINGER COMEY. New York and London. 1896. pp. xx+515. 8vo.

Prof. Comey is to be complimented on the completion of the first part of his extensive undertaking, and chemists are to be congratulated on the publication in such good form of so important an aid to research. It is to be hoped that this volume will be so well received as to encourage the author to follow promptly with the organic section.

Index to the Literature of the Detection and Estimation of Fusel Oil in Spirits, by W. D. BIGELOW. *J. Amer. Chem. Soc.*, Vol. xviii., No. 4, p. 397.

This was announced in our report for 1895.

Bibliography of Embalming, in a Thesis entitled: 'Embalming and Embalming Fluids,' by CHARLES W. MCCURDY (of the University of Idaho). *Post-graduate and Wooster Quarterly*, April, 1896.

A very full bibliography of this unique subject, which has its chemical aspects as well as its grave ones. It comprises about 500 entries, in several modern languages, arranged alphabetically by authors.

* Presented at the Buffalo Meeting of the American Association for the Advancement of Science.

References to Capillarity, by John Uri Lloyd, in his 'Study in Pharmacy.' Privately Printed. Cincinnati, 1895–96. 8vo.

Atomic Weights form the subject of a brief bibliography (24 titles) accompanying an article on the same topic by Alexander Scott. *Science Progress* Vol. I., p. 542 (August, 1894).

The Composition of Water, a short bibliography, by T. C. Warrington. *Chem. News*, Vol. lxxiii., p. 137 *et seq.* (March, 1896.)

A Short List of Books on Chemistry. Selected and annotated by H. Carrington Bolton, *Scientific American Supplement*, October 19, 1895.

Bibliography as a feature of the Chemical Curriculum. By H. Carrington Bolton. Science, October 4, 1895.

Review of American Chemical Research, edited by Arthur A. Noyes. In the *Technology Quarterly*, issued by the Massachusetts Institute of Technology, Boston, Mass.

The first paper appeared in the number for April, 1895 (Vol. viii., p. 90); the reviews consist of abstracts of papers in periodicals, grouped under the following heads: General and Physical Chemistry, Inorganic, Organic, Technical, Sanitary, Agricultural, Vegetable, Metallurgical, Assaying, Geological, Mineralogical, Apparatus. Each abstract is signed by the abstractor.

This review promises to be an important contribution to contemporary chemical science of America, and deserves to be well supported.

Enumeration of Titles of Chemical Papers. This bibliography has been published monthly since May, 1894, in *Science Progress*, London. It embraces titles (without comments) in several European languages.

Bibliography of Agricultural Chemistry (American).

The several publications of the scientific bureaus of the United States government contain many valuable contributions to chemistry in its applications to agriculture and the arts, widely scattered in their pages, and it has been difficult to keep informed with reference to them. Thanks, however, to the excellent bibliographical work of the Office of Experiment Stations, U. S. Department of Agriculture, Washington, D. C., the chemical treatises published in the Bulletins of the State Institutions are made accessible; this is accomplished in the three publications here named:

Experiment Station Record, Vol. iii., No. 12 (July, 1892). *Bulletin* No. 19 (1894), and *Bulletin* No. 23 (1895). Organization Lists of the Agricultural Experiment Stations, U. S. Department of Agriculture, Office of Experiment Stations.

These contain: 'Lists of Station Publications,' giving dates, bulletin numbers and titles of each bulletin, under each State, alphabetically arranged. For the agricultural chemist these bibliographical helps are too important to be overlooked.

The Committee also chronicles the publication of the following valuable aids to chemical research:

Synopsis of Current Electrical Literature during 1895, by Max Osterberg. New York (D. van Nostrand Co.), 1896. pp. xiii+143. 8vo.

This is a classified index, with an index to authors, compiled from fifty-nine foreign and American periodicals; it is intended to be published annually.

General-Register zu Ladenburg's Handwörterbuch der Chemie. Breslau, 1895. pp. 160. 8vo.

Bibliographie des travaux scientifiques * * * publiés par les sociétés savantes de la France, dressée sous les auspices du ministère de l'instruction publique; par J. Deniker. Paris, 1895. 4to.

REPORTS OF PROGRESS.

The Index to the Mineral Waters of the World, by Dr. Alfred Tuckerman, noticed in previous reports, has been completed and accepted for publication by the Smithsonian Institution.

The manuscript of a new edition of the 'Catalogue of Scientific and Technical Periodicals, 1665–1882,' by Dr. H. Carrington Bolton, has been completed and is now going through the press. The new edition will be issued by the Smithsonian Institution as a volume of the Miscellaneous Collections. The bibliography includes chemical journals, and is brought down to the year 1895.

Dr. Bolton reports progress on a supplement to his 'Select Bibliography of Chemistry, 1492–1892,' the printing of which is, however, postponed.

Prof. James Lewis Howe reports the completion of the manuscript of an Index to the Literature of Platinum and its Compounds; this will be presented to the Chemical Section at the same session with this report.

Prof. F. P. Venable has completed an Index to the Literature of the Periodic Law. It accompanies his 'Development of the Periodic Law,' published by the Chemical Publishing Co., Easton, Pa.

WORKS IN PREPARATION.

Dr. Alexis A. Julien has no less than three bibliographical works well advanced:

(1) A Bibliography of Sand (including chemical analysis, etc.).

(2) A Bibliography of Pedesis, or the Brownian movement.

(3) A Bibliography of the Condensation of Gases on the surface of Solids.

Dr. Arthur C. Langmuir is engaged on an Index to the Literature of Zirconium.

Mr. George Wagner, of the University of Kansas, has undertaken an Index to the Literature of Oxygen, on a large scale. In this work he will have the counsel of Prof. Albert B. Prescott.

Dr. C. H. Joüet has the manuscript of an Index to the Literature of Thorium well advanced towards completion.

Prof. Rudolph A. Witthaus has compiled a Bibliography of Forensic Toxicology, which will appear in Vol. iv. of Witthaus and Becker's Medical Jurisprudence, New York, 1896.

The Journal of the Society of Chemical Industry announces a Collective Index for the whole series, 1881–1895. This is to be ready in 1896 and will form a volume of about 500 pages quarto.

Attention is called to a plan for facilitating bibliographical researches, adopted by the American Pharmaceutical Association. The Research Committee of this Association employs a reference reader whose duty it is to supply original literature to investigators working in the Committee and with it. A list of the chief serials and a few encyclopedic works are placed in the hands of those who apply for the services of the reader. Transcripts, abstracts and translations are supplied. The service is chiefly for literature beyond the smaller libraries, and is under the direction of the Chairman of the Committee.

Perhaps a similar scheme might be organized within the American Association for the Advancement of Science.

In conclusion, the Committee on Indexing Chemical Literature desires to state to those not acquainted with the announcements made in the preceding annual reports, that it labors to foster individual undertakings in chemical bibliography, to prevent futile duplication of work, to record in these reports completed bibliographies and new enterprises, as well as to chronicle progress in bibliography in lines bordering on chemistry. Suggestions as to topics, methods, channels of publication, etc., will be cordially furnished by the Committee. Address correspondence to the Chairman, at Cosmos Club, Washington, D. C.

H. Carrington Bolton, *Chairman*,
F. W. Clarke,
A. R. Leeds,
A. B. Prescott,
Alfred Tuckerman,
H. W. Wiley, *Committee*.

CURRENT NOTES ON PHYSIOGRAPHY.

PACIFIC OCEAN CURRENTS.

Dr. Cäsar Puls contributes an elaborate discussion, based on original records, of the surface temperatures and currents in the equatorial belt of the Pacific Ocean to the 'Archiv der Deutschen Seewarte' (Hamburg, XVIII., 1895, 1–38, with 12 monthly charts). The chief interest attaches to the equatorial counter current, which maintains its eastward course all across the ocean between the wind-driven, west-flowing equatorial currents on the north and south, the latter being much the stronger of these two. The north equatorial current, from 9° to 20° N., is strongest in March; it is not altogether supplied at its east end by the weak southward current along our west coast; it receives much water from the counter current which turns northwest at its east end, and not southeast, as ordinarily mapped. At the west end of the north equatorial current, part turns north to flow past Japan, and a lesser part south to join the counter current. The great south equatorial current, from 12° S. to 5° N., is strongest in September, and has its highest velocity along its northern margin, sometimes over 100 nautical miles in 24 hours. It is largely supplied by up-welling water along the west coast of South America, where the wind blows off-shore; the Humboldt surface current is not sufficient to feed it. Part of this great equatorial current turns south before reaching the Solomon Islands; the rest passes on north of New Guinea and turns sharply back at the 'root' of the counter current, except from December to May, when this branch is turned back on itself by the northwest monsoon then and there prevalent, forming a short counter current south of the equator. The north counter current, extending all across the ocean, is said to be much influenced, but not produced, by the winds. Near its west end it is favored for three-quarters of the year by the southwest monsoon; and from July to October, when it is, as a whole, strongest and broadest, its east half is favored by the narrow belt of monsoon winds there and then occurring. It is narrowed and weakened in our winter, when these favoring winds are wanting, and from January to March, under the extended northeast trade, it may be stopped or locally reversed; but where and whenever these adverse winds weaken or shift, the current reappears, and sometimes with increased strength. Yet, as a whole, it is regarded as a compensation current, discharging eastward the excess of the wind-driven south equatorial current, which has no sufficient escape at its west end.

If a narrow current, 8,000 miles long, can be a compensation current, a prévious note on this subject in Science (III., 1896, 921) should be somewhat modified. It may be added that according to these descriptions the Pacific counter current serves indirectly to carry water continually from the southern into the northern hemisphere, receiving a supply from the south at its west end, and discharging its flow chiefly northward at its east end; thus doing what is more directly accomplished in the Atlantic by the cross-equator extension of the south equatorial current past the Guiana coast. In the Pacific, as in the Atlantic, a compensation for this excess of surface movement into the northern hemisphere must exist beneath the surface, and with fuller data as to deep temperatures this may aid in deciding the cause of the deep oceanic circulation. (See SCIENCE III., 185, 824.)

THE EAST AND WEST INDIES.

PROF. K. MARTIN, of Leyden, discusses the origin of the above-named region (Zur Frage nach der Enstehung des ost- und westindischen Archipels. Hettner's Geogr. Zeitschr., II., 1896, 361–378). His style of treatment is elementary and somewhat incomplete, and his method does not reach far into the past. Sea cliffs cut in elevated coral reefs are described at three levels on Curaçao, where the successive steps seem to be of artificial regularity. As the cliffed reef rings around the island with small interruption, it is regarded as an uplifted atoll. Other examples are given. In the East Indies, on Saparua, east of Amboina, eleven terraces are found in elevated reefs; on Buton, southeast of Celebes, nine. The coastal plain of Dutch and British Guiana slopes gently northward; here reefs are wanting, as the shallow impure water was unfit for coral growth; but former shore lines are distinctly marked by elevated beaches, largely composed of shells, like the existing beach walls. Fourteen of these have been counted, Paramaribo being on one of them. Elevated coral reefs are again wanting on the larger East Indian islands, but their marginal plains contain plentiful marine shells of recent species; these being well preserved about Batavia. Additional facts are mentioned, but they hardly cover the wide areas considered. It is concluded that at a recent date the configuration of the shore lines was very unlike that of to-day, and that an extensive elevation has been in progress.

THE RIVER ETSCH.

PENCK gives an account of Etsch, flowing southward through the Tyrol to the Italian plain, where it is known as the Adige (Zeitschr. Deutsch. u. Oesterr. Alpenvereins, XXVI., 1895, 1–15). The river lies somewhat to the east of the axis of a Tertiary trough that is included between the Adamello Mountain group on the west and the dissected Dolomite plateau on the east. Below its torrential headwaters, rock is not exposed in the aggraded valley floor. Lateral streams bring in much detritus, forming fans at their mouths and driving the main stream against the opposite valley wall. Up stream from each fan the slope is moderate, and the flood plain is sometimes swampy; but immediately down stream from the fans the descent is rapid. No cause is assigned for the clogging of the rock-cut valley. The narrow gorge through which the river emerges upon the plain is here, as commonly elsewhere, a result of morainic displacement from the preglacial valley. The valley is slightly incised beneath the general level of the plain for about a third of the way to the mouth; but on reaching the level where the ground water of the plain emerges in numerous springs (fontanili) the river becomes an aggrading stream and rises above its surroundings, so as to need diking. In this lower part of its course it is turned aside from the Po, whose aggrading action is more powerful, and for this reason the Adige pursues an independent course to the Adriatic.

HARVARD UNIVERSITY. W. M. DAVIS.

CURRENT NOTES ON METEOROLOGY.

CLIMATIC CONTROL OF CIVILIZATION IN AFRICA.

THE influence of climate on civilization in Africa was brought out by Scott Elliot before the Geographical Section of the British Association at Liverpool. Africa may be divided into four regions: (1) the wet jungle, characterized by great heat and continuous humidity; (2) the deserts, with no proper rainy season; (3) the acacia and dry grass region, with distinct dry and wet seasons, and (4) the temperate grass and forest region, with moderate rainfall, modderate heat and no season so dry as to leave a permanent mark on the vegetation. As regards the characteristics of the people who inhabit these different regions, it seems that the wet jungle is the home of small weak tribes in the lowest stage of civilization. Healthy and vigorous tribes, on the other hand, inhabit the desert. The acacia region is rather densely populated everywhere, but no large emigrations have taken place from it. The temperate grass and forest regions are inhabited by vigorous and turbulent native tribes, who have, except in one instance, resisted both the Arab and the European.

ECLIPSE OBSERVATIONS.

Meteorological observations made in Russia during the solar eclipse of August 9th are at hand (Met. Zeitschr., October, 1896, 399–400). At the Central Physical Observatory, in St. Petersburg, in spite of the low altitude of the sun, the dull weather and the light rain, a fall in the temperature of the air and of the earth's surface was noticeable. At the beginning of the eclipse (4:51 a. m.) the air temperature was 55.4°; at 5:45, 55.2°, and at the end of the eclipse (6:43 a. m.), 55.7°. The temperature of the earth's surface fell more decidedly. At Pawlowsk, where the sky was also covered with clouds almost all the time, and light rain was falling, the air temperature at the beginning of the eclipse was 56.6° ; at the middle, 56.1°. A Sprung barograph showed a sudden fall of .25 mm. before the beginning of the eclipse, while during the eclipse there was a rise of .75 mm., and after it a fall. Such rises of pressure have been previously observed during solar eclipses, and are probably due to the decrease in temperature caused by the cutting off of the sun's rays and the resulting in-creeping of the air above.

EARLY MEASUREMENTS OF CLOUD HEIGHTS.

The October number of the *Meteorologische Zeitschrift* contains a note on the earliest measurements of cloud heights of which there is record. It appears that two Jesuits, Ricciolo and Grimaldi, made some trigonometrical measurements of the heights of clouds in 1644 near Bologna. Riccioli, in his work, 'Almagestum novum,' collected the previous writings on the subject and proposed a scheme for calculating the heights of clouds by observations of their shadows. The luminous night clouds, about which there has been some discussion within the past few years, were observed by Maignan, and explained by him, in 1648, as being illuminated by the sun, they floating at so great a height as to be outside of the earth's shadow.

THE TORNADO OF SEPTEMBER 10TH IN PARIS.

An account of the Paris tornado of September 10th., last, appears in *L'Aerophile* for October, together with diagrams showing the curves traced by the self-recording instruments at the Tour St. Jacques Observatory. The barograph curve indicates a sudden fall of 6 mm., an immediate recovery to a slightly higher (.25 mm.) pressure than was recorded just before the fall; then a slight fall of .50 mm., followed by a gradual rise. The air temperature at the top of the tower rose at the time of lowest pressure, rather suddenly, and then fell. The hygrometer indicated decreasing humidity for some time before as well as during the time of minimum pressure. The data as to the destruction caused by, and the general characteristics of, the phenomenon point to its having been a true tornado, though not by any means a violent one.

NOTES.

The Hot Winds of Northern India and *An Account of a Storm Developed in Equatorial Regions* are the subjects of two recent papers by Eliot and Dallas respectively, in Vol. VI., Part III., of the Indian Meteorological Memoirs.

R. C. Mossman: *The Meteorology of Edinburgh.* Transactions Roy. Soc. Edinb., Vol. XXXVIII., Part III., No. 20, 1896. Contains the reductions of observations made in Edinburgh during the past 132 years, with colored plates illustrating some of the principal features of the climatology of the city.

Th. Arendt: *Die Bestimmung des Wasserdampfgehaltes der Atmosphäre auf Grund spektroskopischer Messungen.* Met. Zeitschr., Oct., 1896, 376–390. The results of an investigation carried on at the Potsdam Observatory during 1895 and 1896.

R. DeC. Ward.

Harvard University.

CURRENT NOTES ON ANTHROPOLOGY.

ARAUCANIAN STUDIES.

The excellent studies of Dr. Rudolfo Lenz in modern Araucanian have already been mentioned in these notes. A new instalment of them includes dialogues in the Pechuenche dialect, some small original pieces in the Picunche and Huilliche dialects (Spanish and Araucanian) and a collection (72 pages) of Araucanian tales and stories published in German in Valparaiso. The latter are divided into mythological tales, animal stories, others of European origin and some songs. They are interesting examples of the present condition of folk-lore among these intelligent natives.

No other investigations into the language of the aborigines of Chili equal in method and accuracy these of Dr. Lenz. They are, in fact, models of their kind.

The language itself is one of beauty and strength. Indeed, in the last century the missionary Haverstadt was so impressed with its resources that in 1777 he published a work upon it ('Chilidugu') in advocacy of its adoption as an universal tongue for the world, a ready-made Volapuk.

The publication of Dr. Lenz can be obtained through Karl M. Hiersemann, Königsplatz 2, Leipzig, Germany.

RACE DEGENERATION IN THE SOUTHERN STATES.

An unusually thoughtful article appears in the Bulletin of the American Academy of Medicine (Vol. II., No. 9), by Dr. John T. Searcy, superintendent of the insane asylum at Tuscaloosa, Ala. The subject treated is insanity in the South, and its relations to race were brought out prominently. Some of these may be noted.

The native American (white) when insane is more adaptable to his environment than any other stock. The American Indian is just the opposite—not at all adaptable to new conditions. Insanity is a symptom of a race-degenerating process. It is more observable in negroes since the Civil War, as, compared to the condition of slavery, "degeneracy is increasing in the majority of the negroes." The whites are less so, because "during the time of slavery brain idleness and brain injury prevailed to a greater extent among the whites than at present." Compared with his previous condition in Africa, the negro was much better off as a slave in America than he ever was before. This general improvement in his condition showed itself in the absence of mental degeneracy. His present types of insanity 'show the same race traits in the hospital which they do on the outside.' That is, they are more emotional, and yet his delusions are weaker and more transient.

D. G. Brinton.

University of Pennsylvania.

NOTES ON INORGANIC CHEMISTRY.

In the last Chemical News Prof. Brauner, of the University of Prague, discusses the theory that argon is a polymer of nitrogen, N_3, and helium a polymer of hydrogen, H_4, or more probably a mixture of H_3 and H_5. His argument is directed almost solely against the elementary nature of argon and helium and the arguments which have been put forward to show that argon is not N_3.

Against the elementary nature of argon and helium stands the difficulty of placing them in the periodic system. He does not agree that the argument drawn from the ratios of the specific heats is conclusive as to the molecule of argon or helium containing only a single atom. The density of argon, 19.94, being less than that of N_3, 21.06, he accounts for by the possibility of the presence of helium or some other inert gas. Of positive arguments in favor of his theory he gives none, but suggests that a determination of the atomic heat would decide the question. He inclines to the view that the constituents of helium were formed from hydrogen in accordance with Prout's law.

The latest contribution to a systematic arrangement of the elements is an article by Richard Lorenz in the Zeit. Anorganische Chemie, on 'Twin Elements.' The author gives this name to elements which have nearly the same atomic weight, resemble each other in occurrence and chemical behavior, and are with difficulty separated from each other. Such twins are sodium-magnesium, cobalt-nickel, phosphorus-sulfur. The atomic weights of each twin differ from those of the next twin by four units. In some instances a single member only of the pair exists or is known, as chlorin is the only element of the twin which lies between phosphorus-sulfur and potassium-calcium. Lorenz develops from this a germinal rule. Taking as his starting point the atomic weights three and four, the latter corresponding to helium, he proceeds by successive increments of four. Of the second pair (7, 8), lithium only is known; the third twin is (11, 12) boron-carbon; of the fourth only oxygen is known; of the fifth (19, 20), we have fluorin, and perhaps argon. Up to the atomic weight of 128, thirty-nine elements correspond to this germinal rule, while there are ten elements whose weights do not fall within the limits of any pair. Fourteen of the thirty-two twins have but one member, four twins have no known member, and one twin, cobalt-nickel, is displaced one unit from its theoretical value. Of the elements of higher atomic weight, ten of the best known follow the rule, while four do not. The author seems to indicate his opinion that this germinal rule expresses the composite nature of the elements, and suggests that the elements which conform to it may be built up analogous to one series of hydrocarbons, while the exceptions may be built up on a different plan.

The article recalls two anonymous contributions to the American Supplement to the *Chemical News* for 1869 (pp. 217 and 339) on the 'Numerical Relations of the Atoms' and the 'Pairing of the Elements,' where very similar ideas were suggested.

J. L. H.

ASTRONOMICAL NOTES.

In our issue of November 15th we called attention to an article by Dr. Marcuse, of Berlin, giving an account of a series of observations made by him with the new photographic zenith telescope belonging to the Geodetic Commission. We have now received Prof. Albrecht's report upon the performance of the same instrument, which has been mounted at Potsdam side by side with the old visual instrument. This arrangement has enabled Herr Schnauder and Dr. Hecker to carry out a simultaneous series of observations with the two instruments, and using the same stars. The result of the research was not favorable to the photographic instrument, since it necessitated much extra labor, without any sufficient compensating advantage in the accuracy attained. It will be remembered that the Geodetic Commission proposes to establish four permanent observing stations on the same parallel of latitude, but differing nearly 90° in longitude, in order to get a continuous and very accurate determination of the latitude variations. The present tests of the new photographic instrument were undertaken with a view to the employment of such instruments at the four proposed stations. The results obtained at Potsdam will, therefore, cause the adoption of the older form of instrument.

PROF. ALBRECHT has published his 1896 report on the variation of latitude. He has included all series of observations from 1890.0 to 1896.5 and, after plotting them, has drawn a curve through the points obtained. This furnishes the means of getting the instantaneous latitude for any place on the earth, and for any time between the extreme dates used in the formation of the curve. This is probably the best way of treating the question, so far as the reduction of recent meridian observations is concerned, but it is useless for purposes of prediction, or for the re-reduction of older series of observations. But perhaps the time has not yet come for a definitive attempt to obtain laws for the motion of the pole which will permit accurate prediction, or which will represent former motions of the pole with entirely satisfactory precision. H. J.

SCIENTIFIC NOTES AND NEWS.

GEOLOGICAL FIELD WORK OF THE UNIVERSITY OF WYOMING.

PROF. WILBUR C. KNIGHT, of the Geological Department of the University of Wyoming, writes that the field work carried on by the department has just closed for the year. The entire season has been spent in studying the Jurassic terrane and collecting its fossils. Besides securing valuable stratigraphical data, many fossils new to science have been discovered. The collection is so large that it will take a year to arrange it for study. The new material can be roughly classified as follows: Invertebrates, six species. Pisces, two species of *Ceratodus*. Plesiosaurs, two species. Ichthyosaurs, one vertebra of a large animal. This must not be confounded with Marsh's *Baptanodon*. Dinosaurs, four species—two carniverous and two herbiverous. Crocodiles, one species.

With this year's discoveries it is now definitely known that there are three species of American Jurassic plesiosaurs, and it is very probable that there are four. This institution has the largest collection of these animals known.

The dinosaurs are very interesting. The largest carnivor is, so far as can be determined at present, a Megalosaur, but not allied to Marsh's *Ceratosaur*. The second carnivor is a very small animal. The two herbiverous animals have not been unpacked. One of them is a very large animal, and the other of medium size. The crocodile is a small species. All of this material has been taken from beds in new localities that have never received any attention.

While collecting new material, parts of most of the saurians that Marsh has described from the Jurassic were found. One of these is probably his Atlantosaurus. The femur in its natural bed measured 6 feet and 3 inches, and a caracoid measured 18×26 inches. Owing to the great additions made this year, the University of Wyoming now claims the second largest collection of American Jurassic vertebrates in the world, Yale having the largest. As soon as this material can be restored it will be described, after which it will be arranged for the students of vertebrate paleontology.

THE BRAIN WEIGHT OF MAMMALS.

AMONG the numerous valuable memoirs in the Gegenbauer *Festschrift* is one by Max Weber, professor of zoology in Amsterdam, entitled 'Preliminary Studies upon the Brain Weight of Mammals.' This contains the most exhaustive and accurate statistics which have been collected hitherto upon the absolute weights of the brain in the mammals and upon the relation of brain weights to body weights. In every case the sex is indicated, also the general condition of the animal. The length of the animal is given, the weight of the body, the weight of the brain, the ratio and the percentage of brain weight to body weight. The conclusions which Prof. Weber draws are thus based upon the most extensive and accurate statistics which have ever been brought together. They are as follows: First, in the matter of absolute brain weight man is surpassed only by the Proboscidia and Cetacea; with this exception the human brain surpasses that of any other mammal. Second, the relative brain weight of the average European is only surpassed by that of certain smaller animals in which the relative weight is exceptionally high. Third, as to the relation of brain weight to body weight in the comparison of the smaller and larger mammals, it is evident that the brain weight does not increase in proportion to the body weight. Fourth, as a general rule, within any natural order of mammals, the relative brain weight decreases with the increase of the body weight; in other words, within any natural order the smaller mammals have relatively larger brains. But this rule is not without exceptions. In growing individuals the relative brain weight falls off until the maximum of growth is reached. Since the growth of the brain is reached earlier than the growth of the body, this decline is not by any means uniform in different cases. Among the animals which surpass man in the ratio of brain weight to body weight are the following: Among the Rodentia, *Sciurus* and *Mus*, and among the Primates many Old and New World monkeys.

GENERAL.

Benjamin Apthorp Gould, the eminent astronomer, died on the evening of November 26th, at his home in Cambridge. His death was due to the effects of a fall that happened two hours previously. He was born at Boston on September 27, 1824. We hope to give an adequate account of Gould's life and contributions to astronomy.

Plans have been filed for the Botanical Museum to be erected for the New York Botanical Garden in Bronx Park. The building will be of brick and terra cotta, with a frontage of 308 feet. The cost of construction is estimated at $250.000.

At the recent meeting of the *Deutsche Naturforscher und Aertze* arrangements were made for a society of pathological anatomy and physiology.

The Governors of St. George's Hospital, London, of which Jenner was a pupil, propose to inaugurate a national memorial to celebrate the discovery of vaccination. Sir Joseph Lister will preside at a meeting on December 7th, at which the best means of carrying out the project will be discussed.

A committee has been formed in London with a view to publicly recognizing the completion of Mr. Herbert Spencer's *Synthetic Philosophy*. It has been proposed to place a statue in the Museum of Natural History, South Kensington, or a portrait in the national portrait gallery, but it is understood that Mr. Spencer himself does not approve of the plan.

M. Berthelot has collected, under the title *Sciences et Morales*, a number of his articles and addresses treating of the relation of science to society and education. Among these may be mentioned the address before the French Senate on higher education biographical notices of Pasteur, Cl. Bernard and P. Bert, and several articles on the history of the sciences, such as the discovery of alcohol, the survival of ancient industries, the chemistry of the Arabs, pearls, and Papin and the discovery of the steam engine.

We have already announced that the New Research Laboratory of the Royal College of Physicians, Edinburgh, was formally opened on November 6th. Dr. Batty Tuke, in declaring the laboratory open, stated that it was the best equipped in Great Britain. It contains well-equipped laboratories for chemistry, histology and bacteriology, a large experimental room supplied with physiological apparatus, and a photographic room. The laboratory is open to those who are competent to undertake investigation in the medical sciences, and chemicals, etc., are supplied free of charge.

Prof. Windham Dunstan, the new director of the scientific and technical department of the Imperial Institute, London, gave a lecture on November 9th, describing the arrangements and work of the department. It occupies large laboratories, which have been well equipped by the Goldsmiths' Company. The Royal Commissioners of the 1851 Exhibition have provided funds for the payment of the staff, and a research fellowship has been endowed by the Salters' Company. The department proposes especially to investigate the natural products of India and the colonies and to assist in the utilization of these. It is prepared to answer questions and furnish information on this subject. Investigations are already in progress on the comparative value of Indian coal deposits and iron ores, of Indian and colonial timbers, fibres, dye-stuffs and tanning materials, and especial attention will be given to the study of medicinal plants. The department is intended to become an imperial bureau of scientific and technical investigation and advice.

WE regret to announce the deaths of Dr. Karl Cornelius, docent in physics and meteorology in the University of Halle, and of Dr. Hanot, the French physician, well known for his numerous and important researches in pathology.

A LETTER from Mr. S. A. Thompsom, at Santa Catalin, Venezuela, published in the daily papers, states that in the course of explorations for the Orinoco Company he, with Mr. Leslie O. Dart, discovered in the Imataca Mountains a waterfall that must rank as one of the greatest in the world. A large river falls over an almost perpendicular cliff from a height estimated at 1,600 feet, not, however, in one body, but breaking into many separate streams.

THE American Economic Association will hold its annual meeting in Baltimore from September 28th to 30th. The President, Prof. H. C. Adams, will give an address on the relation of jurisprudence to economics. The organization of the census for 1900 will be especially discussed.

AMONG industrial expositions announced for 1897 is one at Stockholm, at which special attention will be given to machinery and applied science. There will also be expositions at Brussels and Kief, and an electrical and engineering exposition will be held at Newcastle-on-Tyne.

Nature states that it has received a circular announcing the formation of a British Mycological Society, having for its objects the study of mycology in all its branches, systematic, morphological and pathological, the publication of annual reports recording all recent discoveries in any branch of mycology, and more especially giving a brief synopsis of the work of European mycologists and the recent additions to the British Fungus Flora. An annual week's meeting or foray will be held at some place previously determined at the annual meeting. Mr. George Massee, Royal Herbarium, Kew, has been elected first President, and Mr. Carleton Rea, 34 Foregate street, Worcester, is the Secretary. The first meeting of the Society will be held in Sherwood Forest, commencing on the third Monday in September, 1897.

WE announced recently that Prof. Koch was on his way to South Africa in order to investigate the rinderpest. The *British Medical Journal* calls attention to the fact that an elaborate inquiry into the nature, origin, method of treatment and pathological status of this disease was undertaken in 1868 by a Royal Commission in which Sir Richard Quain, Dr. Burdon Sanderson, Lord Playfair and others took an active part. At that time, however, bacteriological science, which has of recent years made such rapid and important progress, was hardly yet in its infancy, and the present methods of investigation, the perfection of which we owe so largely to Dr. Koch himself, did not exist. Elaborate and careful as was the inquiry, it did little more than prove the intense contagiousness of the malady, and the hopelessness of any available method of treatment except by the pole-axe. The policy of stamping out was urgently recommended, together with a system of liberal compensation. These measures had decisive and successful results within their limits, and the epidemic has not since been able to extend itself within these islands. No subsequent information of a scientific or curative kind has since been obtained, and Dr. Koch's investigation into its possible bacterial origin will be awaited with much interest.

THE *British Medical Journal* states that M. Lemoine, of Rheims, has exhibited before the Biological Society the *clichés* of photographs, obtained by Röntgen's rays, of fossils embedded in the chalk strata of Rheims. The Röntgen rays pass imperfectly through phosphates; the bones of the fossils are clearly indicated in all their details. M. Lemoine has thus photographed a series of birds, reptiles and mammals.

In the number of the Transactions of the Academy of Science of St. Louis (Vol. VII., No. 10) issued on November 10th, Mr. J. B. S. Norton contributes a study of the Kansas Ustilagineæ with special reference to their germination. Mr. Norton gives a list of 33 species found in Kansas. These belong to the genera *Ustilago*, *Tilletia*, *Entyloma*, *Sorosporium*, *Urocystis* and *Doassansia*. Germination studies were made on about half this number by means of hanging drop cultures in water and nutriant solutions. Notes on the distribution of the species in the State and the effect on the host plant are recorded. Two new species are described, *Ustilago filifera* on *Bouteloua racemosa* and *B. oligostachya*, and *Ustilago minor* on *Bouteloua hirsuta*. Five plates illustrate the germination and figure the spores and habit of the new species.

The question of telegony must be decided by experiment, and not by casual observations. In the meanwhile, however, it may not be amiss to reproduce the following alleged cases communicated to the *British Medical Journal* by Mr. E. J. Lowe, F.R.S., and apparently resting on his personal observation. The lasting effects of coition in the male are especially curious. The cases are as follows :

1. A white sow was sired by a black Berkshire boar and produced a litter of black and white pigs ; this sow was next sired by a red Tamworth boar, and although there was no black in either of the parents the progeny were red, black and white, the patches of black being very conspicuous.

2. A black sow and boar (Duckering breed) had always bred their progeny black. The boar then sired a white sow for the first time ; two months later it was sire of the original black sow, which then produced a litter of black and white pigs, although there was no white in either of the parents.

3. An Alderney bull sired a shorthorn cow, the calf being a half-bred Alderney. Afterwards this same cow was sired by a shorthorn bull, but still the calf was partly Alderney.

4. A smooth fox terrier was sired by a rough Scotch terrier, and had rough pups ; it was then sired by a smooth fox terrier, but the pups were many of them rough-coated, and none were like the parents.

5. A Manx tailless tom-cat was sire to an ordinary English cat, and a portion of the kittens had either no tails or very short ones. The tailless tom-cat died some years ago, but up to the present time a few tailless kittens are born.

6. A fair light-haired Englishman married a Brazilian lady, but had no children. Twenty years after he married a light-haired English lady, who subsequently had a dark-haired son that was more a Brazilian in appearance than English.

Among the lectures to be given at the Franklin Institute, Philadelphia, during the present season are the following :

Oct. 30, Dr. Edwin J. Houston, professor of physics, Franklin Institute. 'X-rays.'

Nov. 13, Prof. W. O. Atwater, Wesleyan University, Middletown, Conn. 'Metabolism of Matter and Energy in the Animal Body.'

Nov. 20, Mr. Henry G. Bryant, Philadelphia. 'Characteristics of the most Northern Eskimos.'

Nov. 27, Dr. Joseph W. Richards, Lehigh University, Bethlehem, Pa. 'The Cyanide Process for the Treatment of Gold Ores.'

Dec. 4, Prof. Henry Trimble, Philadelphia College of Pharmacy, Philadelphia. 'Recent Advances in the Study of the Resins.'

Dec. 11, Mr. Francis A. Fitzgerald, with the Carborundum Co., Niagara Falls, N. Y. 'Manufacture and Development of Carborundum at Niagara Falls.'

Dec. 18, Mr. H. M. Chance, mining engineer and geologist, Philadelphia. 'Applications of Electricity in Gold Mining.'

Jan. 4, Lieut. Bradley A. Fiske, U. S. N. 'Electricity in Warfare.'

Jan. 8, Mr. Henry Harrison Suplee, consulting engineer, Philadelphia. 'Locks and Fastenings of Security.'

Jan. 15, Mr. John Carbutt, Philadelphia. 'The Practice of the New Photography.'

Jan. 22, Chas. B. Dudley, Chemist to the Penna. Railroad Co., Altoona, Pa. 'The Ventilation of Passenger Cars on Railroads.'

Jan. 29, Dr. Karl Langenbeck, Supt. of the Mosaic Tile Co., Zanesville, Ohio. 'Chemistry in the Pottery Industry, and some recent Improvements in Imperishable Decorations in Clay Tiling.'

Feb. 5, Dr. Lee K. Frankel, Analytical Chemist, Philadelphia. 'Food Adulteration and the Pure Food Law.'

Feb. 12, Rev. Horace C. Hovey, D. D., Newburyport, Mass. 'The Mammoth Cave and other Magnificent Caverns.'

Feb. 19, Dr. Daniel G. Brinton, Media, Pa. 'The Weights and Measures of Primitive Peoples.'

Feb. 26, Mr. Harold M. Duncan, with the Lanston Monotype Machine Co., Washington, D. C. 'Machine Substitutes for the Composition of Types by Hand.'

March 5, Col. Ira Ayer, Special Agent U. S. Treasury Department, New York. 'The Tin Plate Industry in the United States.'

March 12, Prof. D. S. Jacobus, Stevens Institute of Technology, Hoboken, N. J. 'Artificial Light: Modern Methods Compared—Electric-Incandescent, Welsbach, Acetylene.'

March 19, Prof. W. P. Mason, Rensselaer Polytechnic Institute, Troy, N. Y. 'Sanitary Problems connected with Municipal Water Supplies.'

March 26, Mr. Alfred E. Hunt, President Pittsburg Reduction Co., Pittsburg, Pa. 'The development of the Use of Aluminum in the Arts.'

April 2, Dr. Conrad Berens, Philadelphia. 'Deafness and its Causes.'

April 9, Mr. George F. Kunz, with Tiffany & Co., New York. 'Precious Stones as they have influenced Geography.'

May 14, Prof. John B. DeMotte. Bryn Mawr, Pa. 'The Physical Basis of Mind.'

MR. J. D. WEEKS has just made a report, says the *Railroad Gazette*, on the supply of natural gas and its decline, from which it appears that the supply has fallen to half in seven years. In 1888 the value of the gas produced was $22,629,875. In 1895 it was $13,006,650. In Pennsylvania the fall has been much greater than in Ohio and Indiana. In 1888 the gas produced in Pennsylvania was worth $19,282,375; in 1895 it was $5,852,000. The decrease has been less rapid since 1891, owing to the general introduction of meters, but it has gone on at the rate of about 5 per cent. a year. As the product shrinks rapidly when pressure falls, it may not be over 10 or 15 years before very little gas is produced.

IT is announced that the *Edinburgh Medical Journal*, which is now owned by Mr. Young J. Pentland and is to be edited by Dr. G. A. Gibson, begins a new series with the issue for January, 1897.

THE report of the Manchester Museum for 1895–6 (says *Natural Science*) notes the importance of the recognition of the museum as a public institution by the Manchester City Council, in that a sum of £400 has been apportioned to the museum out of the Free Library Rate. The average Sunday attendance is 519, and may be considered highly satisfactory, seeing that the largest attendance ever recorded on a week day was 1,079. The increase in the collections and library is very marked. The arrangement of the minerals by Mr. Gilbert Rigg, under the supervision of Dr. Burghardt, has been completed as far as the end of the silicates, and it is hoped that a guide to this collection may shortly be published.

UNIVERSITY AND EDUCATIONAL NEWS.

THE tenth annual convention of the Association of Colleges and Preparatory Schools of the Middle States and Maryland was held at the University of Pennsylvania on November 27th and 28th. The subject to which the meeting was especially devoted was the consideration of college entrance requirements. The requirements in history and in science were discussed separately, the latter by Prof. Ira Remsen, Prof. George F. Barker and Mr. O. D. Clark. The conference on college entrance requirements, with special reference to the age at which students now enter college and graduate from the professional schools, was taken part in by a large number of speakers, including Superintendent Edward Brooks, Philadelphia; President Eliot, Harvard University; Vice-Provost Fullerton, University of Pennsylvania; President Gilman, Johns Hopkins University; Commissioner of Education Harris; Chancellor Holland, Western University of Pennsylvania; President McCracken, New York University; President Patton, Princeton University; President Schurman, Cornell University; President Sharpless, Haverford College; President Thomas, Bryn Mawr College; Principal Thurber, Morgan Park Academy, and President Warfield, Lafayette College. On the evening of November 27th Dr. J. C. McKenzie gave the President's address, and brief addresses were made by Superintendent Brooks and President Eliot.

THE Hamilton Court Building Company, composed of friends of Columbia University, have bought for about $200,000, sixteen lots having a frontage of 200 feet on the east side of Amsterdam avenue and a depth of 200 feet on 121st and 122d streets. It is proposed to erect at a cost of $1,000,000 a dormitory that will accommodate about 900 students.

THE Board of University Regents in California have decided to locate in San Francisco the trade school for boys endowed by the late J. C. Wilmerding with $400,000.

THREE new instructors have been appointed at the University of Vermont: Dr. David Irons in Philosophy, Dr. W. G. Bullard in Mathematics and Mr. F. S. English in Civil Engineering.

LORD REAY has been proposed for election as President of University College, London, in the room of the late Sir John Erichsen.

THE Austrian government proposes to admit women after next year to all faculties of the Universities except theology.

ABERDEEN UNIVERSITY will add a wing for science at a cost of about $50,000. The government has refused a grant for the purpose, but it appears that the city will pay the cost in return for land given by the University Court.

THE following appointments are taken from the *naturwissenschaftliche Rundschau:* Dr. Knövenagel, of the University of Heidelberg, has been made associate professor of chemistry; Dr. Wladislaw Rothert, associate professor of botany in the University of Kasan; Dr. Seitaro Goto, professor of botany in the First High School at Tokyo, Japan; Dr. Kepinsky, associate professor of mathematics at the University of Krakau; Dr. Dalwigk has been recognized as docent in mathematics in the University of Marburg, and Dr. Beer as docent in comparative physiology in the University at Vienna.

DISCUSSION AND CORRESPONDENCE.

THE DATE OF PUBLICATION.

IN SCIENCE for November 20 (N. S., Vol. IV., No. 99, pp. 760, 761) Prof. E. D. Cope has appeared in defense of the resolution adopted by the Zoological Section of the American Association for the Advancement of Science, criticised by me in the issue of SCIENCE for November 6th (N. S., Vol. IV., No. 97, pp. 691–693). I am glad to see that in this reply Prof. Cope has clearly defined the issue. It is comprised in the following statement: "The test of publication is according to Dr. Allen that it be offered to the public. I agree with this, but hold that the only determinable test of date of offering to the public is the date of printing. The presumption is that as soon as a book is printed and bound it is offered to the public. That is the object of printing books."

It is gratifying to find that Prof. Cope agrees that the test of publication is the offering of a work to the public. As he says, in the case of books issued for sale, it does not matter whether or not any copies are sold, the book is published when it is offered for sale.

On the other hand, his contention that the "date of offering to the public is the date of printing" is an amazing misconception of what constitutes publication. Yet he concedes that, "in case of the detention of a book by the government subsequent to the printing the question of the coincidence of the date of printing and of 'offer to the public' will depend on whether copies of the book can be had on demand or not. If the book can be had it is 'offered to the public.' If it cannot be had it is not offered to the public." In this statement Prof. Cope, in trying to obscure the issue, fairly begs the question, and implies a condition of things that does not exist, as no one probably knows better than himself.

To speak in general, and in relation to other points raised by Prof. Cope, he says: "The date of printing, or alleged printing, of the last part of a book, the title page, has always been regarded as the date of publication. * * * We are accustomed to refer to the title page, or last page, to ascertain this date, for further than this we cannot go." This is quite true when there is not palpable evidence of misdating, particularly of antedating. Hence the rule generally adopted by scientific bodies, as stated in my former paper, "to the effect that the ostensible date, as that given on the title page of a book or pamphlet, or at the bottom of the signatures, shall be taken as the correct date, *unless known to be erroneous.*" This rule is not only approved by Prof. Cope, but he strangely claims that it is in essential accord with the resolution of the Zoological Section of the American Association for the Advancement of Science, which, as he, himself, states it, 'recommended that the date of printing be regarded as the date of publication.'

In the case of the majority of works issued in the past, or at periods too remote to bear obvious evidence of having been antedated, and especially of works issued by responsible publishers, the ostensible date must be accepted. This fortunately covers a large part of scientific literature, but strangely and most unfortunately does not always include the proceedings, memoirs and other publications of scientific societies, the ostensible dates of publication of which are not to be relied on, a fact now thoroughly well known. There are, of course, many exceptions, when the ostensible date is the correct date, and in many other cases the approximately correct date is determinable.

Prof. Cope states: "The probabilities are so great that a book is 'offered to the public' at the date affixed to it that it is not safe to assume that it is not, except in two contingencies." One of these is the fraudulent antedating of a book; the other is that "brought forward by Dr. Allen, that the government publications which are issued at a date later than that which they carry on their title pages." This latter case Prof. Cope claims 'is not well taken,' because, "although some reports issued by our government may bear dates much prior to the dates of issue, it does not follow that the date of printing bears any such relation to the date of issue!" Yet he tells us in another paragraph, as already quoted, that we must accept the date given on the title page as the date of publication! Sometimes a government scientific report is issued reasonably near the date it bears, but, at least in recent years, this is the exception rather than the rule, even with publications issued by the U. S. National Museum. This, of course, is not the fault of the authors, nor even of the Museum,* but is due to the peculiar ways of the Government Printing Office. Nor is the United States government the only offender; things are not managed any better under State Printers, and in some cases even worse. Columns of this JOURNAL could be filled with titles of State reports on geology and natural history bearing dates one to three years prior to the dates when the first copies were distributed, although the final proofs were read by the authors, and the pages probably printed in conformity with the date on the title page. And during the interval between the dates of printing and distribution copies of the works were *not* to be *'had on demand,'* even by the authors.

Hence it would seem that no one possessing a knowledge of these facts can candidly contend "that the date of printing [should] be regarded as the date of publication." In the case of official documents issued by the different States or by the general government, the date of distribution, or *publication*, is doubtless quite as easy to determine as the date of printing.

The 'whereases' preceding the resolution here under consideration, relating to the difficulties of determinating 'a rule of distribution,' were not considered in my former communication—a fact to which Prof. Cope calls attention—nor are they now, since for the most part they are obviously of little weight, and are sufficiently covered in considering the resolution itself.

J. A. ALLEN.
AMERICAN MUSEUM OF
NATURAL HISTORY, NEW YORK.

*The articles in the Proceedings of the U. S. National Museum are distributed separately to specialists, and to some extent to libraries, as soon as printed, but of late they are sent out without date. There is nothing on the title pages to show when they were issued. When the volume to which they belong is completed and issued, six months to a year after some of the papers were distributed, the date of distribution of each article is given on a leaf following the table of contents. As the early distribution of 'separates' of articles is obviously to secure an early date of publication, the desirability of adding the date is obvious. As this is a matter apparently within the control of the officials of the Museum, there may be some practical difficulty in the way of affixing a really correct date that is not obvious to the public.

VITALITY OF THE SPERMATOZOON.

AN instance that may illustrate some of the physiological properties of the mature male sex cells was observed last summer in the course of instruction in invertebrate zoology at the Marine Biological Laboratory at Woods Holl, Mass. Illustration is also given of the rate at which the more interior tissues may harden when the entire animal is subjected to the action of alcohol.

When the study of Mollusca was begun, a

large number of 'short clams' (*Venus mercenaria*) were brought into the laboratory to be used in dissection. It was the plan of the instructors to harden a portion of these in such a way that thick free-hand sections of the whole animal could be made, thus to aid in demonstration of the anatomy. To accomplish this result quickly, as we supposed, it was decided to place them directly into commercial alcohol.

About five dozen specimens were, therefore, selected for this treatment; one of the valves of the shell of each was crushed, in order to allow the fluid to penetrate freely into the mantle chambers, and the whole number was then placed in a large aquarium jar and covered with 95% alcohol. This was at about eleven o'clock in the evening of July 15th. The material was not used on the next day, and so lay undisturbed until ten o'clock of the day following, *i. e.*, July 17th, a period of not less than 35 hours. A series of thick sections was then made by one of the students in the course, Mr. N. B. Sloan, of Hillsdale College, and laid out in a dish of fresh sea-water. In order to determine the sex of the specimen so treated, a bit of the gonad was shown by him to be that of a male, in which the sex cells were not only mature but were also showing their characteristic movements in an unmistakable manner. The attention of the instructors was called to this, and the fact that the cells were alive was tested by adding a drop of corrosive sublimate at which all the movements quickly ceased.

These germinal cells were toward the interior of the visceral mass of the clam, and if the influence of the alcohol had reached them at all through the investing sheath they were at least able to resist it and to resume their normal activities under the proper conditions. Whether any of the somatic cells of the same tissues of the animal were also living, such as the leucocytes, was not tested, but even if no alcohol had reached these germ cells, yet under the adverse conditions, inasmuch as the ordinary life processes of the animal had been so long suspended, their vitality is remarkable.

It may be, therefore, inferred that as they reach maturity the spermatozoa of this lamellibranch may possess the ability of withstanding many unusual conditions of the surrounding water into which they may be shed. But whether it implies a long continued or a temporary vitality was not sought by us; nor was it attempted to show by experiment whether these sexual elements could withstand greater chemical changes in the ordinary sea-water than can the smaller marine Protozoa, for example. It is certain, however, that as far as this species is concerned, great promise is inherent in the spermatozoa for obtaining the necessary distribution.

J. I. Peck.

THE APPEARANCE OF THE MOON.

To the Editor of Science: The following incident might supplement Mr. Brinton's interesting account of the different pictures different persons see in the moon. I was a member of a jury in an important case a few months ago and the members were much more than ordinarily intelligent. While out for a walk in charge of the sheriff one evening, the full moon was coming over the hills to the east, and I suggested that each man write down the impression it gave him as to size. The slips were deposited in a hat, and when drawn out the comparisons ran from 'the size of a twenty-dollar piece' up to 'twelve feet.' When near to the horizon it struck me as being about eleven inches across, and several put it about that, but the thirteen men made it all sizes, four, six, ten inches, three feet, five feet, etc. One man said it was the size of a flour barrel and another of a buggy wheel, etc.

R. L. Fulton.

Reno, Nevada.

SCIENTIFIC LITERATURE.

Grundriss einer exacten Schöpfungsgesichte. Von Hermann Habenicht. Vienna, Hartleben. No date. 136 pages, 7 folded plates.

Habenicht has been for many years one of the expert cartographers in the geographical establishment of Justus Perthes at Gotha. His competent and sincere work in this exacting field must secure him a courteous hearing if he has anything to say about the world as a whole, so much of which has come, at second hand, under his fingers; but in the collection of his essays under the above title, the fruit of nearly forty years of professional, morphological study of the earth's surface, the deference that we owe to a senior worker is severely tried. The book claims to be the first attempt to unite the well-established facts of astro- geo- and experimental-physics, and to refer the form of continents and sea basins, mountain chains, volcanoes and earthquakes, fossils, glacial periods, etc., to a single fundamental law of nature. The argument is briefly as follows: The cooling of the earth is discarded as a cause of surface crumpling, not because the process is insufficient, but because such cooling would—it is alleged—cause only tensile and not compressive forces in the crust (a complete misapprehension of the hypothesis). Insomuch as temporary stars have been explained as explosions of occluded gases, it is concluded that overwhelming catastrophes might thus be caused on the earth. The huge craters produced by such eruptions are most gratuitously assumed to be the means of determining the leading lines of terrestrial relief; the collapsing of the craters causes the lands to slide and wrinkle; and inasmuch as the successive catastrophes must have extinguished all forms of life, evolution is brushed aside and the Mosaic account of creation is re-established. The author's graphic skill is employed to illustrate the post-Tertiary changes of the continents in a series of six beautiful diagrams, whose absurdity would be amusing were their imaginative innocence not plaintive.

Much more might be said; but less would hardly constitute fair mention of a book that claims to be the 'outline of an exact cosmogony.'

W. M. D.

SOME RECENT RESEARCHES ON THE CHEMISTRY OF THE CELL.*

MIESCHER'S untimely death, after many years of patient work, left his epoch-making researches upon the chemical composition of the sperm of the salmon still unfinished. The results contained in the paper here reviewed represent but a small part of all that he accomplished, but this much only was it possible for Dr. O. Schmiedeberg to collect and put together from Miescher's scattered notes. Regarding the structure of the spermatozoon Miescher has little to add to his account of 1874. The head of the sperm consists of a hull and an inner substance. The hull was of alkaline reaction since it stained in decolorized cyanin, but not in methyl green. The inner substance stained deeply in methyl green. The head also contained a so-called 'Centralstäbchen,' apparently a prolongation of the tail forward into the head. No middle-piece could be distinguished.

1. *Histo-chemical Isolation.*—If the ripe, quite fresh sperm be centrifugalized, the sperm-fluid in which the spermatozoa float may be separated from them. This fluid was found to contain 0.19% organic constituents (a mere trace of albumen), and 0.75% inorganic salts, chiefly $NaCl$, Na_2CO_3, KCl and K_2SO_4. It is evidently a harmless fluid, analogous to physiological salt solution, in which the spermatozoa are suspended and which serves only to give the sperm-mass the necessary fluidity for ejection.

If, after removal of this fluid by Glauber's salts solution (in which the spermatozoa remain intact) the clean sperm be extracted with successive portions of water and many times centrifugalized, the tails swell and pass over into the fluid, leaving behind a sediment of sperm-heads. In this way it is possible to obtain separately heads and tails in sufficient quantities for separate analysis. Under the microscope the heads are seen to retain intact their characteristic form. Collected under alcohol they look like an inorganic, heavy, snow white powder like barium sulphate or calcium oxalate.

2. *Constitution of the Tails.*—Analysis of the substances obtained from the tails isolated in this manner show that they consist of 41.9% albumen not farther investigated; 31.83% lecithin, a body generally present in all cells but especially abundant in nerve-tissue; and 26.27% of fats and cholesterin. The fats consist of fatty acids, which occur as soaps. The tails contain no nucleic acid or protamin. In a letter to W. His the author writes: "The farther I go with the tails, the more probable it seems to me that we have before us essentially

*1. F. Miescher. Physiologico-chemical Researches on the Sperm of the Salmon (contributed by O. Schmiedeberg): Archiv für Experimentelle Pathologie and Pharmakologie, XXXVII., 1896.

2. A. Kossel. On the Basic Stuffs of the Cell-nucleus: Zeitschrift für Physiologische Chemie, XXII., 1896.

the chemical type of the non-medullated nerves, *i. e.*, of the axis cylinder.''

3. *Composition of the Sperm-Heads.*—The analysis of the sperm-heads led to the surprising result that it is practically possible to express their constitution in a chemical formula, *i. e.*, that they are almost exclusively composed of one chemical substance. This substance is protamin nucleate,

$$\underset{\text{nucleic acid.}}{10(C_{40}H_{54}N_{14}O_{17},2P_2O_5,}\quad \underset{\text{protamin.}}{C_{16}H_{28}N_8O_2)}$$
$$\underset{\text{free nucleic acid.}}{+\ C_{40}H_{54}N_{14}O_{17}2P_2O_5}$$

For this research the heads were first extracted with ether-alcohol to remove the last traces of lecithin. The substances thus obtained were generally soaps, and amounted to only 0.74–2.56%. *The lecithin of the spermatozoon is thus shown to be confined entirely to the tail.* The poverty of the head in ether extractive is in striking contrast to the richness of the tails in such stuffs. The residue of the sperm-heads consists almost wholly of a mixture of the nucleic acid and basic protamin salts of nucleic acid.

The protamin, a simple albuminous body also isolated by Kossel from Sturgeon sperm, was isolated by treating the sperm with 0.25–0.50% HCl. The protamin passes into solution, the nucleic acid remains behind. There was thus obtained 19.78% of the sperm-heads as protamin. The hydrochloric acid extract also contained some calcium, iron, and calcium phosphates amounting to 2.94%.

The residue, after extraction of the protamin, consisted in large part of nucleic acid, a substance characteristic of all chromatins thus far examined. This constitutes, according to the phosphorus determination, about 60.50% of the sperm-head. The greater part of this nucleic acid is readily soluble in dilute sodium hydrate. There was thus actually isolated from the heads 95% of the total nucleic acid calculated to be present from the phosphorus content. It is certain from this determination that the total amount of phosphorus in sperm free from lecithin, except the trace occurring as phosphates, is contained in the nucleic acid.

After extracting the protamin and nucleic acid a small residue of the heads remained undissolved. This proved to be a compound of nucleic acid and protamin which had been slightly altered by the action of the extracting acid used, and so rendered less soluble.

From these analyses the composition of the salmon sperm is as follows: In sperm freed from lecithin and fat 87% of the substance lies in the head, and 13% in the tail. Of the original unextracted sperm (containing lecithin) 76% lies in the head and 24% in the tail. The tails consist of 41.9% albumen, 31.83% lecithin, and 26.27% fats and cholesterin. The heads consist of 35.56% protamin, and 60.50% nucleic acid, or 96.06% of neutral protamin nucleate. Of the other 4%, 2.5% were insolated as gypsum and calcium. The other 1% probably consists of albumen.

"The result that the fat-free heads contain 96% of protamin nucleate is astonishing. Since this salt is not an organized structure (Gebilde) it is questionable whether the heads, on the whole, contain any such. That the albuminous matter out of which such a structure must be compounded should be separated with the tails on the isolation of the heads is not to be considered, because the heads, after the isolation of the tails, on microscopical examination have the same appearance as before. Treatment with eosin, after good isolation, shows no trace of tail, middle piece, or other albuminous substance remaining behind, while the inner space may by the respective reagents be as beautifully differentiated as before. It (the inner space) has certainly a different nature from the hull, although both consist of the same substance. This difference rests apparently on the fact that nucleic acid and protamin are not uniformly distributed in the heads as a neutral salt, but in such manner that the *basic* protamin salt of nucleic acid occurs on the surface, and the *acid* protamin salt in the interior. This is indicated also by the fact, above mentioned, that after treating the heads with hydrochloric acid the nuclear colors are then also taken by the hull. That the hull has an alkaline reaction is proved by their blue coloration in decolorized cyanin solution, while the inner space remains uncolored."

"If the sperm, nevertheless, contains a special living structure (Gebilde) or a ferment-stuff, the mass of the latter compared to that of the heads can only be extraordinarily small.'' Schmiedeberg then suggests that in such case the protamin nucleate might be the protector of this. This suggestion will hardly be accepted by those who believe in an active physiological *rôle* of the chromatin, since there can be no doubt that the protamin nucleate is the sperm-chromatin.

Miescher has also some interesting results on the differentiation of the chromatin (nuclei) during the formation and ripening of the sperm.

By treatment of the unripe testes with a solution of sodium taurocholate and calcium chloride, the nuclei of sperm-mother-cells and spermatocytes were isolated free from cytoplasm. *No protamin could be obtained* in the acid extract of these nuclei, although it may possibly have remained undissolved. There was obtained, however, an albuminose which proved to be practically identical in composition with a so-called deutero-myosinose isolated by Chittenden and Kühne from muscle. This is most interesting in the light of the fact that the salmon takes no food after entering the Rhine, and the material which serves as food for the developing testis is derived, as Miescher showed, from the body-muscles. Apparently, therefore, we have, in this fact, a chemical proof that the food-substance is taken into the nucleus. There can be little doubt that this albuminose is the mother-substance from which the protamin is differentiated during ripening. This fact is also in harmony with Kossel's observation that protamin can not be isolated from the unripe testis, and that protamin forms a combination with albuminoses not to be distinguished from the histon isolated from other nuclei.

Kossel's paper, published almost coincidently with that of Miescher, is of particular interest for two reasons: first, because Kossel finds protamin present in the sturgeon sperm as in the salmon; and second, on account of the important character which Kossel shows protamin to have. He finds that the sturgeon sperm yields protamin and nucleic acid, like the salmon, but contains a larger percentage of albumen. The protamin constituted, in the form of the sulphate, about 20% of the dried sperm (freed from fat and lecithin). The chemical analysis coincided with that obtained by Miescher in the protamin of salmon sperm, with the exception that sturgeon protamin contained one molecule more water. This may have been due, however, to incomplete drying. In physical character the two protamins differed. Thus, salmon protamin sulphate is easily soluble in hot water and on cooling separates out as an oil, while that of the sturgeon remains dissolved on cooling. The sturgeon protamin, too, is not so easily precipitated in strong salt solution as the salmon. Kossel also isolated substances resembling protamin and nucleic acid from the testes of the trout and the whiting, so that we are tolerably sure that a large portion of the sperm head of fishes consists of protamin nucleate.

Perhaps the most interesting part of the paper is that concerning the chemical nature of protamin. This substance is a basic body which gives all the reactions of albumen except that of Millon. Inasmuch as the latter reaction depends on the presence of certain radicles contained in albumen, these are seen to be lacking in protamin. Prof. Kossel suggests that protamin is the essential kernel of all albumens. We seem to have in protamin an albumen in the lowest terms. This is shown by the fact that on its decomposition protamin yields those products, arginin and lysin, which have so far been isolated from all albuminous bodies studied, but gives these products in very much larger proportion than albumen. Apparently albumen is protamin plus a greater or less number of other radicles.

The amido-acids were almost entirely lacking among the decomposition products. It is thus shown that protamin differs from the peptones in lacking the group out of which the amido-acids are formed. It follows also that the so-called biuret reaction of albumen is dependent on that group which falls into arginin and other bases.

Protamin unites in ammoniacal solution with albumoses, forming thereby bodies which could not be distinguished from the histon isolated by Kossel and Lilienfeld from the nuclei of the thymus gland. There are thus formed new albuminous bodies, which will yield more arginin than the original albumoses. "If we assume that this combination (Anfügung) also takes place in the cell, we have an explanation of the fact, observed by Hedin, that different albuminous bodies yield on hydrolysis different amounts of arginin."

The fact that we have finally procured in protamin a chemically pure substance of a comparatively simple nature, which is, in all probability, the fundamental radicle of albumen, is of the very greatest importance in the study of the composition of the albumens, and may, perhaps, lead ultimately to their artificial formation.

In a third paper, 'On the Formation of Thymin from the Fish-sperm,' Kossel shows thymin to be a decomposition product of the nucleic acid of the sturgeon sperm, just as it is derived from the nucleic acid isolated from the thymus gland. He establishes its identity, also, with the body called 'nucleosin,' isolated by Schmiedeberg from the salmon sperm nucleic acid. From this there can be little doubt that these three acids are very closely similar in structure.

It has recently been found by the reviewer, in Kossel's laboratory, that the sperm of the sea urchin, *Arbacia*, also consists largely of protamin and nucleic acid.

It seems probable, from these results, that the head of the spermatozoon generally is composed of two very interesting substances, of nucleic acid, the essential chromatic constituent probably of all chromatins thus far isolated, free or combined, from yeast, pancreas and thymus gland; and of protamin, the radicle of albumen. The sperm seems to have rid itself of all superfluities and taken the essentials in their most compact form.

From Miescher's work we also have a good idea of the chemical nature of the sperm tail, although it is probable that the lecithin isolated therefrom is in reality combined in life with the albumen. As to the chemical nature of the middle piece little or nothing is so far known, but it is possible that, if the methods of histochemical isolation used by Miescher shall be found generally applicable, something may in time be learned of this.

We are still uncertain whether the protamin nucleate is identical in composition with the chromatin in the head of the living sperm, or whether in the process of isolation it has in some way changed, but the latter may not improbably be the case. At any rate it cannot be long until we have a general comparative chemistry of the chromatins, just as we have at present of the nucleins. The work of Kossel and Lilienfeld upon the chromatin of the calf's thymus, that of Kossel and Altmann upon the chromatin of yeast, of Hammarsten upon the pancreas chromatin, of Kossel upon the chromatin of the sturgeon's sperm and salmon, and that of Miescher upon the salmon sperm form the first stones of the foundation.

ALBERT MATHEWS.

SCIENTIFIC JOURNALS.

THE PHYSICAL REVIEW, VOL. IV., NO. 3, NOVEMBER–DECEMBER, 1896.

Experimental Determination of the Temperature in Geissler tubes: By R. W. Wood. It has been admitted for some time past that the light effects in Geissler tubes cannot be interpreted as indicating a high temperature. The phenomenon is unquestionably one of luminescence. Several writers, among whom Warburg may be especially mentioned, have discussed the theory of the phenomenon, and have arrived at results indicating that the temperature in an active Geissler tube is not greatly above the temperature of the surrounding air.

Mr. Wood has undertaken the difficult problem of actually measuring the temperature in the interior of a Geissler tube, making use of a fine wire bolometer so arranged that it could be moved from point to point through the tube. His results are, in the main, in agreement with the predictions of Prof. Warburg. The temperature in no case exceeds that of the surrounding air by more than 20 or 30 degrees. The temperature, however, is not found to be constant throughout the tube, but varies in accordance with definite laws throughout the space separating the two electrodes. The most striking results obtained by Mr. Wood apply to the case of a stratified discharge. In the curves which he presents to show the variation in temperature from point to point, a well defined ripple is seen corresponding to each layer or stratification. In passing from a bright layer to the adjacent dark space a sudden temperature change amounting to four or five degrees was observed in almost all cases.

It can hardly be doubted that Mr. Wood's results will prove of great assistance in the development of the theory and explanation of Geissler discharge phenomena.

The Specific Heats of the Metals: By F. A. Waterman. Dr. Waterman's article contains, first, a critical discussion of the methods heretofore used in the determination of specific heat, which is accompanied by a table giving the values obtained by various experimenters. This table appears to have been prepared with much care and will be found extremely useful. The paper also contains the description of a new form of calorimeter devised by Dr. Waterman and used by him in determining the specific heats of bismuth, tin, aluminum, copper, gold and zinc. A description of the apparatus is beyond the limits of this abstract, but the instrument seems to be capable of a high degree of accuracy, and the results are thoroughly concordant.

Dr. Waterman has used especial care in obtaining pure specimens of the metals studied, and in this way avoids what is perhaps the commonest source of error in previous determinations.

The Viscosity of Mercury Vapor: By. A. A. Noyes and H. M. Goodwin. Determinations of the viscosity of mercury vapor, hydrogen and carbon dioxide were undertaken by the writers, with the object of finding whether the viscosity of a gas can be made to furnish a criterion for distinguishing between monatomic and polyatomic molecules. As the authors very justly state, the recent discussions in connection with the atomic weight of argon have thrown some discredit on the indications of the specific heat ratio in this connection.

The kinetic gas theory shows that a simple relation exists between the viscosity of a gas and the cross section of the gaseous molecule. If the space occupied by a molecule is widely different from that occupied by an atom, we should therefore expect the viscosity of a monatomic gas such as Hg to differ widely from that of a diatomic gas like H. Such differences were however not found. Messrs. Noyes and Goodwin conclude that the space occupied by a molecule is of the same order of magnitude as that occupied by an atom, and that the viscosity can therefore not be used to determine the molecular complexity.

An Example in Thermometry: By A. S. Cole and E. L. Durgan. The piece of work described in this paper was undertaken at the suggestion of Prof. Wm. A. Rogers, and has to do with the calibration of a mercury themometer. The object of the paper is to give a description of the methods used in such calibrations, with sufficient detail to enable one to become thoroughly familiar with the process. The thermometer studied was one of those employed by Profs. Morley and Rogers in their work on the coefficient of expansion of Jessop's steel.

A Study of the Apparent Capacity of Condensers for Short-charge Periods: By H. V. Carpenter. The 'soaking in' of a charge in a condenser is a phenomenon whose existence has long been known, and for which various explanations have been suggested. As is well known, the phenomenon leads to troublesome complications when it is desired to measure the capacity of a condenser, for the amount of charge taken up by a condenser will depend upon the duration of charging. Mr. Carpenter has undertaken to determine experimentally the variation in the apparent capacity due to this cause, as the period of charge is increased from a few thousandths of a second up to about half a second. Data are given for a mica condenser, a condenser made of paraffined paper, and one furnished by the Stanley Electric Manufacturing Company. The charging circuit was made as nearly as possible non-inductive, so that the effect studied could be separated from the similar effect which might be produced by self-induction. Results are shown in form of curves giving the variation in the charge as a function of the time of charge. Observations were made at various voltages. It appears that the rapidity of absorption varies greatly with different condensers. It seems also to depend somewhat upon the potential to which the condenser is charged. The rate of absorption is found not to be proportianal to the potential difference. Mr. Carpenter's curves indicate great uniformity in the behavior of a given condenser, and while the laws of the phenomenon cannot yet be derived they at least appear to be definite.

Note on the Osmotic Theory of the Voltaic Cell: By H. M. Goodwin. Prof. Goodwin dissents in this article from some conclusions reached by Prof. Bancroft in a recent paper on 'The Chemical Potential of the Metals,' and presents results of recent determinations of the E. M. F. of certain types of cells in support of his position.

The Division of an Alternating Current in Parallel Circuits with Mutual Induction: By Frederick Bedell. This paper is devoted to a discussion, both graphical and analytical, of the case of branch circuits which act inductively upon one another. The general formulæ are derived and several special cases are considered. The results are not of a character which could be presented here to advantage.

On the Specific Gravity and Electrical Conductivity of the Normal Solutions of Sodium and Potassium Hydroxides, and Hydrochloric, Sulphuric Nitre and Oxalic Acids: By E. H. Loomis. The results of careful determinations of the specific gravity and conductivity are here presented in the case of some salts and acids for which these quantities had not previously been accurately determined.

New Books.—Wuller: Experimentalphysik. Carhart and Patterson: Electrical Measurements. Le Blanc: Electrochemie. Fleming: Alternate current transformer. Bedell: Principles of the Transformer.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

The Section of Geology and Mineralogy, held its regular monthly meeting November 16th, with Prof. Albert H. Chester in the chair, as chairman *pro tem.*

The first paper was by Dr. E. O. Hovey, entitled 'On a Deep Well-boring at Key West, Fla.' Dr. Hovey described the geological section uncovered by the well for a depth of more than 2000 feet. A number of microscopic organisms were obtained. It proved somewhat difficult to identify the geological horizons, but without much doubt the well penetrated a considerable distance into Miocene. In the limestone many grains of quartz, possibly of secondary depositions, were met, and also rolled grains of quartz, doubtless in the nature of sand. Dr. Hovey commented on the significance of the phenomena, and expressed his obligations to Prof. Alexander Agassiz, from whom the samples had been obtained. The paper will appear in full in an early number of the Bulletin of the American Museum of Natural History.

Prof. A. J. Moses then exhibited a number of new mineralogical instruments which had recently been sent from Europe. They included a little adjustable dark room which could be fitted to a Fuess No. 2 Goniometer, so that crystals could be measured by daylight. Perfect signals could be obtained even in a well-lighted room. The instrument is called the Traube Verdunklungsvorrichtung. The universal rotation attachment for mineralogical microscopes which has been invented by Prof. Klein, of Berlin, for measuring the angle of the optic axes of microscopic crystals was also shown. Klein's new rotation apparatus for the orientation of thin sections was next described. The new attachment which can be adjusted to the Fuess Goniometer No. 2 for measuring the optic axes was shown and an opportunity was afforded to test it by actual experiment. The von Federow mica wedge (Glimmerkeil), which consists of a series of superposed $\frac{1}{4}$-undulation mica plates in step-like arrangement and is used for all the purposes of a quartz wedge, concluded the paper.

The third paper was read by Mr. A. Chester Beatty, and was entitled 'The Minerals of the Elkhorn Mine, Montana.' Mr. Beatty exhibited with comments, a remarkable series of calamine, smithsonite, native silver and other minerals.

Prof. A. H. Chester presented a paper on the new discovery of the brassy, micaceous mineral which seems, from the only analysis, to be chalcodite, and which has been found in a quarry at Rocky Hill, New Jersey. He also exhibited a remarkable series of rutile from Graves Mountain, Georgia.

G. F. Kunz described a new meteorite from Guatemala, and read a joint paper by Dr. Hillebrand and himself upon a new discovery of prosopite in Utah. He read also a joint paper by J. H. Pratt and himself on the new find of saphires at Utica, Mont.

Mr. Frederick Braun described his discovery of spinels and chondrodite in dolomite, at Fordham, New York City, an association closely resembling that at Edenville, N. Y. It was discussed by Prof. J. F. Kemp, who remarked on the interest attached to this association of minerals because of the difference of opinions prevailing among geologists as to whether they indicated contact metamorphism or merely regional metamorphism.

The last paper of the evening was by Prof. J. F. Kemp, entitled 'Exhibition of interesting minerals collected during the summer.' The speaker exhibited covellite, goslarite, enargite, chalcodite and tetrahedrite from Butte, Montana, which were exceptionally fine crystals. Remarkably large prisms of andalusite from the Black Hills were also shown and zircons and allanite from Mineville, Essex County, New York.

A collection of chalcodite from a quarry near Reading, Pennsylvania, was exhibited by Mr. Roebling, of Trenton, New Jersey, in connection with the paper by Prof. Chester.

The Academy then adjourned to inspect the minerals.

J. F. KEMP,
Secretary.

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 253d regular meeting of the Anthropological Society was held Tuesday, the 17th of November, 1896.

Dr. J. H. McCormick read a paper on a 'Primitive Village Site in Maryland,' in which he described a discovery of an Indian village site recently made by him, in Montgomery county, Md., about thirty miles from Washington. He exhibited a collection found upon, and near the site, which illustrated perhaps, better than any other collection, the contemporaneous existence of the rude chipped stone implements and the most highly polished stone implements associated together, which substantiates Prof. W. H. Holmes's claim of the contemporaneity of the Palæolithic and neolithic ages. It was also noted that these implements, contrary to the usual rule, increased in this region, as we approached the interior, and that the camp site was always situated northeast from water supply, whether spring or stream.

The implements were discussed at some length, and compared to many specimens found in various parts of the United States. For the most part they were of stone not found in the vicinity. Several ceremonial stones, of exquisite workmanship, were of the Tennessee slate and one a phallus. The paper was discussed by Messrs. McGee, Thos. Wilson, Pierce, Blodgett, Cushing and Mason.

Mr. Cushing read a paper on the 'Shell Mound Explorations from Maine to Florida,' in which he described the recent explorations of the shell heaps in Maine and Florida. He exhibited a beautiful collection from the Florida coast and described the Pile dwellings and artificial islands and inlets made by these primative people. The specimens were found in the peat and marl beds of the Mangrove swamps and were obtained with much difficulty owing to the inflow of water into the excavations. The specimens showed the soaked condition in which they had existed for centuries, and upon drying, cracked and shrunk to such an extent, that many specimens broke into innumerable pieces. Among the most unique and beautiful specimens were the masks, of which water color drawings had been made as soon as they were taken from their bed, for by the following day the shrinkage had so disturbed them as to have lost their beauty.

Mr. Cushing called attention to the fact that there were no bows used, but throwing sticks instead and that the inhabitants were related to the southern and not to northern Indians, and suggested that perhaps the Seminoles were the survivors of this ancient race of people. The collection, as a whole, was the most striking and valuable ever found in these regions.

J. H. McCORMICK,
Secretary.

GEOLOGICAL CONFERENCE OF HARVARD UNIVERSITY.

October 13, 1896.—'The Eruptive Rocks of Sussex County, N. J.' By J. E. Wolff.

'Note on the proposed Excursion to the Coastal Plain of Southern Maine.' By. W. M. Davis.

October 20, 1896.—'The Excursion to Hoosac Mountain' (illustrated with stereopticon). By J. E. Wolff.

'Some Features of the Cornwallis Valley, Nova Scotia.' By V. R. Marsters.

'Exhibition of the New Two-circle Goniometer.' By Charles Palache.

'Note on the Hurricane of October 10–14.' By R. De C. Ward.

October 27, 1896.—'Recent Accessions of Geological Material.' By W. M. Davis.

'On an Instrument for inclining a Preparation in the Microscope.' By T. A. Jaggar, Jr.

November 3, 1896.—'Review of the Excursion to Nahant.' By N. S. Shaler.

'The Tourmalines of Mt. Mica, Maine.' By Charles Palache.

'A remarkable Joint Specimen from Somerville, Mass.' By J. B. Woodworth.

Prof. Joseph LeConte was present at this meeting and gave some interesting reminiscences of the early days of the Lawrence Scientific School, from which he was one of the first graduates.

November 10, 1896.—'Material illustrating the Appendages of Trilobites.' By R. T. Jackson.

'The Excursion to the Blackstone Valley.' By J. B. Woodworth.

November 17, 1896.—'Magnetic Observations in Geological Mapping.' By H. L. Smyth.

T. A. Jaggar, Jr.,
Recording Secretary.

THE ONONDAGA ACADEMY OF SCIENCE.

The Society held its first regular meeting Friday, November 20, 1896. The President, Dr. Charles W. Hargitt, of Syracuse University, delivered an inaugural address, defining the 'Aims and Purpose of the Academy.' He considered the 'creation and cultivation of science, the dissemination of knowledge and the acquirement of a depository for everything scientific' the chief aims of the Academy. Mr. Horace W. Britcher gave a short talk, entitled: 'A Summer Laboratory on the Coast of Maine,' which was amply illustrated with photographs and alcoholic specimens.

The Onondaga Academy was organized October 24, 1896, the constitution and by-laws being adopted at that time. The Academy is the outgrowth of the scientific committee of the Onondaga Historical Association, which held scientific meetings throughout the summer, attracting numerous scientific workers from the vicinity. It has a charter membership of twenty-one. The well-known reputation of central New York, in the various scientific branches, gives considerable range to the work of the Academy, which has started out under most auspicious circumstances.

Philip F. Schneider,
Secretary.

NEW BOOKS.

The Gases of the Atmosphere: The History of their Discovery. William Ramsay. London and New York, The Macmillan Co. 1896. Pp. viii+240. $2.

Bibliographia Physiologia, 1895. Ch. Richet. Paris, Félix Alcan. 1896. Pp. 896. 3 fr. 50.

Papers presented to the World's Congress on Ornithology. Edited by Mrs. Irene Rood, under the direction of Dr. Elliott Coues. Chicago, Charles H. Sergel Co. 1896. Pp. 208. $5.

Les Aryens au Nord et au Sud de l'Hindou-Kouch. Charles de Ujfalvy. Paris, G. Masson. 1896. Pp. xv+488.

Round the Year, A Series of Short Nature Studies. L. C. Miall. London and New York, The Macmillan Co. 1896. Pp. viii+295. $1.50.

Sixteenth Annual Report of the United States Geological Survey to the Secretary of the Interior, 1894–95. Charles D. Walcott, Director. In four parts: Part I.—Director's report and papers of a theoretic nature. II.—Papers of an economic character. III.—Mineral resources of the United States, 1894; metallic products, David T. Day, Chief of Division. IV.—Mineral resources of the United States, 1894; nonmetallic products, David T. Day, Chief of Division. Vignette. Washington Government Printing Office. 1896. [II.. III. IV., 1895.]

Cambridge Natural History. Vol. II. London and New York, The Macmillian Co. Pp. xii+560. $3.50.

SCIENCE

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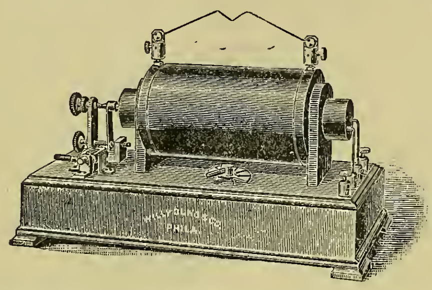

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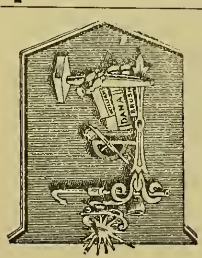

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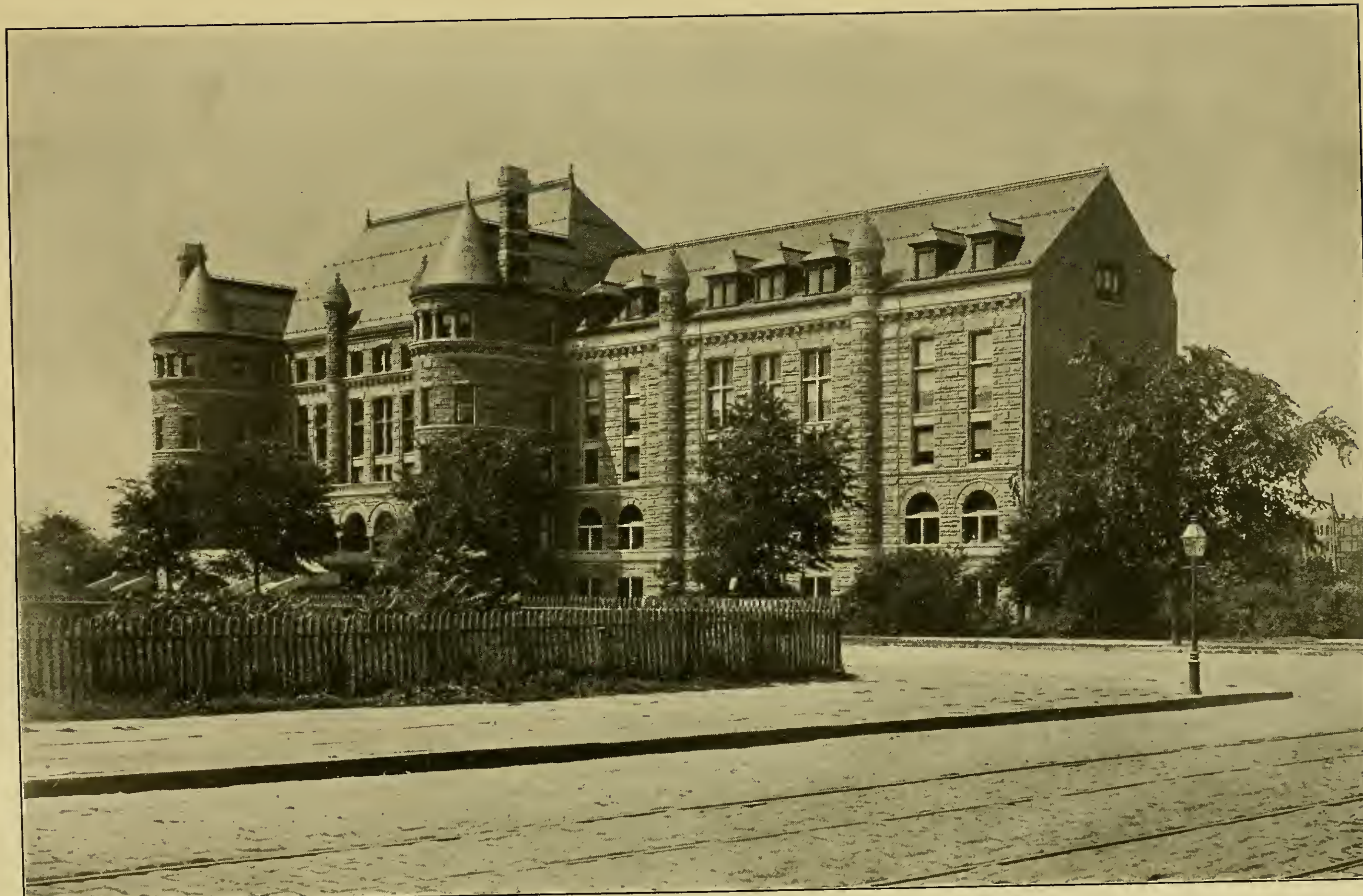
View of Museum Building, 1878.



L. C. LAUDY, PHOTO.

VIEW OF MUSEUM BUILDING, WITH EAST WING, 1894.

SCIENCE

FRIDAY, DECEMBER 11, 1896.

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

OPENING OF THE EAST WING OF THE AMERICAN MUSEUM OF NATURAL HISTORY.

THE opening of the east wing of the American Museum, upon November 30th, marks the latest step in its rapid development. The old wing of the building, completed in 1873, contained 35,020 square feet. With the west wing, now in course of erection, the Museum will have a total exhibition floor space of 148,258 square feet. The construction of the east-corner wing has been authorized by the Legislature, and this will nearly complete the south façade in 1900.

The Twenty-seventh Annual Report of the President, recently issued, shows that the last two years have been of exceptional activity in the development of the collections and educational work of the Museum. During 1895 seventy-five thousand dollars was received from the city of New York for maintenance, and sixty-five thousand dollars from the Endowment Fund; there was, however, a deficit of nearly eight thousand dollars on these two accounts, which was met by special subscription from the Trustees. The expedition in Peru under the direction of Mr. Adolph F. Bandelier, referred to in previous reports, has been eminently successful, and arrangements have been made to continue his work until the close of 1896. The expedition to Honduras was made in cooperation with the Peabody Museum at Cambridge, the latter Museum having a concession from the government of that country. Mr. Rudolph Weber returned early in the autumn of 1895 from Sumatra, where he has been collecting for the Museum with a fair degree of success. Dr. Lumholtz has continued his explorations among the Indian tribes of the Sierra Madre Mountains, adding greatly both to the collections and to our knowledge of the primitive people in that region. Another interesting collection is from the cliff houses and burial caves of Utah, presented by the Messrs. Hyde, who have not only given their collection to the Museum, but have also arranged to continue their explorations in the Southwest for several years, under the general direction of the Curator. The Peary Relief party sent out in coöperation with the American Geographical Society, included a thorough and skilled collector, and the numerous specimens obtained through this source were added to the Department of Mammals and Birds. Mr. Joseph F. Loubat has supplemented his previous donations with a gift of the widely-known 'Charnay' casts of sculptures from the ruins of Tikal, Guatemala; Manché, Chichen-Itza and Uxmal, Yucatan, and from Palenque and other localities in Mexico.

The Curators in the various departments of the Museum have been occupied for several months preparing for the opening. Every department has received notable additions. The two new halls which were opened for the first time, those of Ethnology and of Vertebrate Paleontology, deserve epecial description.

The Fossil Mammal Hall is upon the third floor of the new east wing of the Museum, and has been arranged under the direction of Prof. Henry F. Osborn, Curator, assisted by Dr. J. L. Wortman and Dr. W. D. Matthew. The department was established by the Trustees in 1891, and a generous annual appropriation from the Museum endowment fund, supplemented by many private gifts, has resulted in bringing together a remarkably complete collection. The field parties under Dr. Wortman have spent from six to eight months each year in the West, exploring especially the Puerco, Wasatch, Wind River, Bridger, Washakie, Uinta and White River formations and the *Aphelops* bed of the Loup Fork. Up to the summit of the Oligocene, the collection is unique, containing, with a few exceptions, more or less complete remains of every genus and species known. Negotiations were early begun for the famous collection of Prof. Cope. This was purchased and removed to the Museum in 1894; it includes 550 types and a number of complete skeletons. Altogether the collection includes twenty-five complete skeletons. Six of these have already been mounted, under the direction of the preparator, Mr. Adam Hermann.

A zoological arrangement of the Hall was early decided upon as the most practicable, also as the most interesting and effective in the education of the public. The entire right, or south side of the Hall, is devoted to the Perissodactyla, beginning with the Titanotheres. The evolution of these animals is illustrated by finely mounted skeletons of *Palæosyops* and of *Titanotherium*, and by a remarkable display of Eocene and Oligocene types, illustrating the complete development of the skull. Further on are the Rhinoceroses, the three diverse types of cursorial, semi-aquatic and land types being represented by mounted skeletons of *Hyracodon*, *Metamynodon* and *Aceratherium*. The horses complete this series at present.

On the north side of the Hall are the Mesozoic mammals, then the meseutherian Amblypoda and Creodonta, the Tillodontia, Rodentia, Insectivora and Carnivora. The Proboscidia occupy the north center, followed by the Artiodactyla, which are at present very imperfectly arranged. A special feature of the opening of the Hall is the exhibit of the series of Ganodonta, or Edentates with enamelled teeth, which demonstrate the early presence, if not the origin, of this great group in North America.

Great attention has been devoted to the labels, and most of the mounted skeletons are accompanied by large water-color drawings, executed by Mr. Charles Knight, which convey an approximate idea of the living form of these various extinct types.

In the ethnological collections an attempt has been made to elucidate all the principal aspects of the culture of each group. Consequently the material is placed in geographical order, each cultural area being treated as a unit. Whenever the collections are sufficiently complete the following subjects are illustrated: Physical types of the people, the relations of man to nature; manufactures and industries; household furnishings; dress and ornament; travel; methods of obtaining food supply by hunting, fishing, stock raising or agriculture; warfare; trade and barter; games music; plastic art; social organization; religion. This plan has been carried out most fully in the largest and most important collection that the Museum possesses, namely, that from the North Pacific coast of America. The larger part of this collection was made by Lieut. G. T. Emmons on his travels in southern Alaska during the past 15 years. The culture of the Indians of British Columbia is represented by material given to the Museum by Mr. Heber R. Bishop and collected by Dr. J. W. Powell, formerly Superintendent of Indian Affairs of British Columbia. In the first section of the exhibit, the relation of man to nature, the use of natural products is illustrated. Objects made of cedar show the multifarious uses of this tree. The uses of other trees and plants, and, further on, those of animals, stones and metals, are shown in the same manner.

Life-size groups bring home the most important and characteristic occupations of the people. Thus we have one domestic scene showing the preparation of objects made of cedar. A woman is breaking cedar bark which is to be used for making towels, aprons or blankets. Another woman is weaving a mat and rocking her baby, lying in its cradle, which is suspended from a cedar branch. A second group illustrates work on the beach in front of the house. There are men splitting logs and a woman preparing to go on a canoe journey.

Most of the other sections of the exhibit, except one or two, require no further comment. As far as feasible, dress and ornaments are shown on busts or full figures. Thus a figure of a tattooed man will be found; busts fitted with labrets, nose rings and ear ornaments; a figure of a warrior in full costume; and these are supplemented by the figures composing the groups.

Special pains have been taken to illustrate the principles underlying the conventionalism of these tribes. One case is devoted to the general treatment of the animal form, while others show representations of the same animal in various materials and on objects of varying form, thus elucidating the influences of technique and of the form of the object to be decorated upon the conventionalized representations. In another section objects illustrating totemism are shown, while that of religion embraces the paraphernalia of the shaman and of secret societies.

The physical types of the Indians of this region are illustrated by means of busts, photographs and skulls and skeletons.

In this whole systematic exhibit, which fills a series of eight pavilion cases, duplicates which do not help to elucidate the object of the exhibit have been excluded most rigidly. These are combined in a study collection which is exhibited in desk cases which are so placed that the contents of each case supplement the contents of the pavilion cases.

The collections from the North Pacific coast fill the whole east side of the Ethnological Hall. On the west side we find collections from the interior of British Columbia, from Arctic Alaska, the Peary collection from North Greenland, the Lumholtz collections from northern Mexico and that part of the Sturgis collection which illustrates the culture of the Melanesians. So far as possible, these collections are arranged on the same principle as the preceding one. The collection from the interior of British Columbia is a recent acquisition of the Museum. It illustrates the culture of the Thompson River Indians, and was made by Mr. James Teit. The material is very valuable, since it is the only existing representation of a culture which has almost entirely disappeared, as the Indians during the last twenty years have rapidly adopted customs and costumes of the whites..

The importance of the Peary collection, a gift of Mr. Morris K. Jesup, President of the Museum, lies in the fact that the tribe whose culture it represents has had very little contact with the whites, so that it is more primitive than most material that has recently found its way into museums. The costumes, industries and utensils of this tribe are represented exhaustively.

The value of Dr. Lumholtz's collection from northern Mexico can hardly be overestimated. Here we have for the first time a fullness of material, bringing before us the ideas and products of the inhabitants of the mountain fastnesses of northern Mexico. The people appear hardly influenced by ideas of the whites. Their offerings to their gods, their altars, and their gods show us a culture that reminds us forcibly of the tribes of the Southwest as well as of the ancient Mexicans. It is to be hoped that the results of Dr. Lumholtz's observations, who undertook his explorations in behalf of the Museum of Natural History, will yield rich information on this interesting region.

The Sturgis collection has been familiar to visitors of the Museum for a long time. Its chief merit lies not so much in a full and systematic representation of the culture of the natives of the South Sea Islands as in the number of beautiful old pieces that it contains. On account of lack of space only part of the collection is exhibited at present.

A number of miscellaneous collections, among which one from the Indians of Guatemala deserves special mention, are temporarily arranged in the gallery of the east wing of the Museum. After the completion of the west wing of the building, which is now in process of construction, these will be removed to the ground floor of the new wing, which adjoins the present Ethnological Hall. Approximately one-half of the ethnological collections of the Museum will remain in storage until the new Hall will become available. After its completion the present Hall will be devoted to North American ethnology exclusively, while other collections will find their home in the new Hall.

A portion of the archæological collection is exhibited in the upper hall of the main building pending the completion of the new west wing. During the past few years these collections have grown rapidly, one of the most noteworthy additions being that from Peru, the result of the explorations made by A. F. Bandelier, under the auspices of Mr. Henry Villard, and later under the Museum. Mr. Bandelier's explorations have given us one of the most complete archæological collections from Peru and Bolivia to be found in any museum in the world. The collection of pre-historic textile fabrics is exceedingly interesting and valuable.

The nucleus for a good Mexican collection has been made, and there are exhibited collections illustrating the culture of several of the civilized tribes of ancient Mexico, the Nahuas, the Zapotecas, Mixtecas, the Mayas, and Tarascos. In northern Mexico the expedition under Dr. Lumholtz has given the Museum a most complete collection of the ceramic art of the old Pueblo stock of Casas Grandes in Chihuahua. In our own country a recent acquisition is that of the Hyde collection of antiquities from the cliff dwellings and ancient pueblos of New Mexico and southern Colorado. This collection will be largely increased by the exploration of ancient pueblos carried on by the Messrs. Hyde during the present year.

There is on exhibition the Mearns collection from cliff dwellings in the Verde valley, Arizona, which is one of the first made in this region. Recent explorations carried on under the auspices of the Museum have given it an interesting series of objects from the village sites and burial places of the Ohio valley. A small portion of the famous Squier and Davis collection from the mounds of Ohio was acquired by the Museum some years ago and is shown in the Ohio valley exhibit. The Jones collection from the Southern States is quite complete and many of the specimens were figured by Mr. Jones in his well-known work on the Southern Indians. A small collection from New York State and the material obtained on Staten Island at a burial place at Tottenville will interest those who are studying the Indian remains in the vicinity of New York. The Chenoweth and J. Bradley James collections from New York City are also shown. California and the West are represented by the Terry collection. During the year the Museum has been carrying on a thorough exploration near Trenton, N. J., in order to secure an authentic collection from this most important region in relation to the very early occupation of the Atlantic coast by man. Many specimens have been obtained during this exploration, but they cannot be exhibited until the new halls are ready. Owing to lack of space many other interesting objects and collections are in storage, awaiting the completion of the new wing.

On the walls of the ground floor of the main building is the well-known collection of Charnay casts of prehistoric sculptures from ancient cities in Mexico and Central America, recently presented by the Duke of Loubat. Among these is the famous Tablet of the Cross from Palenque.

THE INFLUENCE OF LIGHT UPON THE DISCHARGE OF ELECTRIFIED BODIES.

Of the many interesting phenomena that are continually being discovered in all branches of physical science, none are more important than those which point to the existence of hitherto unknown relationships between the different branches of physics; for it is by the careful study of such relationships that we may hope to proceed most rapidly with the further development of the science. This fact has been generally recognized by investigators, and the attempt to find new relations between apparently isolated classes of phenomena has led in the past to many important discoveries. The discovery by Oersted of the magnetic action of the current may be cited as one well known example.

In recent years the theory of light has gained greatly by the recognition of the close relationship between optical and electro-magnetic phenomena. The discovery by Faraday of the magnetic rotation of the plane of polarization afforded the first experimental proof of a relation between light and magnetism; the fact that certain dielectrics become doubly refracting when subjected to electrostatic stress (Kerr) indicated a connection between light and electrical phenomena; while the experiments of Hertz upon electric waves have given to the electro-magnetic theory of light a standing almost equal to that of the most firmly established physical theories.

In 1887 still another class of electro-optical effects was discovered. It was then found that the passage of a spark between the terminals of an induction coil takes place more readily when the negative electrode is illuminated by ultra-violet light. The original observation, which was made by Hertz in the course of his experiments on electric waves, has since been abundantly confirmed. It appears that ultra-violet rays possess the power of assisting the discharge of negatively charged bodies, the magnitude of the effect being dependent upon the surrounding medium as well as upon the nature of the charged surface. Within the last few years Elster and Geitel have shown that the same effect is in some cases produced by the visible rays. The phenomenon has gained additional interest from the discovery by Lenard that a similar discharging power is possessed by the cathode rays, and this similiarity has been cited by Jaumann in an attempt to develop a theory of cathodic radiation. Still more recently it has been found that the effect is produced by the X-rays in yet more marked degree.

In spite of the comparatively short time that has elapsed since Hertz's original discovery, the literature of the subject is quite extensive. Strangely enough, only a few of the more important papers have been publshed in English, so that it is a matter of some inconvenience to learn just how far our knowledge of the phenomenon has progressed. For this reason, and in view of the evident importance of the subject, the writer has prepared the following account of the investigations which have thus far been published.*

* For a very brief account, see J. J. Thomson, Recent Researches in Electricity and Magnetism, p. 58–62.

DISCOVERY BY HERTZ.

1. As already mentioned, the phenomenon was first observed by Hertz* in 1887. The discovery was made during the progress of some of his earlier experiments upon electro-magnetic waves, and was purely accidental. In investigating the field near a Hertzian oscillator by means of an ordinary resonator some difficulty was met with in observing the faint sparks which occurred at the resonator. With the thought that observations could be more readily made in the dark, the resonator spark gap was surrounded by a box of non-conducting material; but it was found that the sparks were now fainter than before, and that the maximum sparking distance was noticeably diminished. On removing successively different parts of the box it appeared that only those portions lying between the primary and secondary spark were effective. The distance of these portions from the spark gap was immaterial; if the secondary spark was adjusted to its maximum length the interposition of a screen at any point between the primary and secondary spark caused the latter to cease.

2. At first thought it doubtless appeared natural to ascribe the effect to some electrostatic or electrodynamic action. Hertz was quickly convinced, however, that this could not be the true explanation, for the screening effect was produced as well by insulators, such as rubber, glass and paraffin, as by conductors. Again, although the phenomenon was first noticed when the sparks used were those of an oscillator and resonator, yet equality in the vibration periods of the two sparks was not essential. When two sparks were simultaneously produced by any other method the effect was still observed.

3. The most convenient means of study-

* Berliner Akademie, June 9, 1887. Wied. Ann. 31, 983.

ing the phenomenon was found to be by the use of two induction coils, whose primary circuits were placed in series with the same interruptor. During most of Hertz's observations the distance between the two coils was about 50 cm. The larger or 'active' spark was about 1 cm. long, while the length of the smaller or 'passive' spark was not far from 1 mm. Although especial attention was directed to the influence of the larger spark upon the smaller, it was proved conclusively that the action was reciprocal. The maximum sparking distance of each spark was increased by the presence of the other.

4. Making use of this apparatus Hertz investigated first the influence of changes in the character of the active spark, and found that the effectiveness of the latter was independent of its form. The spark could take place between spheres, or between points; could be short and straight, or long and zigzag; could be brilliantly white, or violet and almost invisible. In all cases its action upon the passive spark was practically the same. By screening successively different parts of the spark gap, it was shown that all portions of the active spark participated equally in the effect. A change in the metal of which the electrodes were made was also without noticeable influence.

5. On the other hand, the sensitiveness of the passive spark appeared to depend greatly on its character. Long zigzag sparks between points were scarcely affected at all by the presence of the active spark. The influence of the latter was best shown in the case of short sparks (1 mm. long) between brightly polished spheres of about 5 or 10 mm. diameter. Different parts of the passive spark appeared to be sensitive to the effect in different degrees. By screening various portions of the spark gap it was found that the effect was much greater when the negative pole was exposed. Hertz was unable to make sure, however, that the action occurred *exclusively* at the negative terminal.

6. A noticeable gain in sensitiveness was obtained by reducing the air pressure at the passive spark, a maximum being reached at about 100 mm. Only slight differences were observed when other gases were substituted for air.

7. Most substances, when used as screens, were found to destroy the effect. Some, however, were in greater or less degree transparent. The following is a partial list of the materials tested by Hertz:

Opaque.—Metals, even in extremely thin sheets; paraffin, sealing wax, rosin, rubber; glass, porcelain, wood, paper, ivory, leather, mica, most crystals; liquid paraffin, benzol, petroleum, liquid CO_2, strongly colored solutions, as fuchsin; various salt solutions, especially the copper and iron salts.

Partially transparent. — Sugar crystals, alum, calcite, rock salt.

Transparent.—Quartz, even in thick pieces, water, sulphuric acid, alcohol, ether.

A number of gases were tested, and in some cases (*e. g.*, burning gas) were found to be somewhat opaque.

8. By changing the relative positions of the two spark gaps it was shown that the effect proceeded from the active spark in all directions and in straight lines. The shadow cast by a screen was sharply defined; on gradually sliding a screen between the two sparks the effects ceased at once when the passive spark passed within the geometrical shadow. Reflection occurred at most surfaces in the same manner as with light. The rays also suffered refraction, being bent out of their course *more* than light rays. By using a prism of quartz it was found that the active rays lie far beyond the extreme violet of the visible spectrum. Attempts to obtain phenomena analogous to double refraction were unsuccessful.

9. A consideration of the results above described led Hertz to the conclusion that the effect must be due to the ultra-violet rays given out by the active spark. He therefore tried the effect of other sources of light, and found that all sources whose spectra are rich in ultra-violet rays produced an increase in the maximum sparking distance of the passive spark. Noticeable effects could be observed with the magnesium light even at considerable distances. The lime light was somewhat less active, while flames, such as burning gas, benzine, alcohol, CS_2, and others, had only a slight influence. No action could be observed with sunlight.

10. A photographic study of the spectra of the lights used showed not merely that the active rays are beyond the visible region, but that they lie at the extreme end of the photographic spectrum. By far the best source for these experiments appeared to be the electric arc. Most of the experiments already described were repeated by the use of the arc light with complete success.

EARLIER EXPERIMENTS OF WIEDEMANN AND EBERT, AND HALLWACHS.

The discovery of Hertz seems to have attracted immediate attention. Early in 1888, only a few months after the publica- of Hertz's work, two articles on the subject appeared simultaneously in Wiedemann's Annalen.

11. One of these articles, by Wiedemann and Ebert,* described experiments similar in character to those of Hertz, but performed with somewhat different apparatus. In place of the induction coil a Holtz machine was used. This proved to be more convenient, as well as more certain in its action. Ultra-violet rays were furnished by an arc lamp. The spark gap was enclosed in a glass tube containing a quartz window, so that experiments could be conveniently performed with different gases and at different pressures. The terminals were platinum spheres 3 mm. in diameter. A convenient means of measuring the effect was furnished by a second spark gap in parallel with the one studied, but screened from the rays of the arc. This could be adjusted until sparks passed across it rather than at the passive spark gap; the change required in this adjustment when the passive spark was illuminated then gave a measure of the effect produced by the rays. With this apparatus the more important experiments of Hertz were repeated, and his results confirmed.

12. Wiedemann and Ebert next investigated the following question: Do the ultra-violet rays merely assist the commencement of sparking, or is the action a continuous one? A Geissler tube placed in series with the active spark showed that the effect was continuous. When the spark was illuminated the Geissler discharge had all the characteristics that are possessed by such discharges when the tube is directly connected with the machine, *i. e.*, the illuminated spark gap acted much as a continuous conductor. As soon as the rays from the arc were cut off, the discharge became discontinuous, such as is usually observed when the connection to the machine contains a gap. A telephone placed in series with the spark gap gave a noticeably higher tone when the gap was illuminated. It thus appears that ultra-violet rays reduce the resistance offered by the spark gap to a disruptive discharge, and that this action continues as long as the illumination lasts.

13. To investigate what part of the arc is most effective in producing the rays needed, an image of the arc was thrown on the passive gap by means of a quartz lens. The effect was found to be greatest when the rays came from the positive carbon.

* Wied. Ann. 33, p. 240, 1888. Abstract in Phil. Mag. 25, p. 162.

This is in contradiction to the conclusion of Hertz, who found that the most active rays are from the arc itself.

14. Illumination of the positive terminal, or of the spark gap between the two terminals, was absolutely without effect. In order to increase the sparking distance the ultra-violet rays must fall upon the brightly polished *negative* terminal.

15. On experimenting at different air pressures it was found that the greatest effect was obtained at a pressure of about 35 cm. The results obtained with ordinary air, and with air that had been carefully dried, were practically identical. The phenomenon was also observed when the spark took place in hydrogen, the results being only slightly different from those in air. In carbon dioxide, however, the sensitiveness of the spark was noticeably increased. Other rays, also, in addition to the extreme ultra-violet, were found to be effective. "With CO_2 the active rays lie between the lines G and K of the visible spectrum." The influence of these rays could also be observed when the spark occurred in air, but in much less degree.

16. Wiedemann and Ebert give a brief discussion of a possible theory of the action based upon 'absorption by the gases condensed upon the electrodes.' This is supposed to facilitate the formation of cathode rays by a process analogous to resonance.

17. A paper by Hallwachs,* which appeared at the same time as that of Wiedemann and Ebert, describes work along a somewhat different line, and indicates the distinct gain which may result from the removal of unessential and complicating conditions. In attempting to reduce the experiments of Hertz to a simpler form, Hallwachs was led to believe that the effect was due to an increased tendency for the discharge of negative electricity, resulting in some way from the action of ultra-violet rays. Such an effect, he argued, might be present even when no spark discharge occurred. The spark gap was therefore dispensed with. A disk of polished zinc, 8 cm. in diameter, was suspended from an insulated support and connected with a gold-leaf electroscope. The two were then charged negatively. When the zinc plate was exposed to rays from an arc lamp its charge was found to be rapidly dissipated. During this experiment the electroscope itself was screened from the rays of the lamp, while in front of the zinc plate was placed a large zinc screen containing a window of gypsum. This substance was found to absorb the rays only slightly.

18. The effect was observed only when the plate was *negatively* charged.

19. Hallwachs was able to show that the active rays are *absorbed*, *reflected* and *refracted* in the same manner as had been determined by Hertz. Everything seemed to show that the increased rapidity of discharge observed with negatively charged zinc was merely another manifestation of the Hertz effect. The fact that the extreme ultra-violet rays are most effective was definitely proven.

20. It was by no means evident in the case of Hallwachs' first experiment whether the action occurred at the charged surface or in the surrounding medium. To test this point two plates were set up parallel to one another and at a distance of 3 cm. apart. Each was charged negatively and connected with an electroscope. When the rays passed between the plates and parallel to the surface scarcely any effect was observed. But if the plates were turned, so that one of them received rays from the lamp, its charge immediately began to fall. It therefore appears that the action occurs at the charged surface itself, and that if the medium exerts any influence it is of only secondary importance. An experiment of Bichat,* who

* Wied. Ann. 33, p. 301, 1888.

* C. R. 107, p. 557, 1888. Wiedemann's Beiblätter 13, 39.

lluminated the *interior* surface of a negatively charged hollow cylinder without observing any effect, confirms this view.

21. Since the effect is produced at the surface, it should depend upon the character of the surface. A well polished surface was, in fact, found to be from 40 to 50 times as sensitive as one that was rough or oxydized. With iron the effect was less marked than with zinc. With aluminum it was *more* marked.

DEVELOPMENT OF A POSITIVE CHARGE BY ILLUMINATION. WORK OF HALLWACHS AND RIGHI.

22. At the close of the article just referred to, Hallwachs mentions experiments indicating that the discharge of negative electricity may occur, under the influence of ultra-violet rays, even from a neutral body.. In a later article* these experiments are described somewhat more at length. A polished metal disk was suspended within a metallic box and connected with an electrometer. When illuminated by rays from an arc lamp 45 cm. distant it was found to acquire a positive charge. The maximum potential reached was about $\frac{1}{2}$ volt for aluminium, 1 volt for brass, and a little more than 1 volt for zinc. The metal screen surrounding the disk was of rusty iron ; this being chosen so that the contact potential difference between screen and disk should have a tendency to charge the former negatively. Otherwise the results obtained might be misleading. In order to prevent direct electrostatic induction from the lamp, the gypsum window through which the rays came was covered with wire gauze. All action ceased upon the interposition of a sheet of mica.

23. Hallwachs' article, which was quite brief, was followed by a note in the Comptes Rendus, by Bichat,† whose results are, to say the least, striking. Bichat's experiments were made with growing plants placed upon insulating supports and illuminated. With the exception of the geranium, all the plants tested were found to acquire a negative charge, with a maximum potential of 7–8 volts. This phase of the subject does not appear to have been carried further either by Bichat or by others.

24. A more elaborate investigation of the effect of ultra-violet rays was undertaken by Righi* in the same year, the first results being published almost at the same time as the work of Hallwachs. Righi's arrangement of apparatus was as follows: A sheet of wire gauze, B, was set up parallel with a metal disk, A, and a short distance in front of the latter. A was connected to one pair of quadrants of an electrometer, B to the other and also to earth. The needle was charged to about 100 volts. Upon grounding A for an instant, insulating and illuminating with rays from an arc lamp, the electrometer showed a deflection. The final deflection was the same even when A had an initial charge. When the steady deflection was once reached a change in the relative position of A and B was without influence upon the deflection. Righi concluded from this that the metals were brought to the same potential by the action of the light. If this is true the steady deflection obtained as above described should be a measure of the contact E. M. F. between the metals.

25. Righi found that the electrometer deflection increased with increase in surface exposed, and with diminished distance from the arc lamp. An arc between carbon and zinc was found especially effective. Sunlight was without influence.

26. Upon combining several pairs (disk and gauze) by connecting the wire gauze

* Wied. Ann. 34, 731, 1888. Phil. Mag. 25, p. 78 (Abstract).

† C. R. 107, p. 557, 1888. Beibl. 13, p. 39.

* Rendiconti d. Accademia dei Lincei 6, p. 185, 1888. Beibl. 12, 286. Reprinted in the *Journal de Physique* 7, p. 153, 1888.

of one to the metal disk of the next, a battery, with increased E. M. F., was obtained. When plates were used without gauze in front, all metals were found to become charged to a gradually and continuously increasing positive potential.

27. Righi was at first of the opinion that those metals which are found least active when judged by the rate of dissipation of a negative charge when illuminated were found *most* active if judged by the positive charge acquired from a neutral condition.* For example, aluminum and zinc showed the most rapid loss of negative electricity under the action of ultra-violet rays, but gold and copper (originally neutral) became more strongly charged positively than either.† Still later observations by Righi appear, however, to contradict the results stated above.‡ A heavily lacquered plate was grounded and punctured with a large number of small holes, through which ultra-violet rays fell upon a parallel polished plate. The final steady potential of the latter (which was insulated) was measured for different distances between the plates. The surface density developed by illumination could then be computed. It was $\delta = 0.000116$ C. G. S., for carbon and $\delta = 0.000161$ for Al.§ Other metals showed a surface density lying between these limits. It appears, therefore, that the charge increases until a certain definite *density* is reached. This density depends upon the temperature, changing in the case of zinc, from .000146 at 24° to .000218 at 10°. In still another article Righi says‖ "it is to be observed that the order" in which the metals stand with regard to taking a positive charge "is almost the same as that which indicates the rapidity with which they lose a negative charge under the influence of illumination."

28. Attempts were made to find some effect with positively charged bodies, but without success.

29. Not only metals, but also sulphur and black rubber, were found to become positively charged when illuminated.

PHOTO-ELECTRIC CURRENTS. WORK OF STOLETOW.

30. It was shown in 1888 by Stoletow* that under suitable conditions it was possible to obtain a *current* by the action of ultra-violet rays. A metal plate 22 cm. in diameter and a parallel sheet of wire gauze were illuminated by an arc lamp. The + pole of a battery was connected to the gauze and the − pole to the metal plate, a sensitive galvanometer being in circuit. Under these circumstances a current was obtained so long as the illumination continued. On reversing the battery connections the galvanometer showed only a small deflection.

31. The effect was increased by carefully cleaning the metal plate. The current was found to be proportional to the illuminated surface. On increasing the distance between plate and wire gauze the current diminished, the law being approximately expressed by the equation $i = E \div (a + bl)$ where l represents the distance between plate and gauze. The current was proportional to E up to 2 volts. Beyond that E. M. F. the current increased less rapidly than the E. M. F.

32. Stoletow found in later experiments,† however, that the current remained constant so long as $\frac{E}{l}$ was constant.‡ "The

* C. R. 107, p. 559, 1888. Beibl. 13, 40.

† l. c.

‡ R. Acc. dei Lincei 5, p. 331, 1889. Beibl. 13, 566.

§ Later observations led Righi to correct these values to .000116 and .000241 respectively. See Atti. del. R. Inst. Ven. 7, 1889. Beibl. 13, 976.

‖ Ibid.

* C. R. 106, p. 1149, 1888. Beibl. 12, 605. Phil. Mag. 26, p. 317. (Abst.)

† C. R. 108, p. 1241. Beibl. 13, 902.

‡ This law does not hold exactly at low air pressures. See Stoletow, Jour. de Phys. 9, p. 471, 1890.

current is therefore a function of the density of the negative charge, or of the electric force acting upon the negative plate." A curve plotted with $\frac{E}{l}$ and i as abscissas and ordinates respectively resembles a curve of magnetization. If the plate and gauze are of different metals the contact E. M. F. between them must be subtracted from E in computing the current.

33. If the metal of which the gauze is made is positive with reference to the plate (*e. g.*, gauze of zinc, plate of copper silver-plated), a current may be obtained without any battery.* The current in this case corresponded to the contact E. M. F. between the two metals (*i. e.*, about 1 volt). This was tested by placing a Daniell cell in the circuit and observing the increase in current. The tendency of illumination appears to be to equalize the potentials of the two metals. By connecting the two to a condenser and discharging the latter after equilibrium has been reached, the contact E. M. F. of the metals can be measured.†

34. Al, Zn, and Pb placed in the arc increase the effect. Stoletow calls attention to the fact that these metals are quite strongly electro-positive, and have strong ultra-violet spectra.

35. The experiment of Stoletow was modified by Borgmann ‡ in such a way as to make the illumination intermittent. If the development of a current followed the illumination instantly it was thought that the intermittent character of the current could be detected by a telephone. Although an E. M. F. of about 120 volts was used, no sound could be heard. Borgmann concludes that the action does not occur at once, but requires a finite time.

*Stoletow, C. R. 106, p. 1151. Beibl. 12, 605.

† Righi has followed up this aspect of the subject at some length. (Accad. dei Lincei, 5, 860. Beibl., 14, 69.) It was found that the contact P. D. depended in many cases upon the gas, and in some cases the direction of the E. M. F. could be reversed by changing from air to burning gas.

‡ C. R. 108, p. 733. Beibl. 13, 565. See also Phil. Mag. 26, p. 272.

36. Stoletow, however, opposed this view* and was of the opinion that the telephone was not sufficiently sensitive to detect the sound. He rotated a disk of cardboard, containing 16 openings, in the path of the rays, while a commutator on the shaft (containing 16 segments) cut out the galvanometer and threw in an equivalent resistance 16 times each revolution. When the brushes were set for a maximum effect the galvanometer was found to be unaffected by changes in speed. Stoletow estimates, therefore, that the actinic current must be set up within $\frac{1}{1000}$ sec. after the beginning of the illumination. In this same paper Stoletow describes experiments with a sectored disk, which was rotated in in the path of the ultra-violet rays in such a manner as to diminish their intensity one-half. Under these circumstances the actino-electric current was also reduced one-half for all speeds of rotation.†

PHOTO-ELECTRIC EFFECTS PROBABLY DUE TO CONVECTION: WORK OF RIGHI, LENARD AND WOLF, HOOR, ETC.

Early in his investigations Righi came to the conclusion that the effects observed were due to a sort of electric convection, which for some reason was accelerated by ultra-violet rays. This conclusion was justified by the following experiments:‡

37. A rod carrying a mirror was mounted in a horizontal position inside a glass box by a delicate bifilar suspension. Thin sheets of Al were fastened to each end, and one of them was charged negatively by being connected with a dry battery. On illumina-

*C. R. 108, p. 1241. Beibl. 13, 902. For resumé of Stoletow's work see also Phil. Mag 30, p. 437.

† l. c., p. 1242.

‡Accad. dei Lincei 4, p. 6, 1888. Beibl. 12, 721. See also C. R. 107, p. 559, for brief statement of these results.

ting this sheet (through a gypsum window) with rays from an arc light, the system was deflected. The charged sheet seemed to be driven away from the light rays. This may be explained as due to the reaction from the electrified particles, which, under the influence of the ultraviolet rays, are being driven away from the surface. When the illuminated sheet was charged positively, or grounded, no effect was noticed.

38. Returning to the apparatus first used (metal disk and parallel wire gauze) an insulated plate of gypsum was placed between disk and gauze, and was observed to become negatively charged on the side nearest the Zn plate. If two plates of gypsum are used, only that nearest the Zn plate is charged. These results are well explained on the hypothesis of electric convection.

39. It was found that the charged particles producing the convection discharge travel along the lines of force of the field. (Suggested first by Hallwachs.) To prove this a vertical zinc cylinder was charged by a dry battery and placed near a large vertical zinc plate, the latter being grounded. The shape of the lines of force of such a system is known. With the exception of a narrow vertical strip the cylinder was lacquered, previous experiments having shown that a coating of lacquer prevents all action from ultra-violet rays. On illumination the convection discharge, if there is one, could therefore only take place from the unlacquered portion of the surface. If the electrified particles traveled along the lines of force it would be possible to predict the position at which they would reach the grounded plate. This was done, and a small insulated piece of zinc placed at the position computed was found to become negatively charged, while if at a different point it was unaffected.

40. In 1890 Righi* began experiments upon 'photo-electric convention,' etc. at low air pressures (going as low as .001 mm.). It was found that at ordinary pressures the electrified particles proceeded along lines of force, as shown earlier. But as the pressure was reduced there was a tendency for the paths of the particles to deviate more and more from the lines of force and to become more nearly coincident with the normal to the illuminated surface. In the course of these experiments it was found that the maximum positive surface density acquired by an unelectrified body when illuminated increases continuously with diminishing pressure. On the other hand, the rate of dissipation from a negatively charged surface increases to a maximum as the pressure is reduced and then diminishes. Righi concludes that the development of a positive charge, and the dissipation of a negative one, are different phenomena.

Numerous experiments by Stoletow* on the effect of diminished pressure upon the actino-electric current can merely be referred to. They seem in the main to confirm Righi's observations.

41. Observations by Bichat and Blondlot† appear at first to be in confirmation of the hypothesis of Righi that the discharge takes place by convection. These observers used an apparatus like that of Righi, gauze and plate being of the same metal. On illumination the plate became positively charged to a potential of 3 to 4 volts. If a draft of air is blown upon the plate, either by fanning or by allowing compressed air to escape against the plate, the potential was increased six or eight times. It would seem that this might be explained by convection taking place more readily under the action of the draft. Further experiments show, however, that the explanation is not so simple.

*Acc. dei Lincei 6, p. 81. Acc. di Bologna 10, p. 85. Beibl. 14, p. 1167.

*Journ de Phys. 9, 468. Beibl. 15, 233.

†C. R. 107, p. 29, 1888. Beibl. 13, 38.

42. The gauze was next connected with the pole of a battery (2 volts), the plate being at first grounded, so that it took a charge by induction, and then connected to the electrometer. When illuminated the plate became negatively charged, *i. e.*, lost electricity. (why?) But on blowing against the plate the deflection of the electrometer was reversed, and the plate became strongly positive. Blowing on the plate does not therefore merely take away the statical charge, regardless of sign.

43. If the gauze and plate are connected through a galvanometer without any battery, no current results from illumination alone. But when air is blown against the plate (with illumination) a considerable current flows. Without illumination no effect can be noticed on blowing.

The authors believe that the effects are in part due to the fact that there is a contact P. D. between metal and air, the latter being positive.*

44. Later in the same year Bichat† was led by other observations to believe that the negative discharge was due to convection. An apparatus similar to that of Righi,‡ which had been used in 1887 apparently without knowledge of any effect from illumination,§ was found to rotate more strongly under the influence of ultra-violet rays.

45. The hypothesis of the negative discharge being due to convection received the strongest confirmation from observation by Lenard and Wolf.|| Their results, however, contradict Righi's view in some particulars. In assuming the existence of convection Righi was of the opinion that the *air particles* became charged at the surface of the body and were then repelled.¶ This action would continue until a certain positive potential was reached, whereupon the attraction between the positive body and the negative particles would bring about a condition of equilibrium.

*For fuller statement of explanation see article.

†C. R. 107, p. 557. Beibl. 13, 39.

‡See § 37.

§C. R. 104, p. 1786. Beibl. 11, 716.

|| Weid. Ann. 37, p. 443, 1889.

¶C. R. 107, p. 559, 1888.

46. Lenard and Wolf urged in objection to this view that it is impossible for the particles of a gas to become charged; dust may receive a charge, but not gaseous molecules.* They therefore think that the cherge must be carried away by particles of the body itself, these being shaken loose in some way by the ultra-violet rays. They experimented first with thin gold leaf, silver and copper foil, etc., hoping to detect the loss of particles by some change in the optical transmitting power. After an exposure of some 50 hours to rays from an arc light the surface was found to be roughened at all points not screened from the rays. By interposing obstacles sharp shadows were cast, as shown by the roughening. No change could be noticed, however, by transmitted light. Any object which is opaque to ultra-violet rays (*e. g.*, glass) was capable of producing a shadow.

47. Being convinced by these experiments that particles were actually sent off under the influence of ultra-violet rays, the authors next attempted to observe the course of the particles after leaving the body. As a source of light the spark from an induction coil was usually employed. The arc lamp was also used with Zn in place of one carbon. The relative values of these lights in producing the negative discharge are shown by the observations described below:

A polished zinc disk 8 cm. in diameter was set up 30 cm. from the source of light, connected with a gold leaf electroscope, and charged to 1000 volts. The time required for the potential to fall to 200 volts was found to be

* In this connection see *Nahrwold*, Wied. Ann. 31, p. 448; also J. J. Thomson, Recent Researches in Electricity and Magnetism, p. 53.

For ordinary arc..................17.2 sec.
Arc between Zn and C.......... 2.3 "
Induction coil spark ....10.7 "

An uncharged Zn or Cu plate 30 to 40 cm. from the spark discharge became strongly charged positively within a few seconds.

48. For detecting the dust developed by the ultra-violet rays a glass vessel was prepared containing a quartz window. The vessel was filled under pressure with carefully filtered air. A dish of water within the vessel kept the air nearly saturated with water vapor. On allowing the air to expand suddenly dust could be detected, if present, by the fog resulting from moisture condensed on the dustparticles. By proper precautions air could be obtained dust free. But when ultra-violet rays had passed through the quartz window for about ten minutes the presence of dust could always be detected, even when no metal was within the vessel. The authors came to the conclusion that quartz itself gives off particles under the action of ultra-violet rays.

49. The use of the glass vessel in which the body to be tested was to have been placed was therefore abandoned. A jet of steam was then used to detect dust. The arrangement of apparatus is shown in the figure. A quartz lens L was placed in an opening in a grounded metal screen, and condensed the rays from the source upon the metal plate, M. Dust particles from the lens were prevented from reaching the steam jet, J, by a glass screen, S. The plate M was first carefully freed from adhering dust. Preliminary tests showed that the steam jet itself exerted no discharging action. When the zinc plate M was negatively charged, a strong dust reaction was obtained on illuminating it. The dust first showed itself in that part of the jet nearest the plate, and gradually extended. The effect was stopped by glass or mica placed in the path of the rays. No dust reaction was detected when the Zn was grounded.

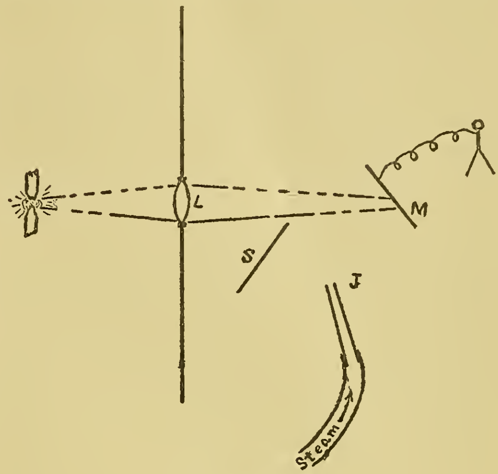


FIG. 1.

When M was charged positively there was also no effect. A potential as low as 300 volts (negative) was sufficient to enable the dust to be detected.

50. Various other metals were tested in in the same way and showed the dust reaction in different degrees. They are arranged below in descending scale, Ag being least sensitive :

Zn, Hg, Pt, Brass, Cu, Sn, Pb, Fe, Au, Ag.

51. With a positive charge no effect was observed in any case.

52. With a very sensitive steam jet the dust could also be observed from unelectrified metals, being best seen with copper.

53. Several liquids were tested, filter paper being soaked in the liquid to be investigated, and then charged. Fuchsin and Methylviolet showed the effect ; water not at all. These liquids were tested also as to the influence of ultra-violet rays in producing negative discharge.* Water was quite inactive, while the other two liquids

* Liquid surfaces had previously been investigated to some extent by Stoletow [C. R. 106, p. 1593] and by Wiedemann and Ebert. [Wied. Ann. 35, p. 211.] See below.

showed themselves about $\frac{1}{5}$ as sensitive as zinc. It appears therefore that the liquids which give a dust reaction are the same that show an increased rapidity of discharge of negative electricity.

54. Further confirmation of the hypothesis of convection is given by the observations of Hoor.* His article contains also a discussion of some of the explanations of the phenomena that might be suggested: *e. g.*, (1) Electrostatic action from the arc light; (2) material particles sent out by the arc; (3) change in the conductivity of the medium (air) in which the body is placed; (4) change in the surface of the illuminated conductor by a transformation of light energy into electrical energy; (5) convection, under the influence of illumination. Rather obvious experimental reasons are given for discarding 1, 2,† and 3, and Hoor prefers to adopt the 5th. He is, however, inclined to accept the suggestion of Wiedemann and Ebert ‡ that the layer of gas condensed upon the surface plays an important part in the phenomenon. Particles of gas from this layer he thinks become charged, and, under the influence of ultraviolet rays, escape. Several experiments seem to show that any influence which tends to remove the layer of condensed gas diminishes the sensitiveness of the surface.

55. For example,§ a plate of either glass or gypsum laid upon the surface of a zinc disk prevented the dissipation of a negative charge by illumination. (Convection prevented.) The zinc plate remained inactive for a short time after the removal of the glass,* but became sensitive again either on resting 5 or 10 minutes, or by repolishing. (Surface gas layer removed by contact with glass, etc., on account of the greater attraction of the latter. A new layer condenses gradually.) (3.) A clean zinc plate was found to lose its sensitiveness after being covered for 3 hours with powdered charcoal. (Condensed gases absorbed by the charcoal.) (4.) A plate is rendered inactive by heating to 55° with a Bunsen burner,† but becomes sensitive again by cooling. (Gas layer dissipated by flame.) (5.) A plate covered with a thin film of glycerine is insensitive. (6.) After a plate has been illuminated for some time its sensitiveness diminishes, but increases again after a rest.

56. Righi at first held the same view as Wiedemann and Ebert and Hoor in regard to the importance of the layer of condensed gas.‡ Later he came to the conclusion that the condensed gases were without influence.§ He detected the alteration (roughening) of the surface under the action of ultra-violet rays independently of Lenard and Wolf, and investigated the shadows and figures produced at some length.|| In some cases the shadows cast by opaque bodies can be better shown by breathing on the surface.

57. Summing up the results in regard to convection, it appears that almost all observers agree in the belief that the negative charge is removed by convection of

*Repertorium der Physik 25, p. 91, 1889. Beibl. 13, 731.

†Hallwachs shows, however [Wied. Ann. 40, p. 332], that charged particles from the arc may cause trouble in some cases and that suitable precautions must be used.

‡This is practically the view first held by Righi.

§First paper, already referred to. Wied. Ann. 33, p. 240.

*Stoletow [C. R. 108, p. 1241. Beibl. 13, 902] contradicts this *absolutely*. He finds no diminution in sensitiveness even after the glass plate has remained in place 24 hours, provided that both glass and zinc are clean and dry.

†This is also contradicted by Stoletow (l. c.), who, however, used an air bath instead of a Bunsen burner.

‡ Accad. dei Lincei 5, p. 331. Beibl. 13, 566, and 14, 68.

§ Atti del Inst. Ven. 7, 1889. Beibl. 13, 976. Also Exner's Repertorium 25, p. 380.

|| Beibl. 13, 566; 13, 976; 14, 68.

some sort. Whether the particles which remove the charge come from the air, or from the condensed gaseous layer, or from the material of the body itself, is still in dispute. It appears to me that the mass of the evidence is in favor of the latter hypothesis. But the possibility that the phenomena may be complicated by electrolytic conduction in the medium surrounding the charged body,* must not be forgotten.

Ernest Merritt.

Cornell University.

(*To be concluded.*)

THE NORTH AMERICAN ORIGIN OF THE EDENTATES.†

The explorations of the American Museum Paleontological party in the basin of the San Juan, New Mexico, during the past summer secured, among other important materials, the larger part of the anterior limb of *Psittacotherium multifragum* Cope, associated with the lower jaws and a number of the upper teeth. The specimen in question was found by the writer, and, with the exception of a few unimportant weathered fragments, was bedded in its original matrix, a soft, friable, reddish colored clay. The jaws and limb were not more than a foot apart, so that there can be very little doubt that they belong to one and the same individual.

It has been the custom of paleontologists to place the genus *Psittacotherium*, after Cope, in the Tillodontia, but it can now be shown that it not only does not belong in this group, but that together with *Hemiganus*, *Ectoganus and Stylinodon* forms a closely connected consecutive series ancestral to and leading directly to the Gravigrada, or ground sloths. A second series, composed of *Onychodectes* and *Conoryctes*, is clearly an allied group, which probably gave origin to the Armadillos.

These two series I have arranged under a new suborder for which I have proposed the name Ganodonta, and considered them as constituting a primitive division of the Edentata.

This suborder has been defined as follows: "Primitive Edentates characterized in the earlier forms by rooted teeth with divided fangs, having a more or less complete enamel investment; in the later forms by the teeth becoming hypsodont, rootless, of persistent growth, and by limitation of the enamel covering to vertical bands in progressive decrease. By the presence of incisors in both jaws, by a typical molar and premolar dentition, by a trituberculate molar crown, which disappeared early in life through wear, leaving the dentine exposed."

The evidence of the Edentate affinities of these forms is displayed most strikingly in the *Hemiganus*, *Psittacotherium*, *Ectoganus* and *Stylinodon* series in the following characters: (1) The enlarged teeth in the front of both upper and lower jaws can now be determined as being canines, and not incisors, as has formerly been supposed. In the earliest genus, *Hemiganus*, from the lower Puerco, the lower canine had already lost the enamel from its posterior face, while the crown of the upper canine is completely encased in enamel; the teeth were rooted, having divided fangs, and the crowns of the molars and premolars in the single specimen known are enamel-covered. (2) In the succeeding genus, *Psittacotherium*, from the upper Puerco, the superior canines had also lost the enamel from the posterior face, the roots of the lower molars and premolars were connate, while the roots of the upper molars were more or less divided into fangs. The crowns of the molars early lost

*In an early paper Arrhenius [W. A. 32, 545; 33, 638. Phil. Mag. 28, p. 75] suggested that the air conducted electrolytically under the influence of ultra-violet rays.

† Bull. Amer. Mus. Nat. Hist., Art. XVI., 1896.

their tuberculate structure and all the molars and premolars are more or less elongated; the incisors were reduced to a single pair in the lower, and very probably a like number in the upper jaw, with the enamel confined to the anterior face. (3) In the Wasatch representative (*Ectoganus*) a still further advance is seen in that the canines grew from persistent pulps; the lower incisors had lost their enamel covering, and in the premolars the enamel is confined to external and internal vertical bands. (4) The Wind River and Bridger genus (*Stylinodon*) continues this specialization, and here we note that in the premolars, and molars as well, the enamel is confined to narrow external and internal vertical bands, with all the teeth hypsodont and growing from persistent pulps. (5) The feet of all these genera, so far as known, are remarkably short and provided with immense more or less compressed claws. (6) The carpus and ulna and radius of *Psittacotherium* are almost identical with that of *Mylodon*, and the humerus of *Ectoganus* displays a remarkable similarity to that of *Mylodon* and *Megalonyx*. (7) The muzzle is short, the lower jaw is heavy and robust, and the posterior end of the tooth line passes behind the enlarged coronoid, which, together with the large, powerful curved canines, growing from persistent pulps, at once recalls, in the most positive manner, the skull of *Megalonyx*. (8) The order Edentata, with the exception of one or two fossil forms, from the Santa Cruz and Monte Hermoso beds of South America, are characterized by enamelless teeth, growing from persistent pulps, notwithstanding the fact, as has been shown, that they possess a rudimentary enamel organ for each tooth in the earlier stages of its development. Ameghino has found that some of the older forms possessed bands of enamel on the molars and premolars similar to those seen in *Stylinodon*.

We know of no other group of extinct mammalia in which this progressive loss of enamel occurs, coupled with increasing length of the teeth, together with their growth from persistent pulps; and when we come to consider the remarkable similarities in other parts of the skeleton, the conclusion, in my judgment, is unmistakable that they are the direct forerunners of the Edentata. It is, indeed, a matter of great surprise that the foot structure of *Psittacotherium*, and for that matter *Hemiganus* as well, should show, even at the very beginning of the Puerco, such a high degree of specialization, almost equal to the large Ground Sloths. It clearly indicates that the modern Edentates are the surviving members of a very ancient and archaic group of mammalia, which had its origin far back in Mesozoic time.

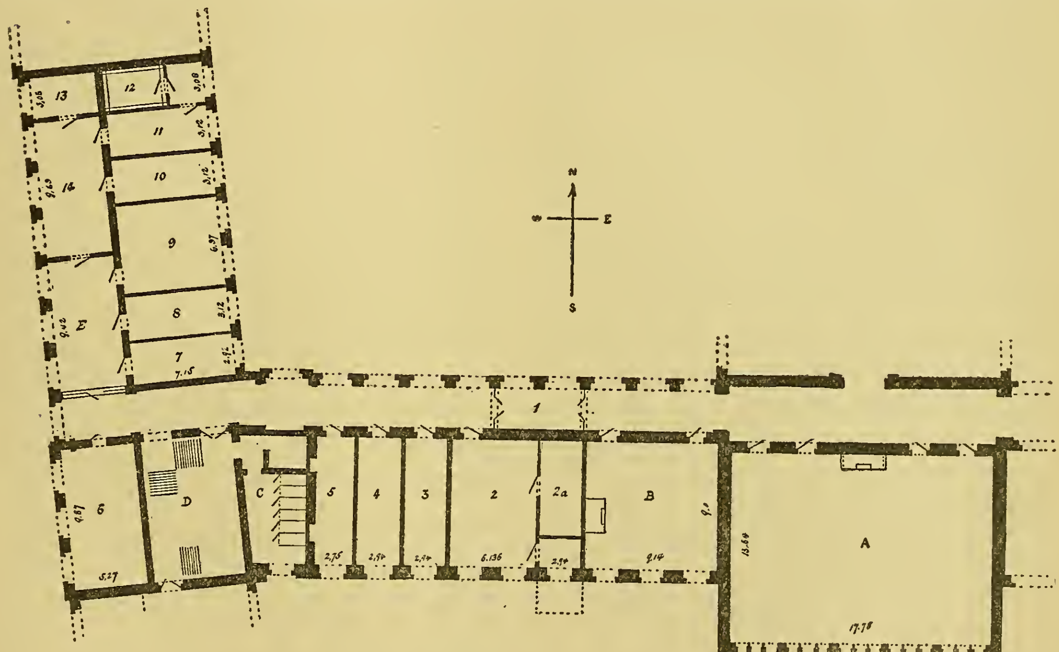
It is also a matter of the greatest interest to note that this group apparently disappeared from North America before the close of the Eocene, no trace of them having as yet been found later than the Lower Bridger horizon, until they reappear in the Pliocene or Post-Pliocene beds of this country. It is also worthy of note that they make their first appearance in South America in the Santa Cruz and Monte Hermoso formations, which would seem to indicate that these beds cannot be older than late Eocene or older Miocene, corresponding with our Uinta and White River formations. Collateral evidence of this migration to the southward in Eocene time is furnished by the disappearance of *Meniscotherium* from our Wasatch and the subsequent appearance of its successors, the *Proterotheriidæ* in South America.

I think, from the evidence just adduced, that it can now be established that the South American Edentata, at least, originated on the North American continent in the group above described.

J. L. Wortman.

THE NEW PSYCHOLOGICAL LABORATORY AT LEIPZIG.

The accompanying plan, published by kind permission of Prof. Wundt, shows the arrangement and dimensions* of the new rooms into which the Leipzig *Institut für experimentelle Psychologie* has recently moved. Of these rooms, situated on the second floor of the magnificent stone structure now being completed for the University, only those on the west side face the street; the others open on large quiet courts, and thus offer the seclusion so necessary for undisturbed experiment. At the same time, the entire set of rooms, except the two lecture halls marked A and B on the plan, are shut off from the rest of the building in which they are situated and are accessible only to members of the *Institut*.



These lecture rooms, with a seating capacity of 420 and 117 respectively, are fully equipped for purposes of demonstration. They are electrically supplied both from the batteries of the laboratory and from the general city current. They can also be darkened if need be. The other eighteen or more rooms are likewise provided with both kinds of electric current, and by means of a central switchboard can be electrically interconnected in such groups as the special investigations require.

Rooms 1 to 5 are arranged more particularly for experiments in optics, room 1 having north light, while the others open toward the south. No. 2a is the dark room, and adjoining it to the south is its small antechamber provided with an outside platform upon which the heliostat or similar instruments may be placed. No. 3 is the Director's Room. In rooms Nos. 4 and 5 are kept various pieces of optical apparatus, for instance, the large perimeter and Helmholtz's double spectroscope. The spaces farther to the west, marked C and D, are occupied by closets and the stairs leading to the laboratory.

The meetings for the introductory course

* In meters.

by Dr. Meumann, as well as all formal assemblies of the members of the *Institut*, are held in room 6. Here, too, are the central batteries and the larger pieces of apparatus for demonstration. On the other side of the corridor is the cloak room, marked E, serving also as a storeroom for the charts and diagrams used in the lectures. No. 7 is the First Assistant's room.

Rooms 8 to 12 are arranged more especially for work in acoustics. In No. 8, for instance, the large phonometer is set up as a fixture. In room 9 are placed various acoustic instruments; the room is, moreover, connected by telephone with No. 12. Rooms 10 and 11 are for a variety of uses, for chronometric work, or for experiments such as those on '*Zeitsinn*.' Next to room 11 is a small protective antechamber leading to No. 12, the silent room with double partitions and doors. Besides the transmission of sound by telephone, these acoustic rooms permit direct air communication by means of lead pipes. In some cases the pipes are bent around an intermediate room, passing, for instance, from No. 9 around No. 10 to No. 11. In others the pipes pass without bend, directly from one room to the other.

In room 13 are lockers for tools and for chemicals. No. 14 is the well-lighted library and reading room.

George M. Stratton.
University of California.

AMERICAN ORNITHOLOGISTS' UNION.

The Fourteenth Congress of the American Ornithologists' Union convened in Cambrige, Mass., Monday evening, November 9th. The business meeting was held at the residence of Mr. Charles F. Batchelder. The public sessions, lasting three days, were held in the Nash lecture room of the University Museum, commencing Tuesday, November 10th.

William Brewster, of Cambridge, Mass., was reelected President; Dr. C. Hart Merriam and Mr. Robert Ridgway, of Washington, Vice-Presidents; John H. Sage, of Portland, Conn., Secretary; Wm. Dutcher, of New York, Treasurer; Charles F. Batchelder, Major Chas. Bendire, Frank M. Chapman, Chas. B. Cory, Drs. Jonathan Dwight, Jr., A. K. Fisher and L. Stejneger, members of the Council. One active and seventy-eight associate members were elected.

By a change in the by-laws ex-Presidents of the Union are now *ex-officio* members of the Council.

Mr. Wm. Dutcher, Chairman of the Committee on 'Protection of North American Birds,' read an interesting and most valuable report of the work done by his committee during the past year. This report will be published in *The Auk* and reprinted as a separate pamphlet.

The Union was honored by the presence of Miss Maria R. Audubon, granddaughter of the renowned naturalist. In her behalf Dr. Elliott Coues exhibited some recently discovered manuscript journals of John James Audubon, including the one giving an account of his famous trip up the Missouri river. A vote of thanks was tendered Miss Audubon for her kindness in allowing the manuscript to be seen.

Under the title 'Ornithological Publications, Present and Prospective,' Dr. Elliott Coues laid before the Union an advance copy of the 'Report of the World's Fair Ornithological Congress,' and stated that he was engaged in the preparation of a new edition of his 'Key to North American Birds.' He also mentioned other works that would soon be given to the public.

A prominent feature of the Congress was the open-air talk by Mr. Abbott H. Thayer, demonstrating his theory of the principles of protective coloration.

Mr. Thayer placed three sweet potatoes, or objects of corresponding shape and size, horizontally on a wire a few inches above the ground. They were covered with some sticky material, and dry earth from the road on which they stood was sprinkled over them so that they would be the same color as the background. The two end ones were then painted white on the under side, and the white color was shaded up and gradually mixed with the brown of the sides. When viewed from a little distance these two end ones, which were white below, disappeared from sight, while the middle one stood out in strong relief and appeared much darker than it really was. Mr. Thayer explained that terrestrial birds and mammals which are protectively colored have the under parts white or very light in color, and that the color of the under parts usually shades gradually into that of the upper parts. This is essential in order to counteract the effect of the shadow, which otherwise, as shown by the middle potato, makes the object abnormally conspicuous and causes it to appear much darker than it really is. In the case of Mr. Thayer's experiment some of the witnesses could hardly believe that the striking difference in the visibility of the three potatoes was entirely due to the coloring of the under side, and Mr. Thayer was asked to color the middle one like the two others in order that the effect might be observed. Mr. Thayer complied with the request, painting the under side of the middle potato white, and shading the white up into the sides as in the case of the others. The effect was almost magical. The middle potato at once disappeared from view. A similar experiment was tried on the lawn. Two potatoes were painted green to resemble the green of the grass above which hey were suspended. One was painted white on the under side and at once became invisible when viewed from a little distance, while the other showed plainly and seemed very dark, the shadow, superadded to the green of the under side, making it remarkbly conspicuous. The experiments were an overwhelming success. In the discussion that followed, Mr. Thayer called attention to the winter dress of the ptarmigan, and stated that inasmuch as the body of the bird is white all over it is clearly impossible for the under parts to be any whiter, and consequently the bird's shadow would tend to make it conspicuous when standing on the snow. To offset the effects of the shadow the under side of the bird would be lightened by the reflected light from the snow. In addition to this, the black of the ptarmigan's tail would have the effect of lessening the apparent depth of the shadow, thus serving to render the bird less conspicuous. Dr. Merriam stated that additional illustrations of the same kind might be mentioned, and cited those of the polar hare and ermine, in which animals the black of the ears and tail would have the same effect as the black tail of the ptarmigan. Dr. Merriam remarked further that the absence of black from the ears and tail of the polar bear, arctic wolf and arctic fox served to prove the correctness of Mr. Thayer's theory, inasmuch as these latter animals chase their prey, and consequently would be rendered more conspicuous by black markings which, being in motion, would direct attention to them.

The subject created much discussion. A vote of thanks was given Mr. Thayer.

Mr. Louis Agassiz Fuertes gave an exhibition of some of his own unpublished drawings of birds from life. Examples of the work of Mr. Ernest E. Thompson were also shown.

Mr. Edward H. Forbush, Field Director of the Massachusetts Gypsy Moth Commission, asked for information and suggestions regarding the advisability of introducing in the United States foreign birds that feed upon the eggs of the gypsy moth. From the trend of the remarks which followed, it was evident that such a scheme would be impracticable and undesirable.

The following is a list of the papers read at the sessions:

The Fringillidæ of Dodge County, Wisconsin. WILL EDWIN SNYDER.

An Ornithological Tour in Yucatan and Mexico, illustrated by lantern slides. FRANK M. CHAPMAN.

Some New England Birds Nests, illustrated by lantern slides from original photographs. WILLIAM BREWSTER.

The Philadelphia Vireo (Vireo philadelphicus). JONATHAN DWIGHT, JR.

The Moult of the Song Sparrow (Melospiza fasciata), and of the Red-eyed Vireo (Vireo olivaceus). JONATHAN DWIGHT, JR.

Notes on the Black Rail (Porzana jamaicensis) in Southern Connecticut. JOHN N. CLARK.

Notes on the Birds of Oregon. C. HART MERRIAM.

Some Notes on the Nesting Habits of the White-tailed Kite (Elanus leucurus), with exhibition of eggs. CHESTER BARLOW.

Two Curious Birds' Nests. WILLIAM BREWSTER.

A Series of Redpolls. WILLIAM BREWSTER.

On the Terns of Penikese Island, Massachusetts. GEORGE H. MACKAY.

On the Terns of Muskeget Island, Massachusetts. GEORGE H. MACKAY.

The next meeting of the Union will be held in New York City, beginning November 8, 1897.

JNO. H. SAGE,
Secretary.

NOTES ON INORGANIC CHEMISTRY.

IN an inaugural dissertation (Amsterdam, 1896), W. P. Jorissen makes a contribution to the knowledge of 'active oxygen.' When a number of substances are slowly oxidized in air or oxygen a part of the oxygen becomes endowed with peculiarly active properties. On studying the oxidation of triethyl phosphin $P(C_2H_5)_3$, Jorissen finds that oxygen is taken up from the air in quantity corresponding to the formation of the oxid $P(C_2H_5)_3O$; but if indigo, which is not oxidized by ordinary oxygen, is present, twice the quantity of oxygen is consumed and the indigo is also oxidized with loss of color. Other substances act in a similar way. The conclusion drawn by the author is that in the slow oxidation of a body the same quantity of oxygen is rendered 'active' as is taken up in forming the primary product of oxidation.

IN the last number of the *Berichte* of the German Chemical Society, Victor Meyer and Max von Recklinghausen give an account of a series of experiments on the slow oxidation of hydrogen and of carbon monoxid by potassium permanganate. Pure hydrogen in a test tube or a flask inverted over a solution of the permanganate is slowly but completely absorbed. Similarly carbon monoxid is in the course of a few days completely oxidized to carbon dioxid. When the solution and gas are shaken in an agitator the same reaction takes place provided the permanganate solution is alkaline or neutral. If, however, it is acid, there is an evolution of oxygen, the quantity being about half that of the hydrogen absorbed. With carbon monoxid and acid permanganate solution there is on agitation also an evolution of oxygen, but not much more than half as much as is the case with hydrogen. This evolution of oxygen is difficult to account for, as in every other known case of oxidation by potassium permanganate the oxygen is wholly consumed in the oxidation process, and none of it escapes. Prof. Meyer suggests a possible similarity of this phenomenon with those of slow oxidation studied by van't Hoff and Jorissen (see above note), where the oxygen molecule seems to divide into two portions with different properties. According to this a molecule of oxygen from the permanganate would divide, one-half going to oxidize the hydrogen, while the other escapes to form molecular oxygen.

IN the same journal G. P. Drossbach describes an investigation of monazite sand in which he finds what he considers to be a new metal, differing somewhat in its properties from any of the known rare earths, and possessing an atomic weight of about 98 or 99. An element of this atomic weight and with the properties the author describes could not find a place in the periodic system. Mendeléef's eka-manganesium would have this atomic weight, but its properties would be very different from those of the new element. The author hence considers the element may not be a simple substance.

J. R. RYDBERG has made further study of the gas evolved from cleveite, and confirms the view of Ramsay that helium is a mixture of two gases. This conclusion is reached from a study of the spectrum of helium.

A FURTHER study of the amount of argon in the atmosphere has been made by Schloesing, in which a remarkable uniformity appears in air from different sources. The average value is found to be 1.184 per cent. of the total volume of nitrogen and argon.

A STUDY of the heat of formation of lithium hydrid by Guntz gives a value of 21.6 calories, a magnitude which might be expected from the great stability of this hydrid. Its dissociation tension at its melting point, 680°, is about 27 mm. J. L. H.

ASTRONOMICAL NOTES.

THE Astronomical Society of the Pacific will publish shortly an interesting account of observations of the eclipse of last August. This eclipse was successfully observed in Lappland, whither an expedition had been sent by the Russian Astronomical Society. An account of the expedition, to be published by the Astronomical Society of the Pacific, has been written by M. Rydzewski, one of the members of the expedition, and will be accompanied with reproductions of several very good photographs of the corona obtained during totality.

THE Academy of Sciences of St. Louis has published a paper on Flexure of Telescopes by Prof. M. Updegraff, of the University of Missouri. The question is treated from a theoretical standpoint. The author points out that the small systematic errors which are often found in the results of declination measures with meridian circles may be the effects of 'unsymmetrical action of gravity on the telescope tube.' H. J.

SCIENTIFIC NOTES AND NEWS.

THE DECIMAL DIVISION OF TIME AND ANGLES.

THE *Revue Scientifique* for October 31st contains an article by M. J. de Rey Pailhade, advocating the introduction of the decimal system in the measurement of time and of angles. The author states that attention was first attracted to this subject when the metric system of weights and measures was introduced into France. Laplace and Poisson made use of the plan proposed at that time, and one measurement, the 'grade' ($\frac{1}{100}$ part of $\frac{1}{4}$ circle), is still in use in the Geographical Survey of the French army. The subject was discussed before the Paris Academy, in 1870, by MM. d'Abbadie, Yvon Villarceau and Wolf, but was not again brought prominently forward till 1893, when it was taken up by M. Pailhade in a paper read before the *Congrès des societés françaises de geographie* at Tours. Since then other scientific societies have recommended the serious study of the question by men of science. Among these may be mentioned the Association française pour l'avancement des sciences, the Société astronomique de France, the Société de topographie de France and the International Congress of Geography held in London in 1895.

All those who are engaged in making elaborate calculations would reap, it is claimed, great benefit from the system. Not only would the time required in computing results be very much shorter, but the chance of error would be greatly decreased. Men of science chiefly, therefore, should be interested in this reform, for though it would also benefit the general public it would do so in a less degree. M. Pailhade lays stress on the fact that the system can only be introduced very gradually, and considers that the only advance that is possible or desirable at present is to decide on the system which, while meeting the needs of men of science would be most acceptable to the general public, and to deliberate on the best means of bringing it into general use.

M. Pailhade proposes (1) that the day should be divided into 100 parts (centijours abbreviated cés) and subdivided into décicés, centicés, millicés and dimicés, (2) that the circle should be divided into 100 cirs and subdivided into décicirs, centicirs, millicirs and dimicirs. The author dwells at length on the simplicity and other advantages of his plan; he finds that it is easily understood by children and advocates its use in schools. In order to facilitate its introduction into general use he has caused a watch to be made in which the figures of the inner circle are those of an ordinary watch, while two outer circles give the decimal division of time.

A TROPICAL BOTANICAL GARDEN.

Prof. D. T. MacDougal contributes to the current number of *Appleton's Popular Science Monthly* an article on Botanic Gardens. He reviews the origin of botanic gardens and describes several of the more important gardens of the world. He calls attention to the need of a botanical garden in the West Indies. The study of living plants has been in large measure confined to those growing between the parallels of 40° and 45° or cultivated under artificial conditions in gardens and conservatories. Prof. MacDougal concludes:

"The centers of botanical activity in Europe are so far removed from the tropical flora that only occasionally does a Transatlantic investigator find time and opportunity to extend his researches to include normal tropical forms. To do this he must visit Buitenzorg or some other garden nearly half way round the world.

"The center of botanical activity in America has at its very doors a tropical region (in the West Indies), unsurpassed in every feature, which may be reached in four or five days from any important city in the country. The establishment of a laboratory and garden in any convenient locality would not only be of untold value in the general development of botanical science, but it would place within easy reach of the investigator or graduate student in American universities facilities unequaled by that of any other country.

"The European botanist would also find a laboratory in the American tropics much more easily accessible than those of the antipodes. The foundation of such an institution would be of direct benefit to the greater number of active botanists, and would go far toward making America the scene of the greatest development of the biology of one of the two great groups of living organisms."

GENERAL.

The Society of American Naturalists will meet at Boston and Cambridge, Mass., on Tuesday and Wednesday, December 29th and 30th. The President, Prof. W. B. Scott, will make an address, and at least one lecture will be given. There will be a discussion on the 'Inheritance of Acquired Characteristics,' in which zoology, botany, paleontology and psychology will be represented. Further details will be given next week. The Secretary of the Society is Prof. H. C. Bumpus, Brown University, Providence, R. I.

The American Physiological Society will hold its ninth annual meeting at the same time and place as the Naturalists, the first day's session being held at the Harvard Medical School, the second day's session at Harvard University. The headquarters of the Society will be at the Hotel Brunswick. Those who will require apparatus or other necessities for the making of demonstrations may communicate with Dr. H. P. Bowditch, Harvard Medical School. The reading of papers is confined to members of the Society and to guests specially invited by the President and Secretary jointly, and papers are limited to a length of twenty minutes. At the meeting arrangements will be made regarding the joint public discussion with the Association of American Physicians at the Medical Congress of May, 1897, upon 'The Internal Secretion of Glands.' Prof. R. H. Chittenden is President of the Society, and Prof. Frederic S. Lee, Columbia University, New York, is Secretary.

The American Psychological Association will also meet at the same time and place as the Naturalists and will join them in the discussion on the 'Inheritance of Acquired Characteristics,' and at the dinner on Wednesday. Prof. G. S. Fullerton, the President of the Society, will make an address on Wednesday afternoon, and the Committee on Mental and Physical Tests will make a report, which will be discussed by members of the Society. The Secretary is Dr. Livingston Farrand, Columbia University, New York.

The American Morphological Society also meets in conjunction with the Naturalists.

The Geological Society of America meets at Washington, D. C., December 29th to 31st, under the Presidency of Prof. Joseph Le Conte. Prof. H. L. Fairchild, Rochester, New York., is the Secretary.

An informal conference of members of Section H, Anthropology, of the American Asso- for the Advancement of Science will be held at Columbia University, New York, at 10 a. m., on December 30th, for the special purpose of discussing the future work and interests of the Section, and to consider the expediency of recommending to the A. A. A. S. the holding of winter meetings of Section H. To facilitate the work of the conference, provision has been made for a few papers. 'The Scope of Anthropology,' and 'The Relations between Anthropology and the other Sciences,' will be treated; and it is earnestly requested that members of Section H contemplating attendance will prepare to participate in the discussion of these subjects either formally or informally. The conference will immediately follow the regular annual meeting of the American Folk-Lore Society, which will be held on December 29th at the same place.

The New York State Science Teachers' Association will hold its first annual meeting at Syracuse, N. Y., December 29th to 31st. The President, Prof. S. H. Gage, will present a paper on the purpose of the Association and the work it hopes to accomplish, and special discussions have been arranged on the teaching of physics and chemistry, of physical geography and geology, and of botany, zoology and physiology. The Association was organized in July during the Buffalo meeting of the National Educational Association, and is intended to unite all teachers of science, from those of the secondary schools to university professors, in order to secure mutual acquaintance and helpfulness. All teachers of science are urged to attend the meeting at Syracuse, which immediately follows that of the Associated Academic Principals of the State.

A British Association for Child Study has been organized, and has held its first meeting at Newcastle-on-Tyne, under the Presidency of Dr. Oliver.

The proceedings of the sixth annual meeting of the German Zoological Society, which was held at Bonn, from the 28th to the 30th of May of the present year, has been published by W. Engelmann, Leipzig. It is edited by Prof. J. W. Spengel and contains 210 large pages.

The Natural Science Association of Staten Island held its sixteenth annual meeting on November 14th. The Secretary reported that the number of active members was 85, an increase of 8 over last year, and the Curator reported a number of additions to the collections and to the library. The officers of the preceding year were re-elected, viz: President, Walter C. Kerr; Secretary, Arthur Hollick; Treasurer, Thomas Craig; Curator, H. Cleaver Brown; Trustee, Wm. T. Davis. The Association has accomplished an admirable work in studying the fauna, flora, antiquities and natural phenomena of Staten Island. Interest in science and the progress of science would be greatly forwarded by the formation of similar societies in other places.

A meeting of the Committee for the Promotion of Agriculture in New York State was held in the house of Mr. A. S. Hewitt, New York, on December 2d. Mr. George T. Powell made a report regarding the work in Westchester county under the auspices of the committee and that accomplished by Cornell University.

There is on exhibition at the American Art Galleries, New York, a collection of butterflies made by Mr. S. W. Denton containing 1300 varieties. The collection has been arranged for artistic rather than for scientific purposes. The collection is for sale, and if not sold in New York will be exhibited in London.

The Berlin Academy of Science has granted 1000 M. to Prof. Maximilian Kurtze, of Thorn, for a History of Geometry in the Middle Ages.

The Columbia Historical Society, Washington, D. C., held a memorial meeting on December 7th in honor of Joseph Meredith Toner, George Brown Goode and Kate Field, all of whom were charter members of the Society.

The *British Medical Journal* states that a statue to Darwin will be erected in Shrewsbury, his native town, by the Shropshire Horticultural Society, at a cost of from $5,000 to $6,000.

Die Natur gives an account of two monuments recently unveiled in Germany. A monument to Stephen Ludwig Jacobi, the discoverer of the artificial culture of fishes, was unveiled at Hohenhausen on July 4th. Jacobi was born in 1711, and published, in 1765, an account of the experiments he had made. A monument to K. A. Lossen, the geologist, especially known for his investigation of the Harz region, was unveiled at Wernigerode on October 19th.

We learn from *Nature* that a monument in memory of Father Secchi, the former director of the Collegio Romano Observatory, has been been erected at Regio, where he was born, at a cost of 78,000 fr., which was collected by subscription.

We regret to notice the deaths of two English naturalists, Mr. Arthur Dowsett, who died on November 6th, and Mr. David Robertson, who died on November 20th. Dr. G. Carton, the archæologist, died recently at Thielt, Belgium.

At the annual meeting of the Edinburgh Royal Society, Lord Kelvin was elected President, and Prof. James Geikie, Lord McLaren, The Rev. Prof. Flint, Prof. J. G. McKendrick, Prof. Chrystal and Sir Arthur Mitchell were elected Vice-Presidents.

Prof. N. W. Sklifosovsky has been appointed President and Prof. J. T. Klein, Vice-President of the Organizing Committee of the International Medical Congress, 1897, and Prof. W. K. Roth has been appointed General Secretary in the room of Prof. Erisman, to whose enforced retirement from the University of Moscow we have recently called attention.

The section o Mineralogy, of the Paris Academy of Sciences, has proposed as candidates for the vacancy caused by the death of M. Daubrée, MM. Michel Lévy, de Lapparent, Barrois and Douvillé. The names are arranged in the order of the preference of the section.

It is reported by telegram from Cape Town that Dr. Edington has discovered the microbe of rinderpest, but no details have as yet been received.

Dr. Hugo de Vries has been appointed director of the botanical gardens at Amsterdam in the place of Dr. Oudemans. Dr. J. de Winter, assistant in the zoological garden at Antwerp, has been made director of the zoological garden at Giseh, near Cairo.

An international botanical garden is to be established at Palermo, under the direction of Prof. Borzi, of the University. It is hoped that the favorable position of the garden may attract foreign students.

The concluding parts of v. Helmholtz's great work, *Handbuch der Physiologischen Optik*, have now been published by Leopold Voss, Leipzig and Hamburg. The four last parts, extending the volume to 1334 pages, contain only eleven pages of text and consist chiefly of an elaborate bibliography of physiological optics compiled by Prof. Arthur König.

The London *Academy* is greatly changed with the issue of November 14th. Mr. Lewis Hind becomes editor, signed reviews are abandoned and portraits are added. We are informed that the journal will hereafter be largely devoted to scientific discussions and announcements.

At the beginning of 1897 a new monthly journal devoted to the nervous system and its diseases, *Monatschrift für Psychiatrie und Neurologie*, will be published at Berlin. It will be edited by Prof. Wernicke, of Breslau and Prof. Ziehen, of Jena.

ACCORDING to *The British Medical Journal*, on the suggestion of Dr. Nicholson, professor of natural history at the University, the Town Council of Aberdeen agreed some time ago to utilize part of the buildings of the old bathing station as a marine aquarium. The tanks have been made, and the further necessary fittings are in hand. In view of the great importance of the fishing trade at Aberdeen further developments have been contemplated with regard to combining a department for fish hatching and culture on a scientific basis with the aquarium. It is to be expected that the investigations carried on in such an institution should prove of great interest and importance to the students of zoology at the University.

Garden and Forest states that the crown forests of Sweden comprise more than one-quarter of the entire wooded area of the country and are managed with scrupulous care. The increase alone is cut, so that a productive forest is to stand forever on all crown lands that are unsuitable for cultivation. More than this, the government has entered upon an extensive system of planting trees on desolate and uncultivated areas, and these object-lessons have induced owners of private forests, especially the larger proprietors, to manage their timber lands so that they will become permanent sources of income. These facts were communicated to our Department of State by Hon. H. W. Thomas, United States Minister to Sweden, and they are of particular interest, not only to Sweden, but also to the United States and to Canada, whose lumber meets the Swedish product as its greatest competitor in the markets of the world. Since the forests in Sweden grow slowly, it has generally been supposed that the immense quantities exported would gradually exhaust this most important source of the nation's wealth, but from the facts stated it appears probable that the forty-seven million acres of forests in the country will continue to be a source of income for all future time. The products of the forest now comprise nearly one-half of the total exports of the country in value.

THE *British Medical Journal* states that the German Medical Press Association held its annual meeting recently at Frankfort-on-Main, under the presidency of Dr. Adler, of Vienna. The following medical journalists were elected members of the committee for the ensuing year: Dr. Adler, of the *Wiener medizinische Wochenschrift;* Prof. Ewald, of the *Berliner klinische Wochenschrift;* Dr. Honigmann, of the *Zeitschrift für praktische Aerzte*, and Docent Dr. Mendelsohn, of the *Zeitschrift für Krankenpflege.* The number of members of the Association is now 39, representing 37 journals. Prof. Virchow was elected an honorary member of the Association, and in acknowledging the honor conferred on him recalled the fact that he had been a member of the German Association of Scientists for 50 years, and during all that time he had been editor of its *Archives.*

UNIVERSITY AND EDUCATIONAL NEWS.

THE will of the late Willard B. Perkins leaves, among other public bequests, $24,000 to Colorado College, and $6,000 each to Columbia University and the Massachusetts' Institute of Technology, for travelling scholarships in architecture.

THE University of Helsingfors has received by the will of the late Dr. H. F. Antells 800,000 M., the interest of which is to be used for travelling scholarships and scientific expeditions.

DR. WILLIS GREEN CRAIG has been elected President of Center College, at Danville, Ky.

DR. PEITHNER V. LICHTENFELS, of the Polytechnic Institute at Graz, has been promoted to a full professorship of mathematics. Dr. Edler, of Göttingen, has been called to an associate professorship of agriculture at the University of Jena; Dr. E. Pringsheim, docent in physics, and Dr. Karl Friedheim, docent in chemistry, have been appointed to professorships in the University at Berlin.

DISCUSSION AND CORRESPONDENCE.

AGE OF THE POTOMAC FORMATION.

TO THE EDITOR OF SCIENCE: In the last number of SCIENCE, Prof. Marsh tells us that the vertebrate fossils of the Potomac formation demonstrate its Jurassic age. This is a matter of much interest, because the evidence from fossil plants has been thought to place the formation in the Cretaceous. The number of persons to whom the local question of correlation is important may not be large, but the whole body of geologists and paleontologists are concerned with the methods and principles of correlation, and an excellent opportunity seems to be here afforded for the comparison of vertebrate with botanic evidence. I therefore write to express the hope that when Prof. Marsh continues the subject, as he has promised to do, he set forth the grounds for the conclusion he has announced with so much confidence. His article states, in effect, that through a comparison of vertebrates from the Potomac formation with vertebrates from other formations he has inferred the Jurassic age of the Potomac; but he gives no hint of the character of his evidence or the course of his reasoning, so that the conclusion has at present only the authority of his statement, without opportunity for verification. Unless I am mistaken, the conclusion that the Atlantosaurus and other horizons of the Rocky Mountain region are Jurassic was announced in the same way, without citation of evidence; and in that case it is important to establish the correlation of the Potomac beds, not merely with these Western horizons referred to the Jurassic, but with European beds whose age admits of no question.

My own desire to learn Prof. Marsh's method of correlation is stimulated by certain considerations which seem to show that it must differ in an important way from the method ordinarily used by students of invertebrate fossils and fossil plants. As he has pointed out, land vertebrates are peculiarly sensitive to climatic and other physical conditions, and the evolution of new forms is consequently rapid. The life of a species is short, and its value for purposes of correlation is correspondingly high because its chronometric indication is precise; but it appears to me *a priori* that this quality of rapid evolution is a two-edged sword; while it facilitates correlation within the same faunal province, it introduces a difficulty when remote provinces are compared. In remote provinces the progress of evolution must follow different lines, so that there can usually be no common species for comparison. Therefore, as correlation by means of other organisms depends chiefly on the comparison of faunas through their identical species, correlation by means of land vertebrates must have a different basis. This point seems to be illustrated by the general problem of Jurassic correlation. In Prof. Marsh's recent classification and synopsis of the Dinosauria (Sixteenth Annual Report, U. S. Geological Survey) it appears that only the higher categories of classification include representatives from both Europe and North America. There is no common species; there is not even a common genus. Of nineteen families referred to the Jurassic, six are European only, eleven are North American, and but two span the Atlantic. One of these last is not peculiar to the Jurassic and is therefore of minor value for the correlation of American horizons; so that the closest affinity of the European and American formations seems to be expressed by the statement that there is one American genus which falls in the same family with a European genus.

There is yet another reason why inference in this particular case needs to be fully supported by evidence, and that is that the physical relations of the beds afford a presumption in favor of their Cretaceous age. Prof. Marsh mentions that the Potomac formation in New Jersey passes by insensible gradation into marine Cretaceous above and is separated by unconformity from rocks of supposed Triassic age below; but he apparently sees in this relation merely the fact that the Potomac lies between formations of Cretaceous and Triassic age. The geologist, however, infers that the unconformity beneath the Potomac represents a time interval, and consideration of the extensive dislocation and deformation of the Newark beds and of the enormous degradation they suffered before the deposition of the Potomac gives the impression that that time interval was very long as compared to the time represented by the Potomac beds themselves. When it is further considered that the lowest marine horizon determined above the Potomac is correlated by its invertebrate fossils with a horizon somewhat above the middle of the European Cretaceous, it seems easier to assign the Potomac to the lower Cretaceous of Europe and correlate the time-break with the Jurassic period than to correlate both the Potomac and the time-break with the Jurassic and assume that the lower Cretaceous horizons of Europe lack representation in our Atlantic series.

In drawing attention to these matters of apparent difficulty I have no intention to controvert Prof. Marsh's view, but merely to show how desirable it is that he set forth the reasons therefor.

G. K. GILBERT.

WASHINGTON, D. C., December 5, 1896.

LE CONTE'S ELEMENTS OF GEOLOGY.

TO THE EDITOR OF SCIENCE: In commenting on Le Conte's 'Geology' (SCIENCE, November 27th), Prof. C. W. Hall objects to 'the multiplicity of theories advanced and discussed.' He says: "A text-book should be the exponent of a doctrine. It should be constructed on the definite and positive plan best adapted, in the mind of the author, to expound his body of principles. When several theories are presented and the student practically told to take his choice, or when he is told that all are true, the function of the text-book disappears." The student who leans upon a text-book based only on facts and well understood phenomena 'subjects himself to the inspiration of positive ideas, and, in his intellectual processes, acquires that habit of decision so essential to practical success.'

It is with diffidence that I venture to dissent from Prof. Hall's opinion, because he is an experienced educator and I am not; but it appears to me that something is to be said in favor of occasionally submitting to students alternative opinions regarding an unsettled question. The scientific text-book which presents only facts and accepted principles, or gives only the author's opinion on open questions, must tend to leave the student with the impression that scientific knowledge is complete. The statement and discussion of rival hypotheses not only exhibits the actual incompleteness of knowledge, but illustrates the method of progress, and it appears to me quite as important to the world's future that the rising generation shall learn the method of research as that it become acquainted with the results of research. It may also be questioned whether the habit of decision inspired by the exclusive assimilation of positive ideas will usually lead to the best results when applied to the practical affairs of life. Problems of affairs resemble, in the complexity of their factors, the problems of such a science as geology; and the mind which habitually suspends judgment until various points of view have been considered may gain, through the wisdom of its decisions, as much as it loses through delay.

G. K. GILBERT.

WASHINGTON, November 30th.

THE POSITION OF THE COMPANION OF SIRIUS.

TO THE EDITOR OF SCIENCE: A brief statement regarding the correspondence of the position of the companion of Sirius as observed with the 36-inch refractor of this observatory with the positions obtained from the published elements may be of interest to the readers of SCIENCE.

So far as I know, four sets of elements have been published, which are based upon all the micrometric measures previous to periastron, namely, those by Auwers, Burnham, Howard and Zwiers. Mr. Burnham gives no ephemeris with his orbit (period, 51.97 yrs.), but from the elements it is safe to say that his ephemeris would not differ very widely from that computed by Zwiers. An approximate interpolation in the ephemerides by the other computers gives the following position for 1896.8:

	P.	s.	Period.
Howard (A. J. 235)	214.°6	4.″75	(57.02 yrs.)
Auwers (A. N. 3085)	175. 7	3. 92	(49.40 ")
Zwiers (A. N. 3336)	186. 4	4. 05	(51.10 ")
The simple mean is	192.°2	4.″24	

The mean of five measures of position angle and four of distance by Prof. Schaeberle and myself gives for the same date, 189.°3, 3.″67 (A. J. 388). This communication is suggested by the note on the same subject by 'H. J.' in the November 20, 1896, number of SCIENCE.

R. G. AITKEN.

MT. HAMILTON, November 30, 1896.

COMPLIMENT OR PLAGIARISM.

MY courteous friend, Prof. Fiske, hastens to acknowledge that the quotation from Halsted's Elementary Synthetic Geometry in SCIENCE, p. 656, shows that "the criticism is not applicable to his more recent work."

Yet he asserts that in no American text-book 'has a thoroughly satisfactory treatment been given,' and says: "In my opinion, it is not possible to discuss, in an elementary manner, propositions relating to the magnitude of curved lines until after the introduction of Duhamel's well-known postulate. It may therefore be of psychologic as well as geometric interest to point out that I had lived through the mental state in which my honored friend, Prof. Fiske, now finds himself, and had already attained simpler and clearer light before 1893, when there appears in my paper 'The Old and the New Geometry' in the *Educational Review* the following:

"That stale stupidity, 'A straight line is the shortest distance between two points,' is equally unavailable for foundation building.

"As Helmholtz says: 'The foundation of all proof, by Euclid's method, consists in establishing the congruence of lines, angles, plane figures, solids, etc.

"'To make the congruence evident the geometrical figures are supposed to be applied to one another, of course without changing their form and dimensions.'

"But since no part of a curve can be congruent to any piece of a straight line, so, for example, no part of a circle can be equivalent to any sect in accordance with the definition of equivalent magnitudes as those which can be cut into pieces congruent in pairs. Thus the whole of Euclid's *Elements* fails utterly to prove any relation as regards size between a sect and an arc joining the same two points. We cannot even affirm that any ratio exists between a circle and its diameter until after we have made extra-Euclidean and post-Euclidean assumptions at least equivalent to the following: 1. No arc is less than its chord. 2. No minor arc is greater than the sum of the tangents at its extremities."

May I be allowed to state that in the years that have followed my printing of this double postulate I have only been more confirmed in my opinion that it is more elementary and more elegant than the one for which I deliberately substituted it, and which Prof. Fiske has again given on p. 724 of SCIENCE. When Prof. Fiske applies these ideas to the geometry of Beman and Smith, I am very forcibly reminded that without the slightest word of acknowledgment these professors '*took*' a whole block of problems and a long note from Halsted's Elements of Geometry.

The section *Partition of a Perigon*, Elements p. 151, is so peculiarly my own that it was as startling as a ghost to meet it unexpectedly in Beman and Smith p. 179. Then follows my Problem I: To bisect a perigon, with my corollary; then follows as their Problem 2 my Problem II: To trisect a perigon, with my corollary. Then my Problem III: To cut a perigon into five equal parts, and my corollary. Then my Problem IV: To cut a perigon into fifteen equal parts, with my corollary. Then before they go on to my Problem V. and Problem VI. and Problem VII. and Problem VIII., they insert my long note, Elements p. 155; but here they out-Herod Herod, or rather out-Perigon Halsted, for where I say that Gauss, in 1796, found that a regular polygon of 17 sides was inscriptible, they make it say 'In 1796 Gauss found that a perigon could be divided into 17, etc.' But, of course, the whole of the *matter* here involved is so well known that I accept the implied compliment, *broad* as it is, and dream that even my rather cranky problem to bisect a perigon was not really as peculiar as I had thought it.

GEORGE BRUCE HALSTED.

AUSTIN, TEXAS.

THE DATE OF PUBLICATION AGAIN.

DR. J. A. ALLEN has not offered any serious objections, to my view of this matter in his remarks in SCIENCE of December 4th, as it seems to me, but he has in one instance misunderstood me, as I now explain. He quotes as follows my remark, that "although some reports issued by our government may bear dates much prior to the dates of issue, it does not follow that the date of printing bears any such relation to the date of issue." What I meant by this may be illustrated by a concrete case. The 'Report of the Commissioner of Education,' which I last received, bears on its back and title page the dates 1893–4. As it was not printed until 1896, I find the date 1896 at the foot of the title page. This will explain my meaning, which would seem to have been misunderstood by Dr. Allen. It also explains my remark that 'the date given on the title page must be accepted as the date of publication.'

The fundamental point in this matter has really not been touched on by Dr. Allen or by myself. What we desire to ascertain is that date at which the discovery of a fact was announced, a formulation made, or a name given, and by whom. Until the description of the fact, the formulation, or the name, is printed, it has no fixity, and may be indefinitely altered. After it is printed the statement cannot be altered. Such a printed statement, wherever and whenever found, determines the question. Whether this be publication or not, the printed document will settle the question of priority, which is the point which we desire to have settled. It appears to me that no rules can set aside this proposition, however inconveniently it may sometimes, fortunately rarely, affect us. If we adopt (or rather follow, as it is already adopted) this view, we escape the complicated, and to my mind insoluble, questions as to publication, which may be brought up. It will probably settle, among other things, questions as to the inaccuracy of dates on 'the proceedings, memoirs, and other publica ons of scientific societies,' which Dr. Allen alleges, and of which I must say, I was quite unaware. E. D. COPE.

PHILADELPHIA, December 3, 1896.

SCIENTIFIC LITERATURE.

A History of the Warfare of Science with Theology in Christendom. By ANDREW DICKSON WHITE. 2 vols. Pp. xxiii, 415; xiii, 474. New York, D. Appleton & Company. 1896.

The title of this book describes its general character. Its range is indicated by the caption of its successive chapters. These embrace the development of Cosmology, Geography, Astronomy, Meteorology, Geology, Anthropology, Archæology, Ethnology, Chemistry, Medicine, Hygiene, Abnormal Psychology, Comparative Philosophy and Mythology, Political Economy, and Biblical Criticism and Theology. A large field for any one investigator to traverse! Yet such is the author's wealth of scholarship that he touches nothing without removing some obscurity, while important provinces are fairly flooded with light.

The book is of interest to the historian, the scientist, the theologian and the philosopher. But in estimating its value they must not forget the limits defined by the author. Dr. White does not, like Whewell, attempt to write a history of the sciences. Still less does he, like Harnack, essay a history of dogma. His theme, though more intensive, is less extensive. Dr. White concentrates attention upon the points at which the sciences, in the several crucial stages of their development, have come into conflict with the dogmas laid down in the creeds of Christendom. His book is a history of those collisions; and history being philosophy teaching by experience, Dr. White does not hesitate to apply its conclusions to the conditions of the present day. Nor is the author merely an historian of events in which he has no personal interest; on the contrary, the multitudinous victory of science over irrational dogmatism rejoices the lover of truth and evokes pæans unknown to the sober analytic historian. But this occasional triumph of the man over the historian does not detract from the historical value of the work. The greatest pains have been taken to secure accuracy; and the foot-notes show that innumerable libraries, both at home and abroad, have been consulted in the ascertainment and verification of the facts cited. Taking the text and notes together, the work may be fairly described as a kind of self-attesting encyclopædia; and as such it is likely to become, at least in the English-speaking world, the standard book of reference on the interesting subject with which it deals. Such books are not wont to be read through by many persons; but this one is likely to be often consulted by scientists who are interested in the early development of their specialty, by historians who deal with the progress of culture and civilization, and by theologians who care to see how the dogmatic apprehension of Christianity has been continuously modified by the inexorable pressure of the historical and natural sciences.

Dr. White makes it clear that the warfare of science is not waged against religion but against theology. The distinction between religion as a life and theology as a theory of that life is, from a logical standpoint, as clear as the distinction between digestion and physiology.

Yet the parallelism is not complete, as may be seen as soon as you look below the surface. Digestion is a material process which, being regulated by laws of physics and chemistry, is not in any way affected by the theories you form of its operation. But religion, as distinguished from theology, is a subjective experience, and, as such, it is liable to modification by any or all the elements entering into such experience—by thoughts and beliefs, therefore, as well as by aspirations and emotions. Furthermore, religion being so important and so pervasive a factor of our being, it tends to draw to itself, to attach, if not to assimilate and absorb, all associated phenomena of mind. There is no room here to expand these statements, yet they describe facts of the utmost importance in any treatment of religion and theology. It results therefrom that a plain Christian naturally supposes that his religious faith is assailed as often as science rectifies those erroneous views of the nature and operations of the material world which he happens to have bound up in the same parcel with his belief in a righteous God, who reveals Himself to the pure in spirit. This is the travail of religious experience. It is this which makes the real tragedy in the historical collisions between science and theology described in Dr. White's book.

But not only has religion the inborn habit of annexing other provinces to itself. There is a second cause of conflict with exact knowledge. It is not given either to the natural man or to the spiritual man, either to the worldling or to the Christian, but only to the investigator who explores and to the philosopher who reflects, to understand the incomplete and fragmentary character of human knowledge at every stage of its development. If Omniscience sees all things in a perfected infinite sphere, human beings get but glimpses of scattered points on the surface, and the scientist counts himself happy if he can but trace the infinitesimal arc of a minor circle. So again the philosopher, analyzing the origin, nature and limits of knowledge, soon discovers that at its best knowledge is a small (though happily an expanding) island surrounded by an infinite unknown. Both the scientist and philosopher, therefore, recognize not merely by general assent, but with genuine appreciation, the inherently provisional character and the progressive destiny of all theories and beliefs which at any given time may be held either by the generality of mankind or by its thinking vanguard. Knowledge is a continuous becoming; it has never attained—it is always on the way. Consequently the most assured dogmas of to-day may need modification and adaptation to the larger vision and deeper insight of to-morrow. But this is just what the uneducated man, whose mind is the victim of fixed and rigid abstractions, cannot understand. And as liberal culture has always been the possession of the few, one sees how the Christian world in general has so often been inhospitable to the progress of exact knowledge and how science has had to wage such a warfare against established modes of thought. Add to this that dogmatic theology, in previous generations at any rate, has, as a rule, set up the ignorant man's intoxication with completeness and finality as an ideal for its own scheme of thought, and you have all the conditions necessary for the explanation of that historic conflict which is the theme of Dr. White's instructive work.

Dr. White himself takes cognizance only of this latter force. Everywhere he makes it clear that dogmatic theology is at war with progressive science. If the explanation of this antagonism which has just been suggested be correct, it becomes clear that the foes of science are not merely the theologians with their fixed and final systems, but all the embattled hosts of ignorance who are indifferent to what is beyond their own purblindness. It is a general opposition of darkness to light. It would still exist were theology and theologians annihilated. There is one passage in Dr. White's work in which the author, if he does not rise to this more general point of view, at least shows that science in its progress has had to contend with unreason which was not the unreason of theologians. He says (Vol. I., p. 405):

"And it must here be noticed that this unreason was not all theological. The unreasoning heterodox when intrusted with irresponsible power can be as short-sighted and cruel as the unreasoning orthodox. Lavoisier, one of the best of our race, not only a great chemist, but a true man, was sent to the scaffold by the Parisian mob, led by bigoted 'liberals' and atheists, with the sneer that the Republic had no need of *savants*. As to Priestley, who had devoted his life to science and to every good work among his fellow men, the Birmingham mob, favored by the Anglican clergymen who harangued them as 'fellow-churchmen,' wrecked his house, destroyed his library, philosophical instruments, and papers containing the results of long years of scientific research, drove him into exile, and would have murdered him if they could have laid their hands upon him."

With this quotation our notice of Dr. White's scholarly and fruitful work may appropriately come to a close. Let us only add that the first martyr to truth was the victim of a mob who hated to hear his teaching. The martyrdom of Socrates occurred four hundred years before the appearance of that unique personality who is the central figure of the dogmatic theology of Christendom.

J. G. SCHURMAN.

CORNELL UNIVERSITY.

Navigation and Nautical Astronomy. By F. C. STEBBING, M. A., Chaplain and Naval Instructor, R. N. Macmillan & Co., London and New York. 1896. 1 vol., 8vo, 328 pp. Price, $2.75.

This volume contains a complete course in all the necessary subjects of modern navigation. It may be recommended to those who have to acquire a knowledge of the theory and practice of the calculations that are required in the navigation of ships. By incorporating the necessary part of the Nautical Almanac for 1895 and referring the examples which are to be worked out to the data there tabulated, the author has overcome, in an original and effective manner, one of the chief obstacles which students of astronomical navigation universally experience in gaining a knowledge of the intelligent use of the data contained in the Almanac.

The book is also to be commended for the large number of useful examples and problems which accompany each division of the subject.

Where necessary, the methods are modernized so as to treat, for change of geographical position during the period of observation, the observations that may be made on board the swift moving vessels of the present day.

It has probably been overlooked that the directions given on page 54 for measuring the distance between two points on a Mercator chart will not generally apply. "The distance is found (nearly) by transferring the interval between the two positions to the graduated meridian, as nearly as possible opposite to the positions, *i. e.*, as much below the more southern as above the more northern; this space turned into minutes is the distance required." This method fails in most cases in which the line to be measured lies far from the middle of the chart, because when the interval is transferred to the graduated meridian one end or the other is likely to fall outside of the border.

Mention is not made of the generally applicable method of taking a small number of divisions of the graduated meridian, near the middle latitude of the line to be measured, between the points of a pair of dividers, and stepping this interval along the line to be measured.

In definition No. 8 it is stated that "A nautical mile is equal to the mean length of a minute of latitude, and is reckoned as 6080 feet." The actual mean length of a minute of latitude of the terrestrial spheroid computed upon the elements of the spheroid assigned by Bessel is 6076.23 feet, and upon the later and more perfect values assigned by Clarke, 6076.82 feet. The length of the nautical mile, or Admiralty knot, which is 6080 feet, corresponds more nearly to one-sixtieth part of the length of a degree of a great circle of a sphere whose surface is equal in area to the surface of the earth. This length is 6080.27 feet.

G. W. LITTLEHALES.

A-Birding on a Bronco. By FLORENCE A. MERRIAM. Houghton Mifflin & Co., Boston and New York. 16°, illustrated. Price, $1.25.

This volume is the result of the studies of two seasons in southern California. About sixty species of birds are spoken of, and with many we become quite well acquainted as we watch their nesting ways through the eyes of the sympathetic bird lover. It has also the novel feature of studying birds, not only with an opera glass, but from the back of a bronco with ideas and ways of his own. The first chapter charmingly describes the valley in which the observations were made, and the bronco who shared the studies. The second, under the name of 'The Little Lover' tells the captivating tale of a pair of Western House Wrens, from the building of the nest to the departure of the little brood. The third introduces us to a bewitching bit of featherhood—the Blue-Gray Gnatcatcher, and rehearses the tragedy that befell the nest. And so it goes on, presenting to us in every chapter a fresh group of birds, in new and always interesting situations. At one time there is a pair of orphaned Woodpeckers to bring up by hand, and at another the vicissitudes of home-making in the Bush-Tit family, cousins of our Chickadee and 'little gray balls with long tails,' as the author calls them. On one page we read o the ups and down in life of a pair of Vireos, on another the efforts of the author to assist the Titmice in nest-building. Rattlesnakes and Burrowing Owls, Jackrabbits and Coyotes appear here and there, and in fact the local color is so strong that the reader is fairly transported to that land of sunshine.

The whole book is delightfully written and most fascinating in interest, and the reader has the added pleasure of knowing that every statement is to be depended upon; there is no dressing-up of incidents or intensifying of situations for purposes of sensationalism. It is an honest and faithful chronicle of the delights of bird study without a gun, in a region unfamiliar to most of us, and it is a most valuable book to place in the hands of a young person, boy or girl. It is well illustrated with cuts that really illustrate, not only characteristic drawings of the birds themselves, but photographs of the valley with the trees and bushes in which they dwell.

Olive Thorne Miller.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON. 206TH MEETING, SATURDAY, NOVEMBER 21ST.

Mr. Frederick V. Coville exhibited a sinew-backed Modoc bow, made of the Western yew, saying that, although the wood was formerly in considerable demand among the Indians, he was not aware that it was used for any economical purpose.

Mr. Theo. Holm showed some old books in which the first attempts were made to demonstrate the presence of two sexes in flowers, viz., De la Croix's 'Le marriage des fleurs (Paris, 1727);' Vaillant: 'Sermo de structura florum (Leyden, 1728),' and Sprengel's illustrious work, 'Das entdeckte Geheimniss der Natur (1793).' The title page of De la Croix's work showed a most curious representation of the sheep plant (now known as *Raoulia mamillaris*), of which the speaker exhibited a photographic reproduction from nature, published in Goebel's 'Pflanzenbiologische Schilderungen.' Mr. Holm then explained the Latin suffix, 'aster, astra, astrum.' Certain authors have recently made new names, composed of individual names in connection with this suffix, erroneously supposing 'aster,' as thus used, to mean a star. Pliny and other ancient authors, besides some of much later date, used the suffix only to signify a genus which looks like another one, but which is of inferior quality, aspect, odor, taste, etc. Pliny says, for instance, that the olive tree (*Olea*) when growing wild is an Oleastrum: "In deteriora mutantur, ex olea in oleastrum." *Mentastrum*, *Lilliastrum*, etc., are additional examples.

Mr. Gilbert H. Hicks presented a paper on the '*Mildews*' (*Erysipheæ*) *of Michigan*, as a contribution to the geographical distribution of fungi. Thirty-one species of this family were accredited to Michigan, as follows: *Sphærotheca*, 7; *Erysiphe*, 5; *Uncinula*, 6; *Phyllactinia*, 1; *Podosphæra*, 2; *Microsphæra*, 10. One new species, a *Sphærotheca*, was described and illustrated with specimens and photographs.

Under the title of *The Inflorescence of the Juncaceæ* Mr. Frederick V. Coville gave a resumé of the present knowledge of the subject, showing that two distinct types of inflorescence occur in the family, one made up of terminal flowers, forming a cymose inflorescence, the other made up of lateral flowers, forming a paniculate inflorescence. Both types pass into a variety of minor forms.

Mr. Theo. Holm read a paper on the *Alpine flora of Pike's Peak and Gray's Peak, Colorado.* He exhibited specimens collected at an altitude of 14,100 feet, some of which represented circumpolar species, and also made a comparison between these species and those collected on San Francisco Mountain and described by Dr. Merriam (North American Fauna, No. 3). Dr. Merriam's statement that most of the alpine plants from San Francisco Mountain are circumpolar species appeared to the speaker too broad. A tabulation of Dr. Merriam's plants showed that the majority of them were not circumpolar and that many of them did not grow outside of the Rocky Mountains.

Mr. C. L. Pollard made *Some Further Remarks on Britton and Brown's Illustrated Flora.*

F. A. LUCAS,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

AT a meeting of the Philosophical Society of Washington, held November 8, 1896, Mr. Lester F. Ward gave an account of a reconnaissance made by himself in company with Mr. T. Wayland Vaughan, in October last, through parts of Indian Territory, Oklahoma and southwestern Kansas. The expedition left Muskogee, Indian Territory, on October 1st, and reached Coldwater, Comanche County, Kansas, on the 16th. It then proceeded to Belvidere, Kiowa County, and to Medicine Lodge and Sharon, in Barber County, where Mr. Ward turned over the outfit to Mr. Vaughan, who returned by a different route to South Macalester, Indian Territory. The distance actually traveled was not less than 400 miles.

The route lay across the western decline of the great Carboniferous anticlinal uplift that separates the coastal plain of the Gulf border and Mississippi embayment from the ancient Mesozoic and Tertiary sea that occupied the present Rocky Mountain region. The rocks accordingly dip gently to the west-northwest. In general the Arkansas River and its southern tributaries were followed, but the immediate valleys were avoided as far as practicable. The principal railroad towns passed through were Tulsa, Perry, Enid and Alva. The Carboniferous consists of shales overlain by coarse, brown sandstones, forming the hills, which are more or less wooded with black-jack (*Quercus nigra*), post-oak (*Q. minor*) and hickory (*Hicoria alba* and *H. minima*). The shales weather red, but are sometimes carbonaceous and dark, occasionally furnishing thin coal seams. The best exposure seen is on Cane Creek, fifteen miles west of Muskogee. The sandstones gradually grow more and more reddish from east to west, and above Tulsa, on the Arkansas, there are fine exposures. Between the Arkansas and the Cimarron, east of Perry, limestones are interstratified between them. The oak barrens are covered with coarse grasses and tall weeds (*Desmodium*, *Lespedeza*, *Frœlichia*, *Eriogonum*, etc.). On the plains east of Perry the first gravel was seen, and the red sandstones were replaced at intervals by clays of different colors, but weathering red. Farther west the sandstones disappear and the underlying strata becomes a red, sandy clay shale, constituting the well-known Red Beds, the base of which, at least, is probably of Permian age, while the summit may even be Cretaceous. These continue to some distance west of the 99th meridian, where they pass under the Cheyenne sandstone of the Comanche Series. These latter were encountered between Evansville and Nescatunga, in Comanche County, Kansas, some twelve miles east of Coldwater.

The work in Kansas consisted in studying the Cheyenne Sandstone and its relations to the Red Beds below and the marine Cretaceous deposits above. The best exposures are in the vicinity of Belvidere. Fossil plants were obtained at three different horizons, showing corresponding changes in the flora. So far as they go they confirm Mr. Hill's conclusion that at least the upper part of the Cheyenne Sandstone belongs to the Wachita Division of the Comanche Series. It may be approximately correlated with the Raritan Clays or the Albirupean series of the Potomac formation.

Mr. Ward collected a large number of plants at all points along the route, some of which are rarely obtained because botanists had scarcely ever visited the region so late in the season. Among the 77 species in his collection may be mentioned the following, which have interest either as rare or as extending the range of these plants: *Lacinaria acidota*, *Physalis rotundata*, *Allionia Bushi*, *Solidago rigidius-*

culus, *Aster Fendleri*. Specimens of these and many others were exhibited to the Society.

Mr. Walter Hough read a paper on 'The Mokis in Relation to their Plant Environment,' and Mr. G. W. Littlehales exhibited and described a new machine for engraving parts of the plates from which charts and maps are printed.

BERNARD R. GREEN,
Secretary.

CHEMICAL SOCIETY OF WASHINGTON.

THE 90th regular meeting of the Society was held November 12, 1896. The President, Dr. de Schweinitz, was in the chair, with fourteen members present. A communication from the Medical Society of the District of Columbia was read, in which the Chemical Society was requested to appoint a representative on a Joint Commission on Vivisection. The commission is to be charged with the duty of investigation relating to the practice of animal experimentation in the District of Columbia, and the representation before Congress of the constituent organizations (The Medical Society of the District of Columbia, the Bureaus o Medicine and Surgery of the Army, Navy, Marine Hospital Service and Animal Industry, the Medical Departments of the Columbian, Georgetown, Howard and National Universities, and the Chemical, Biological, Anthropological, Entomological and Philosophical Societies of the District of Columbia).

The first paper of the evening was on 'Poisonous Honey,' by V. K. Chesnut, who referred to the literature, and enumerated several recent cases of poisoning which happened in New Jersey and North Carolina. Reports of other poisonous honeys had been received from Texas and California.

The principal cases were ascribed to honey derived from the laurels (*Kalmia latifolia* and *Kalmia angustifolia*). A new method of detecting the presence of andromedotoxin in honey was described and specimens were exhibited of poisonous honey and the plants from which it was derived.

The discussion of Mr. Chesnut's paper was by Prof. Stokes, Munroe and Seaman and Dr. de Schweinitz. Prof. Stokes asked if the flower of the horse chestnut was known to be poisonous to bees. Mr. Chesnut was not aware of the fact, but thought it possible; the flowers of the Judas tree have a similar reputation. Prof. Munroe spoke of the honey locust, Prof. Seaman of the possible evaporation of gelsemine from gelsemium honey, and Dr. deSchweinitz cited a historical case of poisoning which happened in Asia Minor.

The second paper was by Dr. de Schweinitz, on 'A Convenient Lamp for Generating Formaldehyde Gas and Acetic Aldehyde.' Several forms of lamps in working order were exhibited. Ordinary lamps are used, but the upper part of the wick is supplemented by a piece of plantinized asbestos. The cotton wick is turned high enough to light. After burning a minute or so the platinized asbestos begins to glow and the flame is extinguished. The glow continues till the alcohol is exhausted. The decomposition is simple. With methyl alcohol, formaldehyde and water are the chief products; with ethyl alcohol, they are acetaldehyde and water.

Traces of carbonic, formic and acetic acids are also present in the reaction. Dr. Fireman asked what the yield of aldehyde was. Dr. de Schweinitz replied that he did not have the exact figures at hand, but that he obtained about three-fourths of the theoretical yield.

A. C. PEALE,
Secretary.

NEW BOOKS.

Handbuch der Physiologischen Optik. H. VON HELMHOLTZ. Zweite umgearbeitete Auflage. Hamburg und Leipzig, Leopold Voss. 1895–6. Parts 11, 12, 13–17.

Primitive Travel and Transportation. OTIS TUFTON MASON. Washington, Government Printing Office. 1896. Pp. 593.

Auto Cars. D. FARMAN. Translated from the French by LUCIEN SERRAILLER. London, Whittaker & Co.; New York, The Macmillan Company. 1896. Pp. 249. $1.50.

Charles Darwin and the Theory of Natural Selection. EDWARD B. POULTON. New York, The Macmillan Company. 1896. Pp. vi.+224. $1.25.

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

THE LIFE AND WORK OF DR. GOULD.

SOMEWHAT more than a week has passed since the sods were placed over the honored grave of Dr. Gould, yet even in the busy haste of our American life there are many who will welcome an appreciative account of the life and achievements of this eminent astronomer. So many notices of him were printed in the daily journals, immediately after the community was apprized of its sad loss, that it is unnecessary here to recount the details of his work. But it may be of service to give, in right perspective, a just idea of the magnitude and character of his contributions to astronomy, to speak of the purpose and importance of what he accomplished for science, and of the nature of his strong personal influence in its advancement.

Considered apart from the great things he accomplished, the first thing that strikes us about his career is the intimate way in which it is bound up with the history of his beloved science on both sides of the Atlantic, and the unique position he held, as illustrated by the number and extent of his personal alliances. It is scarcely possible to realize that he was the friend of von Humboldt, then in his 77th year; that it was due to the friendly interest of this great man, indeed, that he became the pupil, friend and intimate in the household of the great master of modern astronomy, Gauss, then in his 70th year; that he was the pupil of the illustrious Encke, of the elder Struve, of Peters and Hansen and Argelander, and the life-long friend of these revered founders of modern astronomy. His correspondence with them after his return to his native land testifies to the mutual confidence that characterized these memorable associations. Following these, in the next generation, come Winnecke, Schönfeld, Auwers and a host of others, which to us are great names, but to Gould were fellow-pupils and associates. Of the same epoch, on this side the water, we have Bache, Peirce, Walker, Hubbard, Coffin, Chauvenet and Winlock. Then come the two existing generations of astronomers, bringing friendships and acquaintances wide as the world itself, extending his relations to the youngest workers in the science. With such universal and intimate connection with the personal forces operating to advance astronomy in all lands, with his intense patriotism, with his positive intellectual and moral traits, he could not fail to exercise a powerful moulding influence upon the development of American astronomy, in correcting wrong tendencies and establishing right standards. It was to this end, in preference to the satisfaction of ambition through what he could accomplish by his personal contributions to the fund of knowledge, that his most earnest efforts, from the beginning of his career, were directed. In one of his letters to von Humboldt, in 1850, after speaking of the dependent condition at that time of science here, its self-distrust and intellectual timidity, he says: "This I knew before returning home, but realize it now, for the first time, to its full extent. Therefore it is that I dedicate my whole efforts, not to the attainment of any reputation for myself, but to serving, to the utmost of my ability, the science of my country, or rather, as my friend Mr. Agassiz tells me to say, science in my country." And to Encke he says, speaking of the establishment of the *Astronomical Journal*, and his fond hopes in its agency as a means of raising the astronomy of America to its proper position: "Though the labor of supporting it will prevent me from working as I otherwise should for the advancement of my own reputation, still the consciousness that I may render now a still greater service to science reconciles me to the abandonment of a good deal of personal ambition." The same spirit breathes throughout his correspondence with Gauss, Schumacher and other leaders abroad, to whom he was wont to confide his projects and aspirations, and who sympathized with and counseeld him in return. His letter books are rich with similar illustrations. They form, indeed, a treasure house of information relating to the inner history of the beginnings of astronomy in the United States. How humble these beginnings were few realize. Astronomy here has made such wonderful strides within a few decades past that it is hard to believe that, with a few brilliant exceptions, its record about the year 1840 was practically blank. We had then no standing among the scientific nations. The soil for its growth was not indeed sterile, but its cultivation had scarcely begun. If the right seed had not been sown we should have had occasion to deplore to-day the same stunted crop which, even in some countries of far older civilization than ours, stands in place of the rich harvest that might have been gathered under more favoring influences. And this brings us to another remarkable feature of Gould's career. If we were asked to place the finger upon the one epoch marking the birth or regeneration of American astronomy, we should feel inclined to name the date, July, 1845, when Gould placed his foot upon the steamer from Boston with the avowed and definite purpose to devote himself to a life of purely scientific research. Up to that time the instance of a man doing this as his only aim, while unassured of a professor's chair or similar appointment, and not as a means of livelihood, was in this country absolutely unknown. With a steadiness of purpose singular in so young a man, he pursued diligently the opportunity he had himself created—a year each at Berlin and Göttingen, and shorter periods at Altona, Gotha, Greenwich and Paris—and returned home, full of early honors and flushed with lofty hopes and honorable ambitions.

From this point Dr. Gould's life became one of incessant activity, impressing its mark in many ways upon the intellectual life of the community; but the line of intensest force naturally took the direction of his own beloved science, to which he communicated an impulse not measured merely by what he accomplished for it by his direct investigations, great as that is, but also by the force which always emanates from so earnest a nature as his. He inspired a new breath into American astronomy. The new atmosphere which he brought with him from Germany, where he had caught the spirit of the great masters under whom he studied, became gradually transfused upon this side the sea. His enthusiasm for the introduction of better means and methods of research was caught by his compatriots, their courage to regenerate our science was sustained, and transmitted through various channels to the next and to the present generation. Thus we may say, without fear of being controverted, that American astronomy to-day is a different thing from what it would have been without Gould's predominant influence, deep and quiet but strong, to upbuild it and to free it from the clumsiness and imperfections which still impede it even in some of the otherwise most enlightened nations of the world. It is under his leadership that American astronomy has climbed to where it looks with steady and level eye upon that of Germany, which occupies perhaps a larger but not a loftier plain. It is his example which will stimulate it, in its upward course during the new century nearly upon us, to attain first, in the friendly and honorable national rivalry, the heights commanding all. We cannot presume to say how far the good fortune which has secured our astronomy so exalted a place has been shared by other branches of physical or of natural science in our land; or, if so, whether it can be traced to any similar instrumentality. But there can be no doubt that, so far as astronomy is concerned, this enviable position has been reached, and that among the personal influences contributing to that result Gould's may be justly regarded as preeminent.

Let us now glance at Dr. Gould's more prominent labors, passing by his earlier important investigations in applied theoretical and in practical astronomy, as well as his numerous and valuable contributions to the literature of science, education and other departments of thought, which we find scattered through the long range of his career.

In 1852 he was appointed to take charge of the longitude determinations of the Coast Survey. He organized, developed and extended his service, retiring in 1867. Meanwhile, in 1855, he became Director of the Dudley Observatory in Albany, equipped and organized the institution, and carried it on without remuneration and at his private expense. He left it in 1859, after a severe struggle to preserve the institution for purposes of scientific investigation.

In 1859 he published his discussion of the places and proper motions of circumpolar stars, for use as standards in the Coast Survey. These, as revised by him in 1861, together with his similar list of clock stars, were adopted as the standards for the American Ephemeris, and, as to the circumpolars, remain in such use to this day. In

1866 he published his reduction of D'Agelet's observations. About the same time he performed a similar service for the greater part of the observations made at the United States Naval Observatory since its establishment, as he had done also several years previously for the expedition to Chili to determine the solar parallax. In 1866 he planned and executed the work of establishing, by the Atlantic cable, the relation in longitude between European and American stations, involving, as a part, interesting researches on the velocity of the galvanic current in submarine cables, similar to those he had already made on land lines.

As actuary of the United States Sanitary Commission, he conducted, and published in a large volume, extensive and important researches upon Military and Anthropological Statistics and the Distribution of Population. About the same time he undertook the reduction of Rutherfurd's photographs of the *Pleiades*. The results, partially published in 1866, were submitted completely, in an elaborate memoir, to the National Academy in 1870, together with a second memoir on the *Præsepe*. He was, indeed, a pioneer in the utilization of photography for exact astronomical measurement. About 1864 he built an observatory in Cambridge, equipped with an 8-ft. transit instrument, and, until 1867, carried on a determination of the right ascensions of all the stars to the tenth magnitude within one degree of the pole. This work was completely reduced, but the discussion and publication were postponed by his removal to Cordoba.

In 1865 he became intensely impressed with a desire to explore the southern celestial hemisphere. The opportunity to do so soon came. This project assumed at first the form of a private astronomical expedition, for which his friends in Boston had promised the pecuniary means; but, under the enthusiastic support of Mr. Sarmiento, at first as Argentine Minister to this country, and later as President of that Republic, it rapidly broadened, and finally led to the establishment, by Dr. Gould, of a permanent National Observatory at Cordoba. This marks an epoch in modern astronomy, the equalization of our knowledge of the two celestial hemispheres. The institution and its work form an impressive monument to his memory.

It is impossible, in brief space, to describe or characterize the marvelous work here undertaken and so faultlessly pushed to completion by Dr. Gould, during the fifteen years of self-imposed exile from his native land, with unfaltering devotion and energy, in the face of difficulty and domestic bereavement. The work on the uranography of the southern heavens was finished in 1874, and was published under the title of the *Uranometria Argentina*, which will remain a classic for all time. The zone-observations of the stars between 23° and 80° south declination, which were the original and always the dominant object of the enterprise, were begun in 1872, substantially completed in 1877, and revised in 1882–83. This work was embodied in the Zone-Catalogues containing 73,160 stars, which appeared in 1884. Parallel with this, and almost overshadowing it in importance, was carried on the independent series of meridian circle observations for the General Catalogue of 32,448 stars, completed in 1885. Dr. Gould, besides, left the manuscript of the remainder of his series of fifteen volumes, not then published—containing the observations and the annual catalogues, incorporated in the General Catalogue—complete to the minutest detail, ready for the printer. These have since appeared from time to time; the last volume, rounding out his work, reaching Cambridge but a few hours before his death.

Another part of the work for the Cordoba Observatory, planned by Dr. Gould as a fitting extension of it, was a *Durchmusterung* of the southern sky. For this, indeed, he had provided the instrumental means and trained the assistants, it being his purpose to be ready to begin it at any time in case of unforeseen delay or accident to the other work. On leaving Cordoba he confined it to the care of Dr. Thome and Mr. Tucker, who have since so worthily conducted it.

Dr. Gould also established, under the auspices of the Argentine government, a meteorological service, second in extent, it is believed, only to that of the United States. Upon leaving South America he intrusted this charge to the hands of his worthy successor, Walter G. Davis.

The earliest to recognize and demonstrate the capabilities of photography to render service to the astronomy of precision, Dr. Gould, by his experience with the Rutherfurd plates of the *Pleiades* and the *Præsepe*, was incited to arrange to carry forward at Cordoba, on an extensive scale, a similar work upon the southern stellar clusters. His other labors there were so onerous that he confined his attention to securing plates suitable for precise measurement. Of these he accumulated about 1,400, and brought them home with him for measurement and reduction. Without permitting himself a well-earned retirement, he turned at once, tirelessly, to this labor, which has been the principal occupation of the last ten years of his life. This is substantially complete, and will be given to the world as it came from his hand.

Dr. Gould had an enthusiasm for the advancement of his beloved science far wider than the limits of what he could by personal investigation accomplish. Early in his career he keenly realized that astronomy had reached a stage of development in America which entitled it to a higher claim than had yet been accorded to it, and that a journal worthily supporting the dignity of a pure science would have very great influence upon its future progress. Accordingly, without ostentation, he established the *Astronomical Journal* in November, 1849, offering it to the use of astronomers, for the publication exclusively of original investigations. He edited and supported it until, at the end of the sixth volume, in 1861, its issue was suspended, first by the war for the preservation of the Union, afterward by his absence in Cordoba. A long nurtured hope was realized when he was enabled, in 1885, to resume its publication and to continue it, at the rate of nearly one volume annually, to the present time. Of all the great enterprises of his life, this is the one which he has most cherished. With careful forethought, he has made due provision for its continuance.

Dr. Gould was born in Boston, September 27, 1824. He entered the Boston Latin School in 1836, and graduated from Harvard College, with high distinction in classical as well as in mathematical and physical studies, in 1844.

He married, in 1861, Mary Apthorp Quincy, daughter of the Hon. Josiah Quincy. She died in 1883. Her sympathy with and influence upon his life-work may be most reverently spoken of by recalling the lines of his dedication of the Zone Catalogue:

"This Catalogue of Southern Stars, the fruit of nearly thirteen years of assiduous toil, is dedicated to the beloved and honored memory of Mary Apthorp Quincy Gould, to whose approval and unselfish encouragement the original undertaking was due, by whose sympathy, self-sacrifice and practical assistance its execution was made possible, who bravely endured privation, exile and afflictive bereavement that it might be worthily finished, but who has not seen its completion."

Dr. Gould received the degree of Ph.D. from Göttingen in 1848, and that of LL.D. from Harvard in 1885, and from Columbia in 1887. During his illustrious career he was the recipient of the highest honors that Europe has to bestow, to an extent scarcely vouchsafed to any other American. A few only will be named here: Mem. Roy. Soc. (London); For. Assoc. Roy. Astr. Soc. (London); Cor. Mem. Acad. Sci. (Institut de France); Acad. Imp. Sci. (St. Petersburg); Kön. Akad. Wiss. (Berlin); Kön. Ges. Wiss. (Göttingen); Kais. Akad. Wiss. (Vienna); Bur. d. Long. (Paris). He was also knighted, of the Order Pour le Merite, by the German Empire, a distinction never given to any other American and exceedingly rare even in Europe.

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THE INFLUENCE OF LIGHT ON THE DISCHARGE OF ELECTRIFIED BODIES. II.

CONNECTION BETWEEN PHOTO-ELECTRIC SENSITIVENESS AND ABSORBING POWER. WORK OF STOLETOW, HALLWACHS, ETC.

58. The fact that water is an inactive substance as regards the negative discharge was shown by Bichat and Blondlot* by means of an apparatus similar to that used by Righi. Instead of a metal plate a sheet of glass was used, over which a stream of water was allowed to flow. In front of this was placed a wire gauze. It was impossible to obtain any current between water and gauze by illumination, even when 80 cells were used. The authors point out that water is transparent to the effective rays, as first shown by Hertz.

59. Stoletow† used a method similar to that of Bichat and Blondlot with various colored liquids, such as solutions of Fuchsin, Eosin and Fluorescin in ammonia. He came to the conclusion that the effect was always greatest in those liquids which were *capable of absorbing the active rays.*

60. This conclusion was in the main confirmed by Hallwachs* by more reliable and systematic methods. The liquids to be tested were placed in a rather large watch glass, and were illuminated by an arc light placed vertically above the surface. A screen of quartz or gypsum was placed beneath the lamp to prevent disturbance from carbon particles. Connection was made between the liquid and the electrometer by a platinum wire, and the effect of illumination was measured by the rate of dissipation a negative charge on the liquid surface.

Some of the results are given below:

Aqueous solutions of Fuchsin, Cyanin	as sensitive as metals
Aqueous solutions of KNO_3, Eosin, Haematoxylin, Aniline	less sensitive
Water; Solutions of Chromic acid, Potassium permanganate, $Co(NO_3)_2$, KNO_3, KBr; Acetone, Amylacetate	no effect

61. Some trouble was experienced on account of the irregularity of the arc lamp. In order to be able to obtain at any time a measure of its intensity, a piece of copper, which had been oxydized by being brought to a red heat, was kept at a fixed distance from the arc, and the rate of negative discharge from its surface measured from time to time. Such a surface is much less sensitive than one that is polished and clean, but it appears also to be more permanent.

62. Hallwachs gives one series of observations showing the influence of the concentration of the solution. It appears that the intensity of the effect increases less rapidly than the concentration.

63. A consideration of the results showed that all the liquids which were sensitive to the influence possessed a strong absorbing power for ultra-violet rays. The connection between absorption and sensitiveness for the effect does not, however, appear to be a

* C. R. 106, p. 1349. Beibl. 12, 605.
† C. R. 106, p. 1593. Beibl. 12, 723.

* Wied. Ann. 37, p. 666.

simple one. An aqueous solution of fuchsin, for example, is very senitive to the action of the ultra-violet rays ; but an alcoholic solution of the same concentration is entirely inactive. Yet the same rays are absorbed by the two solutions, the absorption being more marked with the alcoholic solution. A cell containing the latter, when placed in the path of the rays, destroyed all action on the aqueous solution. The author suggests that the case is analogous to such as occur with fluorescent substances, where the solvent has great influence upon the intensity of the fluorescence.

64. Hallwachs next made an attempt to investigate the effect of different wave-lengths in the neighborhood of ultra-violet absorption bands. A solution of fuchsin showed a strong band between $\lambda = .250\,\mu$ and $\lambda = .275\,\mu$. The solution was tested in a spectrum formed with a quartz prism. But the effect was so weak as to make reliable results impossible.

An approximation to monochromatic rays was obtained by using suitable absorbing media. But it then appeared that the most active rays were in the *extreme* ultra-violet, beyond the absorption bands. The effect in the neighborhood of the bands was too small to enable any conclusion to be drawn.

65. During his experiments Hallwachs found that some of the less active liquids showed some slight effect when *positively* charged. He was inclined to believe, however, that this effect was accidental, and due to the discharge of the induced *negative* electricity on neighboring bodies.

LATER WORK OF WIEDEMANN AND EBERT.

66. At about this time further investigations were undertaken by Wiedemann and Ebert* upon the spark discharge as influenced by ultra-violet rays. The method was practically the same as that first used by these writers.*

*Wied. Ann. 35, p. 209. Before Hallwachs and Lenard and Wolf.

*Wied. Ann. 33, p. 211. See §§ 11–16.

Various metals were first investigated. The electrodes were made of the same form in each case, and great care was shown in obtaining the same intensity and quality of illumination. It was found that Pt was by far the most sensitive of all the metals tried. A telephone, placed in series with the spark gap, showed an especially noticeable change in the character and pitch of the sound when a spark gap of about 2 to 3 mm. was illuminated. The effect in other metals is very much less intense.

In the order of decreasing sensitiveness, the metals are as follows: Zn, Cu, Fe, Al, Pd, Ag.

67. The sparking distance most favorable for showing the effect was found to be different with different metals. The change in the appearance of the spark, under the influence of ultra-violet rays, is discussed in Wiedemann and Ebert's paper at some length (p. 213 l. c.).

68. Experiments with liquids showed that strongly absorbing solutions were most active. The most sensitive liquid was found to be a solution of Nigrosin. Water showed only a very slight effect, which, however, was greatly increased by impurities.

69. At low pressures the effect of illumination was practically *nil*. (But a *slight* reduction of pressure increases the effect. See Hertz, and Wiedemann and Ebert 1st paper.) "As soon as the pressure conditions are such as to cause a considerable development of cathode rays, the influence of illumination can no longer be noticed" (p. 217).

70. Wiedemann & Ebert call attention to the fact that, since their experiments were made upon disruptive discharges, some caution must be used in applying these results to cases of continuous discharge, such as those investigated by Hall-

wachs, Righi, etc. The difference in the nature of the discharge may be a sufficient explanation of apparent contradictions.

71. In discussing the various observations upon the phenomenon in question, E. Wiedemann * is inclined to favor the view that the effect is due to the absorption of ultra-violet rays. He points out that the absorption of rays by resonance brings the absorbing molecules temporarily into the same condition of vibration which they would have if heated sufficiently to send out the same kind of rays as those absorbed, *e. g.*, fluorescence. The rapid and violent vibrations produced in the surface layers of a body by ultra-violet absorption will produce by collisions increased velocity of translation among the molecules, *i. e.*, a rise of temperature. Although the actual temperature rise will be small, yet individual molecules may receive very high velocities, and, being close to the surface, may escape. Convection discharge will therefore be accelerated by the action of ultra-violet light. Note that this explanation fails to give any reason for the selective discharge of negative electricity, unless there is some reason why the particles take on a negative charge by preference. It also fails to explain the fact that the action of ultra-violet rays is much more intense when CO_2 is used instead of air. †

PHOTO-ELECTRIC EFFECT OF SUNLIGHT. BEHAVIOR OF SODIUM AND POTASSIUM.

72. It will be remembered that all of the early observers failed to detect any action

* Wied. Ann. 35, p. 257.

† Wiedemann and Ebert. Wied. Ann. 33, p. 240. This result, first obtained for spark discharges, was found to be also true in the case of a continuous discharge. See Stoletow, C. R. 107, p. 91. Beibl. 12, 723. Observations by Breisig, in which zinc was used as the metal and a lamp flame as the source of illumination, fail to confirm Stoletow's observations. [See Beibl. 17, 60, 1891.] But on the other hand, Breisig's results are contradicted by Cantor. [Beibl. 19, 583.]

produced by sunlight, either on the spark discharge or upon the continuous dissipation of negative electricity. In 1889, however, Hoor claims to have detected some slight effect.* During the same year Nodon† found that insulated conductors of carbon or metal became positively charged when illuminated by sunlight. And almost simultaneous with Nodon, Elster and Geitel ‡ observed both the discharge of negative electricity and the development of a positive charge. A freshly polished zinc plate was found to acquire a positive potential of 2.5 volts. Even diffused daylight produced a measurable effect. Mg and Al were found to be more sensitive than Zn.

73. Based upon this action of sunlight upon the atmosphere and the surface of the earth, Arrhenius § developed in the same year an interesting theory to explain atmospheric electricity, the aurora, etc.

74. The first article of Elster and Geitel is merely a brief note, hurriedly published, probably in order to secure priority. Two months later a full description of their experiments appear in the Annalen.|| The first results were obtained with zinc. A shallow dish 20 cm. in diameter was set up (insulated) in the open air, and was connected with a sensitive electrometer in an adjacent building. The dish was surrounded by a metal case, the top of which could be removed by means of a cord running into the laboratory. Above the sur-

* Exner's Repertorium, 25, p. 91; Beibl. 13, 731. Righi, however, (Exner's Repertorium 25, p. 380. Beibl. 14, 68) contradicts the results of Hoor, and states that he has ' never succeeded in obtaining the slightest trace of an effect from sunlight.' Elster and Geitel (Wied. Ann. 38, p. 498) were also unable to obtain any action with the substances used by Hoor.

† C. R. 109, p. 219. Beibl. 13, 976.

‡ Wied. Ann. 38, p. 40. Phil. Mag. 28, p. 427. (Abst.)

§ Meteorologische Zeitsch. 5, pp. 297 and 348. Beibl. 13, 328.

|| Wied. Ann. 38, p. 497.

face of the dish, and only a few millimeters distant, was placed a grounded piece of wire gauze, which served to protect the dish from the influence of the atmospheric electricity. With this apparatus a marked effect could be observed both with direct and diffused sunlight. Wires of Zn, Mg, or Al carefully cleaned and attached to an Exner electroscope were found to give a simple and sensitive portable apparatus.

75. Elster and Geitel appear to have been at first interested in the phenomenon chiefly on account of its important bearing upon meteorology, atmospheric electricity, etc. Much has in fact been written on this phase of the subject, which can only be mentioned here. They were anxious to obtain some instrument by which the actinic intensity of sunlight could be measured from hour to hour and day by day. Since the effect is influenced so greatly by slight changes in the character of the sensitive surface, it was difficult to find any active substance which would remain permanent. *Amalgamated zinc* was however found to fulfill the requirements, being much more permanent than pure zinc, and also more sensitive.

76. Elster and Geitel called attention to the fact that only *electro-positive* metals appear to possess 'actino-electric' sensitiveness.* It seemed therefore natural to expect that metals that are even more positive than Zn, Al and Mg, should show the effect in more marked degree. K and Na were tested, but, on account of the rapid oxydation of the surface, no action could be observed. The same trouble was met with in the case of solid amalgams of K and Na. By using a dilute solution of K or Na in mercury, and allowing the liquid to flow continuously from an aperture, a clean surface could however be maintained, and under these circumstances the effect of light upon a negative charge was very marked. With positive electricity there was no action. Pure mercury was entirely inactive.

*See § 34.

77. The most sensitive metals as regards the action of sunlight were, in the order of sensitiveness:

K, Na, Al, Zn, Sn.

This series is exactly the same as the Volta contact series.

78. Sunlight produced no effect on unamalgamated but clean surfaces of

Sn, Cd, Pb, Cu, Brass, Fe, C, Pt.

79. From a meteorological standpoint experiments with surfaces of water appear of considerable interest. The zinc dish described above was therefore filled (1) with pure rain water; (2) with: hot water (rapidly evaporating); (3) with salt water. No action could be detected from sunlight in any case. If any action exists it must be hundreds of times smaller than that observed with zinc.

80. In the course of these experiments Elster and Geitel obtained a noticeable effect with a powder used in making luminous paint (Balmain's Leuchtfarbe).

81. The action in the case of sunlight seems to depend upon somewhat longer waves than those of the extreme ultra-violet. Glass and mica, for example, do not stop the effect completely.

82. Elster and Geitel describe, at the close of their article, convenient forms of apparatus for showing the fundamental phenomena.* Lecture experiments are also suggested by Hallwachs.†

83. A method of conveniently using the highly sensitive sodium amalgam without deterioration of its surface was devised soon after by Elster and Geitel.‡ The amalgam was prepared and kept in a vacuum

* An improved form of apparatus for this purpose is described in Wied. Ann. 42, p. 564.

† Wied. Ann. 41, p. 161.

‡ Wied. Ann. 41, p. 161.

tube, the pressure being in the neighborhood of 1 mm. Under these conditions the surface remained permanently unaltered. Such an active electric cell was extremely sensitive. Diffuse light was effective even through the glass sides of the tube; no quartz window or similar arrangement was at all necessary. The surface is sensitive even to rather long waves, for a slight effect was observed with the sodium flame.

84. In 1891 Elster and Geitel* again took up the investigation of the actino-electric behavior of sodium and potassium. Instead of amalgams, the clean unoxydized surfaces of the metals themselves were used. Such surfaces were prepared in vacuo by a method described at length in the article cited. The apparatus and connections are shown diagrammatically in Fig. 2. The metal, M, was kept perma-

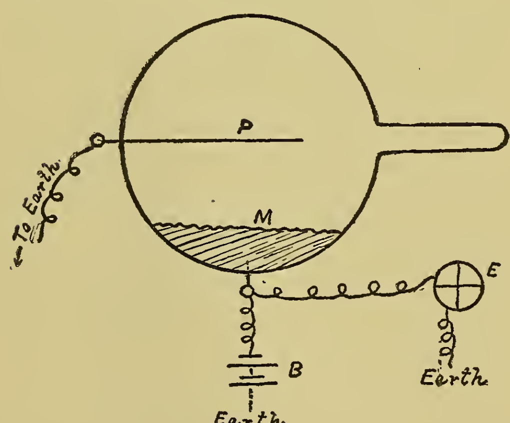

FIG. 2.

nently connected with the negative pole of a 'Zamboni' battery, B (a dry battery. See Wied. Elect. I.: 272), the positive pole of the battery being grounded. The potential of the negative pole was then measured by an Exner electroscope. (E in figure.) A platinum electrode, P, above the surface of the metal was kept grounded and served to carry away the charge dissipated from M.

* Wied. Ann. 43, p. 225.

85. Surfaces of pure potassium were found excessively sensitive. It was impossible to maintain a negative charge at all in a room lighted by daylight. An oil lamp 10 cm. distance reduced the potential from 212 volts to zero. Even at a distance of 6 m. its effect was noticeable. Magnesium light at the latter distance reduced the potential 60%. Even the rays from a Bunsen burner were effective, as was also the fluorescent light from luminous paint. A noticeable effect was observed with moonlight.

86. The effect of various absorbing media was next studied. Finally, the apparatus was placed in the solar spectrum formed by a glass prism. The maximum effect was found in the blue, but the influence was noticeable as far as the red, and far into the ultra-violet. It is suggested that this apparatus may be used to advantage in showing (for lecture experiments) the existence of rays beyond the violet.

87. On charging the potassium positively Elster and Geitel in some cases observed what appeared to be an increased rate of dissipation of *positive* electricity.* They show conclusively, however, that this result is due to the action of diffuse rays upon the (now) negative platinum electrode, P (see Fig. 2), and are strongly of the opinion that other observers who have published accounts of an action on positive charges have been misled by some similar disturbance.

88. Pure sodium surfaces were found somewhat less active than potassium. Experiments upon various amalgams gave results showing that the order of sensitiveness is as follows: Rb, K, Na, Li, Mg, Tl, Zn. Pure K and Na are more sensitive than any of the amalgams.

89. After a number of papers dealing with atmospheric electricity and the meteorological aspect of the negative discharge phenomena, Elster and Geitel again took

* l. c., p. 236.

up their study of the alkali metals in 1894.* Cells containing metallic Na, K and Rb were prepared by methods described in earlier papers.† An atmosphere of hydrogen was used in each case, the pressure being reduced to such a value (about $\frac{1}{2}$ to $\frac{1}{3}$ mm.) as would make the apparatus most sensitive. All measurements were made with a galvanometer, current passing between the illuminated surface and a ring of wire placed just in front of it.

90. Rubidium was found much more sensitive than either Na or K. The maximum effect was also further toward the red than in the case of Na and K, as shown by experiments with various absorbing solutions. For Rb the maximum was in the yellow, with a very noticeable effect in the orange and red. With both Na and K the maximum action was in the blue.

91. Elster and Geitel draw the conclusion that "not only does the actino-electric sensitiveness increase with the electro-positive character of the metal, but the electro-positive metals also show an increased tendency to be affected by light of greater wave-length."

92. In this same article‡ observations are also described showing the effect of illumination in helping the development of Hertz vibrations in vacuum tubes. The effect is especially marked when one of the alkali metals is present. These observations are intimately connected with work by Zehnder, Warburg and others on the behavior of Geissler tubes containing sodium. To follow out the matter in detail would require the considerable literature of this subject to be consulted. I shall therefore merely state the conclusion reached, viz: that in the presence of one of the alkali metals the effect of illumination is to render the gas capable of conducting the rapidly oscillating currents from a Hertzian oscillator.* Taken in connection with Arrhenius' discovery that rarified gases conduct electrolytically when illuminated,† this result has an important bearing upon J. J. Thomson's suggested explanation of actino-electric phenomena.‡

*Wied. Ann. 52, p. 433.

†A special mode of procedure was necessary in the case of Rb.

‡ l. c., p. 445.

BEHAVIOR OF FLUORESCENT MINERALS.

93. The theory advanced by Arrhenius, by which many phenomena of atmospheric electricity are explained as a result of the action of sunlight in discharging negative electricity from the earth's surface, seems to require that other substances besides the metals should be acted upon. A number of minerals, woods, etc., were therefore tested by Lampa,§ with negative results. Preliminary experiments by Elster & Geitel|| also failed to show any action of sunlight upon such substances. The sensitiveness of one non-metallic substance (Balmain's luminous paint) had however already been proved.¶ This substance being phosphorescent, it seemed not improbable that other phosphorescent materials would show the effect. Later experiments by Elster and Geitel** confirm this view. Various artificial phosporescent powders (*e. g.*, the sulphides of Ca, Sr, etc.) were found to show greater or less actino-electric sensitiveness, according as they were more or less strongly phosphorescent.

94. To observe the action of sunlight upon phosphorescing minerals, more sensitive apparatus was needed than that previously used. The arrangement of apparatus is shown in the figure. A dish, D, of oxydized iron was enclosed in a grounded

*See Wied. Ann. 52, p. 454.

† Wied. Ann. 32, p. 545; 33, p. 638.

‡ See § § 112, 113, below.

§ Wiener Anz. 1890. Beibl. 15, 384.

|| Wiener Berichte 99, p. 1008.

¶ Wied Ann. 38, p. 507.

** Wied Ann. 44, p. 722.

metal case, S, with an insulated wire leading outside to an electrometer. Just above D was a sheet of iron wire gauze, G. The substance to be tested was placed in the dish, D (in powder form), and the gauze, G,

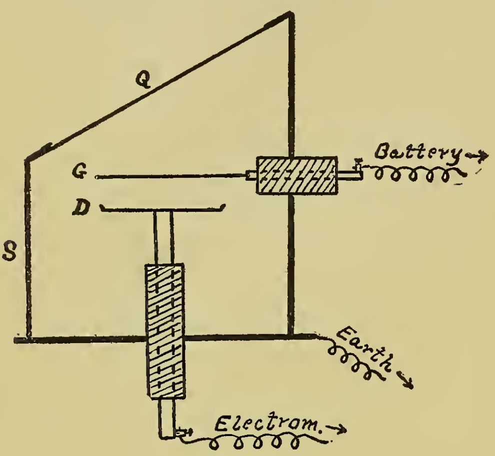

FIG 3.

was kept at a positive potential of 300 volts. The quartz window, Q, being covered by a metal plate, D was grounded for an instant. The ground was then broken and light allowed to shine upon D. As the induced negative charge was dissipated, the electrometer showed an increasing deflection. This arrangement was found much more sensitive than that used before.

95. Among the minerals tested, certain varieties of fluorescing fluorspar were found most sensitive. The most effective rays were not the ultra-violet, but the blue. The sensitiveness of fluorite was not increased by diminished air pressure; and was not destroyed by wetting the surface with water.

96. Fluorite was rendered insensitive by being heated to redness; and its power of phosphorescing was also destroyed by this means. Elster and Geitel suggest that the phosphorescence and actino-electric activity are due to the presence of some organic impurity which is removed by heating.

Various other materials were tested and found to be slightly sensitive. Freshly fractured surfaces were more active than old surfaces.

EFFECT OF A MAGNETIC FIELD ON ACTINO-ELECTRIC PHENOMENA.

97. In the course of his low pressure experiments in 1890,* Righi found that the positive charge acquired under the influence of illumination is lessened when a magnet is so placed as to make the lines of force parallel to the surface. The particles which carry the charge 'appear to meet with opposition in their motion through the magnetic field, so that the actino-electric action is weakened.'

98. The influence of the magnetic field in diminishing the effect of illumination was discovered independently by Elster and Geitel,† who were led to investigate the matter through a consideration of somewhat similar effects in the case of the spontaneous discharge between incandescent and cooler bodies.‡ Amalgamated zinc was used as the active metal and the spark of an induction coil as a source of light. At pressures below 5 mm. the influence of illumination could be in some cases entirely destroyed by a magnetic field. In place of air H, CO_2, and O were also tried. CO_2 was found especially sensitive, both to the actino-electric effect and to the restraining influence of the magnetic field, but much lower pressures were necessary to exhibit the latter action. (Maximum at .005 mm.) These experiments were successfully repeated with daylight, sodium amalgam being used instead of zinc.

99. At the close of the article just cited § Elster and Geitel discuss at some length the probable cause of the phenomena. While accepting some form of convection as the

* Acc. dei Lincei 6, p. 81. Acc. di Bologna 10, p. 85. Beibl. 14, p. 1167.

† Wied. Ann. 41, p. 166. 1890.

‡ Wied. Ann. 37, p. 315 ; 38, p. 27.

§ l.c., p. 174.

method by which the negative charge is dissipated, they are inclined to adopt Righi's original view that the air particles act as carriers for the electricity. Against the explanation of Lenard and Wolf (particles of the body itself carrying charge) they urge the objection that charged dust particles will not be acted on by a magnetic field. (Why not, if in motion?) Elster and Geitel do not believe in the action of the condensed layer of gas (Hoor), but think that by a sort of resonance the ultra-violet rays make it easier for the gas particles in the neighborhood of the surface to receive a charge.

LATER INVESTIGATIONS OF ELSTER AND GEITEL. ACTINO-ELECTRIC EFFECT OF POLARIZED LIGHT.

100. Further actino-electric investigations by Elster and Geitel appear in Wiedemann's Annalen in 1892.* The authors point out that the behavior of an illuminated cathode is similar in many respects to that of an incandescent cathode.† If the analogy holds true, the resistance of a Geissler tube should be diminished by illumination of the cathode, as it is by heating the latter. The observations of Wiedemann and Ebert, however, contradicted this conclusion for low pressures.‡ Elster and Geitel therefore repeat these observations, using potassium as a cathode in a tube filled with hydrogen. Illumination of the potassium surface was found very noticeably to diminish the resistance (as shown by using an adjustable spark gap in air, in parallel with the tube). The effect was most marked at low pressures (0.1 mm. to 0.01 mm).

101. This same tube was then used to study the action of a magnetic field upon the actino-electric current. It was found that when the lines of force of the field were perpendicular to the direction of the convection current, the action in restraining the discharge produced by light was greatest. If the lines of force were parallel to the current, the action was either *nil* or else slightly reversed. In these investigations Elster and Geitel found it possible to measure the actino-electric current with a galvanometer, instead of using an electrometer.

102. In 1894 observations were made by Elster and Geitel* upon the actino-electric action of polarized light. Wanka† had already tried to detect a difference in the discharging action of light depending upon the direction of the plane of polarization, but without success. The difficulty seems to have been partly in the character of the surface and partly in the fact that completely polarized ultra-violet rays are not readily obtained. Elster and Geitel avoided the last difficulty by using cells of Na and K, which were sensitive to visible rays. A smooth and approximately plane surface was obtained by using the metals in liquid form. The light used was polarized by means of a nicol.

103. At oblique incidences the actino-electric effect was greatest when the vibrations of the incident light took place in a plane perpendicular to the sensitive surface, (Fresnel's Hypothesis), and least when the vibrations were parallel to the surface. The difference between the maximum and minimum was a function of the angle of incidence, and was found to be greatest for an incidence of about 60°.

104. In a later article‡ Elster and Geitel describe still further experiments on the action of polarized light. Keeping the

*Wied. Ann. 46, p. 281.

†The discharge from incandescent metal surfaces has been investigated by Elster and Geitel and others at considerable length. Most of the work on this subject will be found in Wiedemann's Annalen.—E. M.

‡Wied. Ann. 35, p. 217.

*Berliner Akad. 6, p. 133. Wied. Ann. 52, p. 440. Abstracted in Phil. Mag. 38, p. 158.

†Mitth. d. Math. Gesellschaft in Prag., p. 63, 1892.

‡Wied. Ann. 55, p. 684, 1895.

angle of incidence constant they investigated the change in the actino-electric current as the polarizing nicol was rotated. Attempts were made to use a cell containing a plane-parallel quartz window, but no cement could be found which would hold and yet not alter chemically the sensitive surface. Cells could, however, be constructed which would remain tight for a short time, and served to check the results obtained with spherical glass cells. In using the latter cells precautions were taken to have the rays from the zircon lamp pass normally through the glass. Only the central portion of the liquid metal surface was used.

105. Indicating the angle through which the nicol was turned from the position of maximum action by x, the actino-electric current was found to be given by the equation:

$$I = A \cos^2 x + B \sin^2 x.$$

This formula agrees with the assumption that the actino-electric effect is proportional to the incident light, but that the proportionality factor is different for light polarized in the plane of incidence and perpendicular thereto.

106. Observations were made at several different angles of incidence (70°, 66°, 40°, 23°). The ratio of A to B was found to depend upon the angle of incidence. Both A and B were small for normal incidence. A increases to a maximum at an incidence of about 60°, and then decreases. B appears to decrease steadily to practically zero at grazing incidence. At 60° the ratio of B to A was found to be 50.

107. Good effects with polarized rays could only be obtained with the smooth, nearly plane surface of liquid K or Na. Solid Na or K always show rather a rough surface and behave in practically the same manner for polarized and unpolarized light.

108. Experiments were tried with amalgamated zinc at ordinary pressures, but here, too, the behavior with polarized rays was scarcely different from that with unpolarized light. The authors think that this is due to the difficulty of obtaining ultra-violet rays completely polarized.

EFFECT OF LIGHT UPON POSITIVELY CHARGED BODIES.

109. When the attempt is made to find a satisfactory explanation of the action of light upon charged bodies, the fact that the action seems to be confined to *negative* charges is of great significance. Several observers have, indeed, found indications of a discharging action in the case of positively charged bodies. Mention has already been made of such indications in the case of the experiments of Hallwachs, Righi, and Elster and Geitel. But these observers were able to show that the apparent dissipation of a positive charge under the influence of ultra-violet rays was in reality a secondary phenomenon, due to the convective discharge from negative bodies in the neighborhood. They were of the opinion that the action of light upon a positive charge, if such action exists at all, is too small to be measured.

110. In contradiction to these conclusions stand the results of numerous experiments by Branly.* Under circumstances where previous observers had found no trace of any action, Branly detected a very rapid dissipation of positive electricity. The lack of a detailed description of the experiments leading to these results makes it impossible to draw any conclusion in regard to their reliability. But the question is of such importance that Elster and Geitel† have recently undertaken a series of experiments intended either to confirm or dis-

*C. R. 110, p. 751, 1890; 110, p. 898; 114, p. 68, 1892; 116, p. 741, 1893; Lumière elect. 41, p. 143, 1891; Jour. de Phys. 2, p. 300, 1893; Abstracts in the Beiblätter.

† Wied. Ann. 57, p. 24, 1896.

prove Branly's conclusions. The experiments of the latter were repeated as nearly as possible under the original conditions, and indications of a loss of positive electricity were in fact found. But it was in all cases possible to ascribe these results to disturbances, as in Elster and Geitel's previous experiments. And when the experiments were modified so as to more completely remove the sources of disturbance, the apparent loss of positive electricity became insignificant. In view of the fact that the X-rays, whose discharging action is in many respects similar to that of ultra-violet light, are capable of dissipating *both* charges, it seems probable that some effect is also produced by light upon a positive charge. The experiments of Elster and Geitel indicate, however, that this action must be extremely small.

THEORIES PROPOSED.

111. Although it has been shown, I think conclusively, that the dissipation of a negative charge by light is accomplished by convection, the theories heretofore cited do not explain how this convection is brought about; and they also leave unexplained the still more important fact that negative charges only are affected. The theories proposed by J. J. Thomson * and by Elster and Geitel† respectively seem satisfactory, however, in regard to both these difficulties.

112. Thomson bases his explanation of the phenomenon upon the hypothesis of Helmholtz that "bodies attract electricity with different degrees of intensity." This conception was shown by Helmholtz to be able to explain electrification by friction and the differences of potential produced by contact. If the attraction of a metal for positive electricity is greater than that of the dielectric surrounding it, the tendency is for the metal to become positively charged. But "when a conductor, which does not disintegrate, is surrounded by air in its normal state, * * * the conductor cannot get charged * * * for the electricity of opposite sign to that which would be left on the conductor has no place to which it can go." "The case is, however, different when the conductor is exposed to the action of ultra-violet light, for then, as Lenard and Wolf's experiments prove, one or both of the following effects must take place: (1) disintegration of the conductor; (2) chemical changes in the gas in the neighborhood of the conductor which put the gas in a state in which it can receive a charge."

113. The first effect mentioned, namely, disintegration of the metal, might be produced by the absorption of the light rays, as explained in § 71. On the other hand, it is quite conceivable that light, and especially the ultra-violet rays, may produce electrolytic dissociation in the gas, and so render the latter capable of taking a charge. This hypothesis is strengthened by the experiments of Arrhenius,* who found that certain gases became conductors when illuminated. That some such change in gases is produced by X-rays is now proven beyond question.

114. The theory suggested by Elster and Geitel depends upon the assumption that the electro-positive character of the metal relatively to the dielectric causes the formation of two charges, viz: A positive charge on the metal, and an equal negative charge in the adjacent portions of the gas. These two charges being extremely close together, their outside effect disappears. When light waves fall upon the surface in such a manner as to give a component electric displacement (electro-magnetic theory) in the direction of the normal, electric oscillations will be set up in the metal. These oscillations may be sufficiently powerful to destroy

* Recent Researches in Elect. and Mag., p. 64.

† W. A. 55, p. 697.

* Wied. Ann. 32, p. 545; 33, p. 638; Phil. Mag. 28, p. 75.

at times the positive surface charge, or even to reverse it. The negatively charged particles of the gas will thus be driven away, while others will come to take their places, and in so doing will impart additional positive electricity to the metal. The fact that strongly electro-negative gases, such as H and CO_2, give an especially marked photoelectric action seems to support this view. On the other hand, as is pointed out by Elster and Geitel, this explanation seems to require that all action should cease when the light rays fall normally on the surface, a conclusion which is not borne out by experiment.

CONCLUSION.

It is clear from what precedes that a thoroughly satisfactory explanation of the discharging action of light has not yet been found, and that many questions concerning the phenomenon remain to be settled by further experimental investigation. That interest in the subject is not diminishing is evidenced by the number of papers that have only recently been published. A list is given below of those that have come to my attention too late to enable their results to be included in this article.

Elster and Geitel. The influence of light on the form of the discharge from a Holtz machine. Wied. Ann. 57, p. 401, 1896.

Elster and Geitel. On a photo-electric after effect of cathode rays. Wied. Ann. 59, p. 417. 1896.

Warburg. The action of light on the spark discharge. Wied. Ann. 59, p. 1. 1896.

Klemencic. A lecture experiment to illustrate the mutual influence of two spark gaps. Wied. Ann. 59, p. 63.

Swyngedauw. Action of ultra-violet light upon explosive, static and dynamic potentials. C. R. 122, p. 131, 1896. Beibl. 20, 660.

Dufour, Dutoit and *Hofer.* Dissipation of electricity under the action of light. Arch. de Genéve, 34, p. 294, 1895.

Simon. On the influence of waves of high refrangibility upon the electrical conductivity of rarified gases. Wiener Berichte, 104, p. 565, 1895.

Batelli and *Garbasso.* On the dissipation of electrostatic charges by ultra-violet rays. Nuovo Cimento III., p. 321, 1896.

Sella and *Maiorana.* Action of Röntgen raysand of ultra-violet light on the disruptive discharges in air. Nuovo Cimento III., p. 238, 1896.

The bearing of the phenomena here described upon the question of the nature of the X-rays is doubtless of especial interest at the present time. The fact that the X-rays are capable of producing a rapid dissipation of electricity from charged bodies has been urged in support of the view that these rays are similar in kind to ultra-violet light, but of excessively small wave-length. The argument loses some of its force when we recall the fact that ultra-violet rays are capable of dissipating a *negative* charge only, while the action of the X-rays is practically the same for both charges. This difference between the two phenomena does not in itself offer a fatal objection to the argument, but recent experiments of Batelli and Garbasso (see above reference) indicate a much more fundamental differerence between the two effects. It has been found that air which has been exposed to X-rays retains the power of discharging electrified bodies even when no longer exposed to those rays. No indication of such an after effect has been found in the case of ultra-violet light. The work of Batelli and Garbasso was undertaken with the special object of testing this point, and their results show that no trace of an after effect can be detected with the rays from an arc lamp, even when the direct discharging action is as great as that produced by X-rays. If these results are confirmed I think we shall be forced to the conclusion that the discharging action of ultra-violet light differs essentially from the similar effect produced by the Röntgen rays.

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*THE LIMITATIONS OF THE COMPARATIVE METHOD OF ANTHROPOLOGY.**

Modern Anthropology has discovered the fact that human society has grown and developed everywhere in such a manner that its forms, its opinions and its actions have many fundamental traits in common. This momentous discovery implies that laws exist which govern the development of society, that they are applicable to our society as well as to those of past times and of distant lands; that their knowledge will be a means of understanding the causes furthering and retarding civilization; and that, guided by this knowledge, we may hope to govern our actions so that the greatest benefit to mankind will accrue from them. Since this discovery has been clearly formulated, anthropology has begun to receive that liberal share of public interest which was withheld from it as long as it was believed that it could do no more than record the curious customs and beliefs of strange peoples; or, at best, trace their relationships, and thus elucidate the early migrations of the races of man and the affinities of peoples.

While early investigators concentrated their attention upon this purely historical problem, the tide has now completely turned, so that there are even anthropologists who declare that such investigations belong to the historian, and that anthropological studies must be confined to researches on the laws that govern the growth of society.

A radical change of method has accompanied this change of views. While formerly identities or similarities of culture were considered incontrovertible proof of historical connection, or even of common origin, the new school declines to consider them as such, but interprets them as results of the uniform working of the human mind. The most pronounced adherent of this view in our country is Dr. D. G. Brinton, in Germany the majority of the followers of Bastian, who in this respect go much farther than Bastian himself. Others, while not denying the occurrence of historical connections, regard them as insignificant in results and in theoretical importance as compared to the working of the uniform laws governing the human mind. This is the view of by far the greater number of living anthropologists.

This modern view is founded on the observation that the same ethnical phenomena occur among the most diverse peoples, or, as Bastian says, on the appalling monotony of the fundamental ideas of mankind all over the globe. The metaphysical notions of man may be reduced to a few types which are of universal distribution; the same is the case in regard to the forms of society, laws and inventions. Furthermore, the most intricate and apparently illogical ideas and the most curious and complex customs appear among a few tribes here and there in such a manner that the assumption of a common historical origin is excluded. When studying the culture of any one tribe, more or less close analoga of single traits of such a culture may be found among a great diversity of peoples. Instances of such analoga have been collected to a vast extent by Tylor, Spencer, Bastian, Andree, Post and many others, so that it is not necessary to give here any detailed proof of this fact. The idea of a future life, the one underlying shamanism; inventions such as fire and the bow; certain elementary features of grammatical structure—these will suggest the classes of phenomena to which I refer. It follows from these observations that when we find an analogon of single traits of culture among distant peoples, the presumption is not that there has been a common historical source, but that they have arisen independently.

* Paper read at the meeting of the A. A. A. S. at Buffalo.

But the discovery of these universal ideas is only the beginning of the work of the anthropologist. Scientific inquiry must answer two questions in regard to them: First, what is their origin? and second, how do they assert themselves in various cultures?

The second question is the easier one to answer. The ideas do not exist everywhere in identical form, but they vary. Sufficient material has been accumulated to show that the causes of these variations are either external, that is founded in environment—taking the term environment in its widest sense—or internal, that is founded on psychological conditions. The influence of external and internal factors upon elementary ideas embodies one group of laws governing the growth of culture. Therefore, our endeavors must be directed to showing how such factors modify elementary ideas.

The first method that suggests itself and which has been generally adopted by modern anthropologists is to isolate and classify causes by grouping the variants of certain ethnological phenomena according to external conditions under which the people live, among whom they are found, or to internal causes which influence their minds; or inversely, by grouping these variants according to their similarities. Then the correlated conditions of life may be found.

By this method we begin to recognize even now with imperfect knowledge of the facts what causes may have been at work in shaping the culture of mankind. Friedrich Ratzel and W J McGee have investigated the influence of geographical environment on a broader basis of facts than Ritter and Guyot were able to do at their time. Sociologists have made important studies on the effects of the density of population and of other simple social causes. Thus the influence of external factors upon the growth of society is becoming clearer.

The effects of psychical factors are also being studied in the same manner. Stoll has tried to isolate the phenomena of suggestion and of hypnotism and to study the effects of their presence in the cultures of various peoples. Inquiries into the mutual relations of tribes and peoples begin to show that certain cultural elements are easily assimilated while others are rejected, and the time-worn phrases of the imposition of culture by a more highly civilized people upon one of lower culture that has been conquered are giving way to more thorough views on the subject of exchange of cultural achievements. In all these investigations we are using sound, inductive methods in order to isolate the causes of observed phenomena.

The other question in regard to the universal ideas, namely that of their origin, is much more difficult to treat. Many attempts have been made to discover the causes which have led to the formation of ideas 'that develop with iron necessity wherever man lives.' This is the most difficult problem of anthropology and we may expect that it will baffle our attempts for a long time to come. Bastian denies that it is possible to discover the ultimate sources of inventions, ideas, customs and beliefs which are of universal occurrence. They may be indigenous, they may be imported, they may have arisen from a variety of sources, but they are there. The human mind is so formed that it invents them spontaneously or accepts them whenever they are offered to it. This is the much misunderstood elementary idea of Bastian.

To a certain extent the clear enunciation of the elementary idea gives us the psychological reason for its existence. To exemplify: the fact that the land of the shadows is so often placed in the west suggests the endeavor to localize it at the place where the sun and the stars vanish. The mere statement that primitive man considers animals as gifted with all the qualities of man shows that the analogy between many of the qualities of animals and human qualities has led to the generalization that all the qualities of animals are human. In other cases the causes are not so self-evident. Thus the question why all languages distinguish between the self, the person addressed and the person spoken of, and why most languages do not carry out this sharp, logical distinction in the plural is difficult to answer. The principle when carried out consistently requires that in the plural there should be a distinction between the 'we' expressing the self and the person addressed and the 'we' expressing the self and the person spoken of, which distinction is found in comparatively few languages only. The lesser liability to misunderstandings in the plural explains this phenomenon partly but hardly adequately. Still more obscure is the psychological basis in other cases, for instance, in that of widely spread marriage customs. Proof of the difficulty of this problem is the multitude of hypotheses that have been invented to explain it in all its varied phases.

In treating this, the most difficult problem of anthropology, the point of view is taken that if an ethnological phenomenon has developed independently in a number of places its development has been the same everywhere; or, expressed in a different form, that the same ethnological phenomena are always due to the same causes. This leads to the still wider generalization that the sameness of ethnological phenomena found in diverse regions is proof that the human mind obeys the same laws everywhere. It is obvious that if different historical developments could lead to the same results, that then this generalization would not be tenable. Their existence would present to us an entirely different problem, namely, how it is that the developments of culture so often lead to the same results. It must, therefore, be clearly understood that anthropological research which compares similar cultural phenomena from various parts of the world, in order to discover the uniform history of their development, makes the assumption that the same ethnological phenomenon has everywhere developed in the same manner. Here lies the flaw in the argument of the new method, for no such proof can be given. Even the most cursory review shows that the same phenomena may develop in a multitude of ways.

I will give a few examples: Primitive tribes are almost universally divided into clans which have totems. There can be no doubt that this form of social organization has arisen independently over and over again. The conclusion is certainly justified that the psychical conditions of man favor the existence of a totemistic organization of society, but it does not follow that totemistic society has developed everywhere in the same manner. Dr. Washington Matthews has shown that the totems of the Navajo have arisen by association of independent clans. Capt. Bourke has pointed out that similar occurrences gave origin to the Apache clans, and Dr. Fewkes has reached the same conclusion in regard to some of the Pueblo tribes. On the other hand, we have proof that clans may originate by division. I have shown that such events took place among the Indians of the North Pacific coast. Association of small tribes, on the one hand, and disintegration of increasing tribes, on the other, has led to results which appear identical to all intents and purposes.

Here is another example. Recent investigations have shown that geometrical designs in primitive art have originated either from naturalistic forms which were gradually conventionalized or from technical motives, or that they were primarily geometrical or that they were derived from symbols. From all these sources the same forms have developed. Out of designs representing diverse objects grew in course of time frets, meanders, crosses and the like. Therefore the frequent occurrence of these forms proves neither common origin nor that they have always developed according to the same psychical laws. On the contrary, the identical result may have been reached on four different lines of development and from an infinite number of starting points.

Another example may not be amiss: The use of masks is found among a great number of peoples. The origin of the custom of wearing masks is by no means clear in all cases, but a few typical forms of their use may easily be distinguished. They are used for deceiving spirits as to the identity of the wearer. The spirit of a disease who intends to attack the person does not recognize him when he wears a mask, and the mask serves in this manner as a protection. In other cases the mask represents a spirit which is personified by the wearer, who in this shape frightens away other hostile spirits. Still other masks are commemorative. The wearer personifies a deceased person whose memory is to be recalled. Masks are also used in theatrical performances illustrating mythological incidents.*

These few data suffice to show that the same ethnical phenomenon may develop from different sources. The simpler the observed fact, the more likely it is that it may have developed from one source here, from another there.

Thus we recognize that the fundamental assumption which is so often made by modern anthropologists cannot be accepted as true in all cases. We cannot say that the occurrence of the same phenomenon is always due to the same causes, and that thus it is proved that the human mind obeys the same laws everywhere. We must demand that the causes from which it developed be investigated and that comparisons be restricted to those phenomena which have been proved to be effects of the same causes. We must insist that this investigation be made a preliminary to all extended comparative studies. In researches on tribal societies those which have developed through association must be treated separately from those that have developed through disintegration. Geometrical designs which have arisen from conventionalized representations of natural objects must be treated separately from those that have arisen from technical motives. In short, before extended comparisons are made, the comparability of the material must be proved.

The comparative studies of which I am speaking here attempt to explain customs and ideas of remarkable similarity which are found here and there. But they pursue also the more ambitious scheme of discovering the laws and the history of the evolution of human society. The fact that many fundamental features of culture are universal, or at least occur in many isolated places, interpreted by the assumption that the same features must always have developed from the same causes, leads to the conclusion that there is one grand system according to which mankind has developed everywhere; that all the occurring variations are no more than minor details in this grand uniform evolution. It is clear that this theory has for its logical basis the assumption that the same phenomena are always due to the same causes. To give an instance: We find many types of structure of family. It can be proved that paternal families have often developed from maternal ones. Therefore, it is said, all paternal families have developed from maternal ones. If we do not make the assumption that the same phenomena have everywhere developed from the same causes, then we may

* See Richard Andree. Ethnographische Parallelen und Vergleiche. Neue Folge, 1889, pp. 107 ff.

just as well conclude that paternal families have in some cases arisen from maternal institutions, in other cases in other ways. To give another example: Many conceptions of the future life have evidently developed from dreams and hallucinations. Consequently, it is said, all notions of this character have had the same origin. This is also true only if no other causes could possibly lead to the same ideas.

We have seen that the facts do not favor the assumption of which we are speaking at all; that they much rather point in the opposite direction. Therefore we must also consider all the ingenious attempts at constructions of a grand system of the evolution of society as of very doubtful value, unless at the same time proof is given that the same phenomena could not develop by any other method. Until this is done, the presumption is always in favor of a variety of courses which historical growth may have taken.

It will be well to restate at this place one of the principal aims of anthropological research. We agreed that certain laws exist which govern the growth of human culture, and it is our endeavor to discover these laws. The object of our investigation is to find the *processes* by which certain stages of culture have developed. The customs and beliefs themselves are not the ultimate objects of research. We desire to learn the reasons why such customs and beliefs exist—in other words, we wish to discover the history of their development. The method which is at present most frequently applied in investigations of this character compares the variations under which the customs or beliefs occur and endeavors to find the common psychological cause that underlies all of them. I have stated that this method is open to a very fundamental objection.

We have another method, which in many respects is much safer. A detailed study of customs in their bearings to the total culture of the tribe practicing them, and in connection with an investigation of their geographical distribution among neighboring tribes, afford us almost always a means of determining with considerable accuracy the historical causes that led to the formation of the customs in question and to the psychological processes that were at work in their development. The results of inquiries conducted by this method may be three-fold. They may reveal the environmental conditions which have created or modified cultural elements; they may clear up psychological factors which are at work in shaping the culture; or they may bring before our eyes the effects that historical connections have had upon the growth of the culture.

We have in this method a means of reconstructing the history of the growth of ideas with much greater accuracy than the generalizations of the comparative method will permit. The latter must always proceed from a hypothetical mode of development, the probability of which may be weighed more or less accurately by means of observed data. But so far I have not yet seen any extended attempt to prove the correctness of a theory by testing it at the hand of developments with whose histories we are familiar. This method of starting with a hypothesis is infinitely inferior to the one in which by truly inductive processes the actual history of definite phenomena is derived. The latter is no other than the much ridiculed historical method. Its way of proceeding is, of course, no longer that of former times when slight similarities of culture were considered proofs of relationships, but it duly recognizes the results obtained by comparative studies. Its application is based, first of all, on a well-defined, small geographical territory, and its comparisons are not extended beyond the limits of the cultural area that forms the basis of the study. Only when definite results have been obtained in regard to this area is it permissible to extend the horizon beyond its limits, but the greatest care must be taken not to proceed too hastily in this, as else the fundamental proposition which I formulated before might be overlooked, viz: that when we find an analogy of single traits of culture among distant peoples the presumption is not that there has been a common historical source, but that they have arisen independently. Therefore the investigation must always demand continuity of distribution as one of the essential conditions for proving historical connection, and the assumption of lost connecting links must be applied most sparingly. This clear distinction between the new and the old historical methods is still often overlooked by the passionate defenders of the comparative method. They do not appreciate the difference between the indiscriminate use of similarities of culture for proving historical connection and the careful and slow detailed study of local phenomena. We no longer believe that the slight similarities between the cultures of Central America and of eastern Asia are sufficient and satisfactory proof of a historical connection. On the contrary, analogy of other similarities make such a connection improbable. But, on the other hand, no unbiased observer will deny that there are very strong reasons for believing that a limited number of cultural elements found in Alaska and in Siberia have a common origin. The similarities of inventions, customs and beliefs, together with the continuity of their distribution through a comparatively small area, are a satisfactory proof of this opinion. But it is not possible to extend this area safely beyond the limits of Columbia River in America and northern Japan in Asia. This method of anthropological research is represented in our country by Prof. F. W. Putnam and Prof. Otis T. Mason; in England by Dr. E. B. Tylor; in Germany by Friedrich Ratzel and his followers.

It seems necessary to say a word here in regard to an objection to my arguments that will be raised by investigators who claim that similarity of geographical environment is a sufficient cause for similarity of culture, that is to say, that, for instance, the geographical conditions of the plains of the Mississippi basin necessitate the development of a certain culture. There are those who would even go so far as to believe that similarity of form of language may be due to environmental causes. Environment has a certain limited effect upon the culture of man, but I do not see how the view that it is the primary moulder of culture can be supported by any facts. A hasty review of the tribes and peoples of our globe shows that people most diverse in culture and language live under the same geographical conditions, as proof of which may be mentioned the ethnography of East Africa or of New Guinea. In both these regions we find a great diversity of customs in small areas. But much more important is this: Not one observed fact can be brought forward in support of this hypothesis which cannot be much better explained by the well known facts of diffusion of culture; for archæology as well as ethnography teach us that intercourse between neighboring tribes has always existed and has extended over enormous areas. In the Old World the products of the Baltic found their way to the Mediterranean and the works of art of the eastern Mediterranean reached Sweden. In America the shells of the ocean found their way into the innermost parts of the continent and the obsidians of the West were carried to Ohio. Intermarriages, war, slavery, trade, have been so many sources of constant introduction of foreign cultural elements, so that an assimilation of culture must have taken place over continuous areas. Therefore, it seems to my mind that where among neighboring tribes an immediate influence of environment cannot be shown to exist, the presumption must always be in favor of historical connection. There has been a time of isolation during which the principal traits of diverse cultures developed according to the character and environment of the tribes. But the stages of culture representing this period have been covered with so much that is new and that is due to contact with foreign tribes that they cannot be discovered without the most painstaking isolation of foreign elements.

The immediate results of the historical method are, therefore, histories of the cultures of diverse tribes which have been the subject of study. I fully agree with those anthropologists who claim that this is not the ultimate aim of our science, because the general laws, although implied in such a description, cannot be clearly formulated nor their relative value appreciated without a thorough comparison of the manner in which they assert themselves in different cultures. But I insist that the application of this method is the indispensable condition of sound progress. The psychological problem is contained in the results of the historical inquiry. When we have cleared up the history of a single culture and understand the effects of environment and the psychological conditions that are reflected in it we have made a step forward, as we can then investigate in how far the same causes or other causes were at work in the development of other cultures. Thus by comparing histories of growth general laws may be found. This method is much safer than the comparative method, as it is usually practiced, because instead of a hypothesis on the mode of development actual history forms the basis of our deductions.

The historical inquiry must be considered the critical test that science must require before admitting facts as evidence. By its means the comparability of the collected material must be tested, and uniformity of processes must be demanded as proof of comparability. It may also be mentioned that when historical connection between two phenomena can be proved, they must not be admitted as independent evidence.

In a few cases the immediate results of this method are of so wide a scope that they rank with the best results that can be attained by comparative studies. Some phenomena have so immense a distribution that the discovery of their occurrence over very large continuous areas proves at once that certain phases of the culture in these areas have sprung from one source. Thus are illuminated vast portions of the early history of mankind. When Prof. Morse showed that certain methods of arrow release are peculiar to whole continents it became clear at once that the common practice that is found over a vast area must have had a common origin. When the Polynesians employ a method of fire making consisting in rubbing a stick along a groove, while almost all other peoples use the fire drill, it shows their art of fire making has a single origin. When we notice that the ordeal is found all over Africa in certain peculiar forms, while in those parts of the inhabited world that are remote from Africa it is found not at all or in rudimentary forms only, it shows that the idea as practiced in Africa had one single origin.

The great and important function of the historical method of anthropology is thus seen to lie in its ability to discover the processes which in definite cases led to the development of certain customs. If anthropology desires to establish the laws governing the growth of culture it must not confine itself to comparing the results of the growth alone, but whenever such is feasible it must compare the processes of growth, and these can be discovered by means of studies of the cultures of small geographical areas.

Thus we have seen that the comparative method can hope to reach the grand results for which it is striving only when it bases its investigations on the historical results of researches which are devoted to laying clear the complex relations of each individual culture. The comparative method and the historical method, if I may use these terms, have been struggling for supremacy for a long time, but we may hope that each will soon find its appropriate place and function. The historical method has reached a sounder basis by abandoning the misleading principle of assuming connections wherever similarities of culture were found. The comparative method, notwithstanding all that has been said and written in its praise, has been remarkably barren of definite results, and I believe it will not become fruitful until we renounce the vain endeavor to construct a uniform systematic history of the evolution of culture, and until we begin to make our comparisons on the broader and sounder basis which I ventured to outline. Up to this time we have too much reveled in more or less ingenious vagaries. The solid work is still all before us.

Franz Boas.

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*PRINCETON IN THE NATION'S SERVICE.**

It used to be taken for granted—did it not?—that colleges would be found always on the conservative side in politics (except on the question of free trade); but in this latter day a great deal has taken place which goes far toward discrediting the presumption. The college in our day lies very near, indeed, to the affairs of the world. It is a place of the latest experiments; its laboratories are brisk with the spirit of discovery; its lecture rooms resound with the discussion of new theories of life and novel programmes of reform. There is no radical like your learned radical, bred in the schools; and thoughts of revolution have in our time been harbored in universities as naturally as they were once nourished among the Encyclopedists. It is the scientific spirit of the age which has wrought the change. I stand with my hat off at very mention of the great men who have made our age an age of knowledge. No man more heartily admires, more gladly welcomes, more approvingly reckons the gain and the enlightenment that have come to the world through the extraordinary advances in physical science which this great age has witnessed. He would be a barbarian and a lover of darkness who should grudge that great study any part of its triumph. But I am a student of society and should deem myself unworthy of the comradeship of great men of science should I not speak the plain truth with regard to what I see happening under my own eyes. I have no laboratory but the world of books and men in which I live; but I am much mistaken if the scientific spirit of the age is not doing us a great disservice, working in us a certain great degeneracy. Science has bred in us a spirit of experiment and a contempt for the past. It has made us credulous of quick improvement, hopeful of discovering panaceas, confident of success in every new thing.

I wish to be as explicit as carefully chosen words will enable me to be upon a matter so critical, so radical as this. I have no indictment against what science has done: I have only a warning to utter against the atmosphere which has stolen from laboratories into lecture rooms and into the general air of the world at large. Science—our science—is new. It is a child of the ninteenth century. It has trans-

*Concluding part of Prof. Woodrow Wilson's oration at the Princeton Sesquicentennial Exercises. Reprinted from *The Forum* for December, 1896.

formed the world and owes little debt of obligation to any past age. It has driven mystery out of the Universe; it has made malleable stuff of the hard world, and laid it out in its elements upon the table of every class-room. Its own masters have known its limitations; they have stopped short at the confines of the physical universe; they have declined to reckon with spirit or with the stuffs of the mind, have eschewed sense and confined themselves to sensation. But their work has been so stupendous that all other men of all other studies have been set staring at their methods, imitating their ways of thought, ogling their results. We look in our study of the classics nowadays more at the phenomena of language than at the movement of spirit; we suppose the world which is invisible to be unreal; we doubt the efficacy of feeling and exaggerate the efficacy of knowledge; we speak of society as an organism and believe that we can contrive for it a new environment which will change the very nature of its constituent parts; worst of all, we believe in the present and in the future more than in the past, and deem the newest theory of society the likeliest. This is the disservice scientific study has done us; it has given us agnosticism in the realm of philosophy, scientific anarchism in the field of politics. It has made the legislator confident that he can create, and the philosopher sure that God cannot. Past experience is discredited, and the laws of matter are supposed to apply to spirit and the make-up of society.

Let me say once more, this is not the fault of the scientist; he has done his work with an intelligence and success which cannot be too much admired. It is the work of the noxious, intoxicating gas which has somehow got into the lungs of the rest of us from out the crevices of his workshop—a gas, it would seem, which forms only in the outer air, and where men do not know the right use of their lungs. I should tremble to see social reform led by men who had breathed it; I should fear nothing better than utter destruction from a revolution conceived and led in the scientific spirit. Science has not changed the laws of social growth or betterment. Science has not changed the nature of society, has not made history a whit easier to understand, human nature a whit easier to reform. It has won for us a great liberty in the physical world, a liberty from superstitious fear and from disease, a freedom to use nature as a familiar servant; but it has not freed us from ourselves. It has not purged us of passion or disposed us to virtue. It has not made us less covetous or less ambitious or less self-indulgent. On the contrary, it may be suspected of having enhanced our passions, by making wealth so quick to come, so fickle to stay. It has wrought such instant, incredible improvement in all the physical setting of our life, that we have grown the more impatient of the unreformed condition of the part it has not touched or bettered, and we want to get at our spirits and reconstruct them in like radical fashion by like processes of experiment. We have broken with the past and have come into a a new world.

Can any one wonder, then, that I ask for the old drill, the old memory of times gone by, the old schooling in precedent and tradition, the old keeping of faith with the past, as a preparation for leadership in days of social change? We have not given science too big a place in our education, but we have made a perilous mistake in giving it too great a preponderance in method over every other branch of study. We must make the humanities human again; must recall what manner of men we are; must turn back once more to the region of practicable ideals.

Of course, when all is said, it is not learning, but the spirit of service, that will give a college place in the public annals of the Nation. It is indispensable, it seems to me, if it is to do its right service, that the air of affairs should be admitted to all its classrooms. I do not mean the air of party politics, but the air of the world's transactions, the consciousness of the solidarity of the race, the sense of the duty of man toward man, of the presence of men in every problem, of the significance of truth for guidance as well as for knowledge, of the potency of ideas, of the promise and the hope that shine in the face of all knowledge. There is laid upon us the compulsion of the National life. We dare not keep aloof and closet ourselves while a nation comes to its maturity. The days of glad expansion are gone; our life grows tense and difficult; our resource for the future lies in careful thought, providence and wise economy; and and the school must be of the Nation.

I have had sight of the perfect place of learning in my thought, a free place and a various, where no man could be and not know with how great a destiny knowledge had come into the world—itself a little world; but not perplexed, living with a singleness of aim not known without; the home of sagacious men, hard-headed and with a will to know, debaters of the world's questions every day and used to the rough ways of democracy; and yet a place removed—calm Science seated there, recluse, ascetic, like a nun, not knowing that the world passes, not caring, if the truth but come in answer to her prayer; and Literature, walking within her open doors, in quiet chambers, with men of olden time, storied walls about her, and calm voices infinitely sweet; here 'magic casements, opening on the foam of perilous seas, in fairy lands forlorn,' to which you may withdraw and use your youth for pleasure; there windows open straight upon the street, where many stand and talk, intent upon the world of men and business. A place where ideals are kept in heart in an air they can breathe; but no fool's paradise. A place where to hear the truth about the past and hold debate about the affairs of the present, with knowledge and without passion; like the world in having all men's life at heart, a place for men and all that concerns them; but unlike the world in its self-possession, its thorough way of talk, its care to know more than the moment brings to light; slow to take excitement, its air pure and wholesome with a breath of faith; every eye within it bright in the clear day and quick to look toward heaven for the confirmation of its hope. Who shall show us the way to this place?

CURRENT NOTES ON PHYSIOGRAPHY.

RECENT UNITED STATES GEOLOGIC FOLIOS.

Recent folios of the Geologic Atlas of the United States contain more examples of physiographic features, well illustrated, described and explained, than can be here noted. The McMinnville, Tenn., folio reveals details of form and structure in a district that has been heretofore practically untouched since Safford's excellent description in the State Survey report many years ago. The Highland, at an elevation of about 1,000 feet, is surmounted on the east by the Cumberland plateau, 2,000 feet elevation, with outliers and deep marginal valleys, and broken on the northwest by the ragged rim that descends to the central basin. The Three Forks, Montana, folio includes the Madison Valley, a typical example of an extinct lake basin, forty miles long by ten wide, formed by warping a preexistent mountain region, and drained by a thousand-foot gorge cut through the enclosing ridge. The lake sediments thus laid bare are about 1,000 feet thick and include thin layers of gray volcanic dust that fell into the lake, covered by thicker layers of reddish weathered dust that washed in from the surrounding country; all these layers are now trenched by the axial and centripetal streams. The outlet gorge is so deep and narrow that access to the bench land of the lake basin is gained at present only by roads that cross over the enclosing ridge. This relation of terraced lake beds and outlet gorge is of frequent occurrence on small and large scale in the Montana Rockies, and has its homologue in the Vale of Kashmir, the control of human occupation and movement being much alike in all. The other folios are equally deserving of physiographic note.

TIDES OF THE BAY OF FUNDY.

BAYA FONDA, named so by the early Portuguese explorers because it reached far into the land, and now anglicized as the Bay of Fundy, has a world-wide reputation for its excessive tides, which by tradition reach seventy feet of rise and fall, and advance with the speed of a galloping horse, as many of us have learned at school. The facts as reported by Chalmers (Geol. Surv Canada, for 1894 (1895), rep't M.) are somewhat more sober, but extraordinary enough. From the mouth of the bay, 48 miles wide and 70 to 110 fathoms deep, the bottom rises at the rate of four feet a mile over a distance of about 145 miles to the head. On the coasts adjacent to the mouth, the spring tides vary from 12 to 18 feet. Within the bay the spring and neap tides are as follows: Digby neck, 22, 18; St. John, 27, 23; Petitcodiac river, 46, 36; Cumberland basin, 44, 35; Noel river in Cobequid bay, 53, 31; the last named being the greatest tidal oscillation in any part of the bay. The flood tide rises about 20 feet above mean sea level; the ebb falls the same amount below, leaving the branch bays empty or nearly so. The tidal bore is seen in Maccan river, entering Cumberland basin, but is stronger in Petitcodiac river, entering Shepody bay. At the bend of this river, by Moncton, 20 miles from the bay head, the bore is seen to best advantage; it rushes in 'as a foaming breaker, five or six feet high, with a velocity of five or six miles an hour.' The spring and neap tides here have 45 and 38 feet range. The ebb tide runs like a mill race; the water rapidly sinking, the bare muddy channel is exposed, and the river is reduced to a small meandering stream. It so remains about two hours, when the rushing waters of the bore are heard again, and the river is soon filled with their sweeping flood.

In this connection, reference may be made to an account of the bore from English sources, at Hang Chow, south of Shanghai, China, in the Annalen der Hydrographie for October.

HÖLZEL'S GEOGRAPHISCHE CHARAKTERBILDER.

THE 37th and latest number of this beautiful and unrivalled series of chromolithographs 'for school and house' (Hölzel, Vienna) represents the gorge of the Rhine, looking southward past the Lorelei, and displaying the gently rolling uplands, with quiet farming villages and broad wheat fields, seldom entered by the stranger, in emphatic contrast with the deep, steep-sided gorge, an artery throbbing with international life, occasionally holding a town of close-packed houses where the little delta of a side stream affords foothold. The descriptive text is prepared by Penck's competent hand, and describes three stages in the evolution of the region: The general denudation of an ancient mountain range, indicated by the bevelling of the extremely deformed strata, reducing them to a *Gebirgsrumpf*, a peneplain; a slight elevation, followed by the excavation of a shallow valley trough in the rolling peneplane, 60 to 80 m. deep and one or two miles wide, still floored with river gravel and alluvium (loess); and a much more recent elevation, accompanied by the trenching of the gorge, about 150 m. beneath the floor of the trough. The cliff of the Lorelei and the narrows and rapids in the river beneath it are caused by a heavy quartzite bed.

THE WANDERING OF LAKE NOR.

SVEN HEDIN gives an interesting account of the apparent recent wandering of Lop (lake) Nor on the level floor of the Gobi desert in Central Asia (Peterm. Mitt., XLII., 1896, 201–205, maps), confirming the views of Richthofen as against those of Prshevalski. The desert basin contains a great accumulation of waste from the surrounding mountains; coarser and steeper sloping around the margin, finer and dead level in the central depression (790 m.); here the aneroid observed from place to place varies only with the weather and season. The chief river is the Yarkand, coming from the west, and at high water in the late summer bringing much silt; this tends to drive the lake to the southeast. The winters are prevailingly calm; but in summer the wind is generally from the northeast, often stormy, drifting the surface sand and bearing so much dust as to darken the sky (hence called Kara-buran, or black storm); this drives the lake to the southwest. The resultant of river and wind action is a southward migration of the lake, but from a comparison of various records, Hedin concludes that there is an intermittent shifting back and forth, according as this or that part of the plain is aggraded. Further account of Hedin's perilous journey across the region of dunes is given in the London Geographical Journal of October.

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CURRENT NOTES ON ANTHROPOLOGY.

THE INDIANS OF THE NORTHWEST COAST.

IN some recent publications Dr. Franz Boas has added to his valuable contributions to our knowledge of the tribes of the northwest coast.

The eleventh report of the British Association Committee is altogether from his researches. It gives notes on the shamans, and a description of their beliefs and customs; also a study of Tshimshian houses, the growth of children and linguistic particulars.

In the 'Internationales Archiv' (Bd. IX.) he reports a number of songs from the Kwakiutl Indians, giving the music, the original words and both a literal and a free translation.

From him also there appears an article on 'The Indians of British Columbia' in the Bulletin of the American Geographical Society (No. 3, 1896). This describes their general appearance, their relationship and the details of their ordinary life.

All this material is at first hand, drawn from his personal studies in this field of ethnography.

THE TEMPLE OF TEPOZTLAN.

THE 'Bulletin' of the American Museum of Natural History for November 13th contains a short article by Mr. M. H. Saville on a ruined temple near Cuernavaca, Mexico. His description is accompanied by several plates and introduces a remarkable relic, hitherto unknown. He states that it is 'the only aboriginal structure still standing in Mexico to which we can probably assign a positive date.' This he thinks can be done by the hieroglyphic inscriptions on its stones, which read the year 10 Tochtli, 1502 of our era, in the reign of Ahuizotl. He acknowledges that the ruins look much older, but he does not mention the possibility that Ahuizotl may have merely inserted his tablet in a wall constructed long before. Both descriptions and plates are interesting.

ANCIENT AND MODERN UMBRIAN SKULLS.

IN the 'Atti' of the Roman Society of

Anthropology (Vol. IV.), Prof. L. Moschen discusses the craniology of the Umbrians. Previous writers (Nicolucci, Calori, etc.) have asserted that the ancient Umbrians were slightly dolicocephalous or mixed. Moschen claims that there are no undoubted skulls of pure blood Umbrians of antiquity, and therefore that these older studies are of little or no value. He undertakes to study the true modern type, following the general terminology of Sergi. They present a large variety of skull forms, with a prevailing tendency to mesocephaly and leptorhiny. He divides his series into eight principal varieties or forms, the ovoids and ellipsoids predominating.

It is difficult to draw any racial conclusions from this study.

D. C. Brinton.

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NOTES ON INORGANIC CHEMISTRY.

The question of impurities in atmospheric air is one that has been investigated by many chemists and from many standpoints, and one upon which much light has been thrown in recent years. One of the most important phases of this subject cannot be said to have yet approached a solution. That air in crowded rooms, and especially exhaled air, is poisonous is well known. The 'black hole of Calcutta' is but an extreme case of what we have all many times experienced in poorly ventilated audience rooms. These evil effects were early attributed to an excess of carbon dioxid, which was certainly present. When it was shown that carbon dioxid of itself is not a poison, a certain mysterious 'effluvium' in exhaled air was conjured up, but its nature eluded investigation. The reduced proportion of oxygen has also been considered a cause. None of these explanations, however, can be considered satisfactory. That the unpleasant effects of crowded rooms could be due to nitrites in the air has also been suggested, but never sufficiently investigated to give a satisfactory answer. A contribution to this phase of the subject has been made by Mr. George Defren at the Massachusetts Institute of Technology, and published in the *Technological Quarterly* (9: 238). His work was mainly confined to the determination of the quantity of nitrous acid (or nitrites) in the excellently ventilated rooms of the Institute Laboratory. After a brief summary of the work of previous investigators, Mr. Defren gives an account of his own experiments.

The method first used was to expose pure water in porcelain dishes for from one to nineteen hours, and then estimate the nitrites absorbed by Griess' reagent. In every case nitrates were found. The quantity was dependent on the time the water was exposed, and on the nature of the work being carried on in the room. The burning of illuminating gas seemed to occasion the formation of nitrites; whether this is due solely to the incomplete oxidation of the nitrogenous constituents of the gas, as Mr. Defren believes, or to a direct union of the nitrogen and oxygen of the air, may be an open question. The second method used was quantitative and consisted in drawing air into large bottles, adding water and analyzing after twelve or more hours. The amount found was small on clear days (as low as .014 part nitrous anhydrid in 10,000 parts air), but was increased by the burning of gas and the presence of the people in the rooms. The largest amount found was .07 parts in 10,000. Exhaled air was tested by blowing through water, but no trace of nitrites was found, contrary to expectation. Mr. Defren suggests that nitrites present would, by the large volume of oxygen present, be oxidized to nitrites, or even decomposed to nitrogen. A test showed that even air containing nitrites, when drawn through water, gave no reaction. On the other hand, water in which the hands were washed showed a strong test for nitrites. It was also shown that the air was very thoroughly washed from nitrites during a heavy shower.

Mr. Defren's results seem conclusive as to the presence of nitrites in the air; that nitrites have a powerful effect upon the human organism is well known; whether the quantity in the air may become large enough, from lack of ventilation, to cause the well known symptoms of oppression, is a point left for further investigation. At all events Mr. Defren's work is a valuable contribution to the problem. A single criticism might be offered, that no account appears to be taken of the fact that nitrous acid, when in solution, is rapidly oxidized by hydrogen peroxid to nitric acid, and similarly ammonia is oxidized to nitrous acid. Wurster's work on this point seems not to be noticed, though the article (Ber. 19 : 3206) is mentioned in a foot note. This reaction might cause Mr. Defren's results to be too low for the amount of nitrous acid in the air, and would probably account for the apparent absence of nitrites in air exhaled through water.

Apropos of air analysis, Dr. T. L. Phipson communicates to the last *Chemical News* a unique method of removing the oxygen from the air. A graduated bell jar filled with air is placed over water. Suspended in the bell jar and not touching the water is a mushroom, *Agaricus atramentarius*. Exposed now to the sunlight, the mushroom rapidly and *quantitatively* absorbs the oxygen of the air, the carbon dioxid given off dissolving in the water, which rises in the bell jar one-fifth of the height. The mushroom itself dries up, becoming mummified in nitrogen. If now a green plant, as *Lysimachia nummularia*, be placed alongside the mushroom, the latter will recommence slowly to vegetate, living on the oxygen furnished by the green plant.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

The details of the approaching meeting of the American Society of Naturalists can now be announced. After the business meeting, on the afternoon of Tuesday, December 29th, the 'Inheritance of Acquired Characteristics' will be discussed by Prof. C. S. Minot, Prof. J. M. Macfarlane, Prof. E. D. Cope and Prof. Wm. James. In the evening, at the Fogg Museum of Art, Harvard University, Cambridge, Mr. Alexander Agassiz will give a lecture, the subject of which will be announced later, and will afterwards hold a reception at his residence. At noon on Wednesday there will be a lecture by Prof. E. B. Wilson, on 'Recent Developments of the Cell Theory,' which will be followed by a luncheon, given by the President and Fellows of Harvard College. In the afternoon Mr. Agassiz will meet the Society in the Museum of Comparative Zoology and describe the Museum. The annual dinner of the Affiliated Societies will take place in the evening at the hotel Brunswick, at which an address will be given by the President, Prof. W. B. Scott.

As we have already stated, the ninth annual meeting of the Geological Society of America will be held at Washington on December 29th, 30th and 31st. The President, Prof. Joseph Le Conte, has chosen as the subject of his address 'The Different Kinds of Earth-crust Movements and their Causes.' Papers have been entered to be read by J. S. Diller, N. H. Darton, Frank Leverett, J. F. Kemp, C. Willard Hayes, Marius R. Campbell, J. B. Woodworth, C. H. Hitchcock, Robert Bell, J. W. Spencer, Ralph S. Tarr, H. L. Fairchild, Angelo Heilprin, George H. Barton, F. B. Taylor, Harry Fielding Reid, Bailey Willis, Warren Upham, Charles R. Keyes, J. E. Wolff, A. H. Brooks, Joseph F. James, Henry S. Williams, David White, Henry B. Kümmel, William M. Clark, T. W. Stanton, F. H. Knowlton, E. H. Barbour, G. Perry Grimsley, George P. Merrill, Alfred C. Lane, Arthur Keith and G. K. Gilbert.

We regard it as somewhat unfortunate that after meeting at the same place as the Naturalists last winter the Geologists should this year meet in Washington, and the Folklore Society in New York. If the 'Jurassic Formation on the Atlantic Coast' is discussed should this be done in Boston or in Washington? If arrangements are made for a winter meeting of Anthropologists should it be done in New York or in Boston? We should like to suggest that in any event all the societies meet in New York two years hence. At that time the new buildings of Columbia University can be placed at the disposal of the societies and will offer much of interest. New York University will also be established in its fine buildings on its picturesque site. Other attractions of great scientific interest will be the Aquarium, the new wings and collections of the American Museum of Natural History, the Botanical Gardens and perhaps the Zoological Park.

THE New York Aquarium in Castle Garden was opened to the public on December 10th. We hope to give in an early number some account of the excellent arrangements carried out under the direction of Dr. Tarleton H. Bean.

A COMMITTEE of the New York Zoological Society met a committee of the Sinking Fund Commission on December 11th, and formally asked for the setting aside of 261 acres of land in Bronx Park for the Zoological Park. The members of the committee said that the Society would raise $250,000 for the purpose, and that they would collect $100,000 of this sum as soon as the necessary land had been set aside for the Park. The Mayor and Sinking Fund Commission will, we trust, decide in favor of a plan so important for the city.

THE Derby and Mayer Museums, Liverpool, will be enlarged at a cost of £72,000, but part of the building will be used for technical schools.

IT is now proposed that the Sedgwick Memorial Museum, Cambridge University, be erected upon a portion of the Downing College site, and that the grace of the Senate which assigned a site for the building on the old Botanic Garden be rescinded. If the site be changed it will be necessary to make new plans for the building.

THE Hebdomadal Council of Oxford University has received and accepted an offer from Professor Poulton to present a statue of Charles Darwin, to be made by Mr. Pinker, and to be placed in the court of the University Museum.

SIR JOSEPH PRESTWICH bequeathed, to take effect on the death of Lady Prestwich, £800 to the Geological Society of London for the establishment of a medal and fund to be awarded once in three years. He also left his collection of pamphlets and reprints to the Society.

THE Paris Academy of Sciences selected, on November 23d, two candidates for the directorship of the Observatory of Paris, vacant by the death of Tisserand. In the first ballot M. Loewy received 42 votes, M. Callandreau 18, and M. Poincaré 1. In the second ballot M. Callandreau received 48 votes, M. Stéphan 2, and MM. Poincaré and Wolf each 1. MM. Loewy and Callandreau are consequently the two candidates presented by the Academy to the Minister of Public Instruction. At the same meeting of the Academy M. Michel Lévy was elected a member of the section of mineralogy, in the place of the late M. Daubrée. He received 54 votes, 2 being given to M. de Lapparent.

PROF. ALPHEUS PACKARD was, on October 1st, elected an honorary member of the Russian Entomological Society.

DR. LEONARD J. SANFORD, who formerly occupied the chair of anatomy and physiology in the medical department of Yale University, died in New Haven on December 12th, at the age of 64 years.

DR. EMIL WOLFF, the chemist, died at Stuttgart on December 7th.

ACCORDING to *Garden and Forest* Mr. C. G. Pringle has just returned from another botanical journey in Mexico, where, during the past season, he has secured about 20,000 herbarium specimens in the valley of Mexico and in Cuernavaca.

DR. NANSEN has ordered a yacht of twenty tons to be built at Laurvig, and intends to continue on it his studies of the coast of Norway and Spitzberg.

THE following items of news are from the current number of *Natural Science*. A portion of the bequest made to the Swedish Academy of Sciences by A. F. Regnell, whose fortune was make as a physician in Brazil, was set aside by the Academy to promote the study of the Brazilian flora. Every six years it yields about £1,150, which is applied in sending two Swedish botanists to Brazil for two years. The first expedition was undertaken by Drs. C. A. M. Lindman and G. O. A. Malme, who in 1892–94 explored Rio Grande, Paraguay and Matto Grosso. Dr. T. N. Tschernyschew, of the Russian Geological Survey, has completed his observations on Nova Zembla. This island bears traces like those in north Russia, of a formidable glaciation, followed by subsidence, during which the whole territory was transformed into an archipelago. Terraces, containing the shells of arctic molluscs, extend along the shores to a height of 160 meters. The present glaciers are in a period of growth. Prof. F. Regel, of Jena, went to Columbia last July on a voyage of exploration, to last some nine months. M. Maindron, the entomologist, has been commissioned by the French government to make a collecting expedition to the Persian Gulf and India.

The publication of *The Astronomical Journal* will be continued by Dr. S. C. Chandler, who cooperated with Dr. Gould in editing the *Journal*. With the assent of the family, it has been decided to place in the title-heading of each number, and upon the title-page of each volume, the words 'Founded by B. A. Gould,' as a permanent memorial.

The Torrey Botanical Club, New York, offers to supply a complete set of the *Memoirs*, five volumes, of which a considerable number remain undistributed, published at $15.00, for half price, or $7.50, the offer to hold good only until January 1, 1897. It is proposed to apply the money derived from these sales to reprinting the numbers of the *Bulletin* which are out of print.

The Commissioner of Labor, Mr. Wright, has submitted to the House of Representatives a plan for the organization of a permanent Census Bureau in Washington. He proposes a separate Census Bureau under the control of a Director of the Census, at a salary of $6,000 a year, with an assistant, at $4,000 a year. The other officers include a chief clerk, at $2,500; a disbursing clerk, at $2,500, and five chief statisticians, at $3,000, each, a year. Such further assistance as may be necessary shall be employed from time to time, the appointments being under civil service laws. It is provided that a general census shall be taken April 15, 1900, and every ten years thereafter, which will include a wide field of inquiry and investigation, of which we hope to give the details when settled.

We called attention last week to the meeting of the New York State Science Teachers' Association, at Syracuse, on December 29th, 30th and 31st. The leaders in the discussions have now accepted and are as follows: *Physics and Chemistry*, Prof. A. L. Arey, of the Rochester Free Academy, and Dr. E. L. Nichols, of Cornell University; *Physical Geography and Geology*, Prof. R. S. Tarr, of Cornell University; Dr. Richard E. Dodge, of the Teachers' College, New York City, and Dr. Frank McMurry, of the Buffalo School of Pedagogy; *Biology*, Prof. Charles Wright Dodge, of Rochester University, and Dr. Thomas B. Stowell, Principal of the Potsdam Normal School.

The anniversary meeting of the Royal Society was held at Burlington House on November 30th. The President, Sir Joseph Lister, made an address. He said, according to the report in the in the *British Medical Journal*, that the Council, in framing new rules for the conduct of the meetings and as to the publications of the Society, had desired, in the first place, to increase the interest of the meetings by giving greater freedom in their conduct and by enlarging the opportunities for discussion; and in the second place to obtain more secure and more rapid judgment on the value of papers, so that while the high standard of the *Philosophical Transactions* was retained, or even raised, greater rapidity in the publication both of them and of the *Proceedings* might be attained. The International Conference on the desirability and possibility of compiling and publishing, by international cooperation, a complete catalogue of scientific literature had agreed to the proposal, and had advised that the scheme should be carried out by an international central bureau, under the direction of an international council. Steps had been taken to encourage the practice of appending subject indices to the papers published by the Society. Sir Joseph Lister then referred to the universal attention attracted to Röntgen's great discovery. He then passed in review some of the more important papers communicated to the Society during the year, and, in speaking of biology, alluded especially to the work of Prof. Schäfer, Prof. Farmer and Mr. Lloyd Williams. The presentation of medals then took place in the manner that we have already announced. In the evening Sir Joseph Lister presided at a dinner at which were present many distinguished guests and a large number of Fellows of the Society.

The Appalachian Mountain Club, of Boston, has secured new and commodious rooms in the Tremont Building. They are centrally located and with a fine view, stretching from Big Blue to Prospect (the highest elevations near Boston), and including the Charles River basin and the State House. The library is now safely housed in a fire-proof building. The rooms are used for Council and Committee meetings, exhibitions and small social gatherings; they contain the library and collections, and are the workshop and office headquarters of the Club. The rooms are under the general supervision of the Room Committee and are open to all members from 3 to 5:30 p. m., under the charge of volunteer custodians.

Natural Science gives some account of the Institute of Jamaica, taken from its report for the year ending March, 1896. The museum has been removed from the lower floor of Date Tree Hall to adjoining new premises. These consist of two floors, the lower devoted to the collections of the Government Geological Survey, the Jamaica woods and most of the natural history collections; the upper floor is filled with the anthropological and the rock and mineral collections. By reason of these changes the library accommodation has been greatly increased, and the art department given room to develop. An attempt has been made to increase the public interest in the museum and natural history generally by the publication of museum notes in the Kingston newspapers. There has been an increase of 28 per cent. in the attendance of visitors to the museum.

UNIVERSITY AND EDUCATIONAL NEWS.

Prof. M. J. Elrod, of the Illinois Wesleyan University, has resigned to accept the chair of biology in the Montana State University.

The following further appointments have been made at the Massachusetts Institute of Technology: Samuel C. Prescott, instructor in biology; Edward M. Bragg, assistant in mechanical engineering; Leonard H. Goodhue, assistant in analytic chemistry; Amadeus W. Grabau, assistant in geology; Minor S. Jameson, assistant in civil engineering; Albert J. Wells, assistant in mechanical drawing; Clarence W. Perley, assistant in biology.

M. Poincaré, now professor of mathematical physics and the theory of probabilities in the faculty of sciences of the University of Paris, has, at his request, been transferred to the chair of mathematical astronomy. M. Boussinesq, now professor of mechanics, takes the chair vacated by M. Poincaré.

There is now once more a University of Paris. The various faculties at Paris have been reorganized with a certain freedom from government control. The inauguration of the University has been celebrated in the new buildings of the Sorbonne with suitable ceremonies, which included an oration by M. Lavisse.

DISCUSSION AND CORRESPONDENCE.

X-RAYS.

To the Editor of Science: The remark has been frequently made that the almost complete absence of specular reflection in the case of the X-rays may depend upon the want of sufficient polish of the reflecting surface. So far as I have noticed, no one has tried the experiment with mercury as the reflector. Very simple arrangements would admit of obtaining a perfectly plane surface, which, as to reflecting power, would leave nothing to be desired. A concave surface of mercury might be found to converge the rays. M. Carey Lea.

REPLY TO PROFESSOR HALSTED.

In the last number of Science Prof. Halsted, by bringing into juxtaposition two statements which were widely separated in a recent note of mine published in Science, appears to convict me of inconsistency and to derive the conclusion that certain subjects introduced in an illogical manner into his 'Elements of Geometry' find a satisfactory treatment in his 'Elementary Synthetic Geometry.' These subjects are *the straight line as a minimum length* and the general notion of *the length of a curved line.* As a matter of fact, neither of these subjects is discussed in the latter work. The only curved line there considered is the circle.

Thomas S. Fiske.

A QUESTION OF CLASSIFICATION.

To the Editor of Science: The communications by Profs. Hollick and Ward in your recent numbers, commenting upon Prof. Marsh's determination of the Jurassic age of the Potomac and Amboy clays of the south New England island series and New Jersey-Virginia coast, and Prof. Marsh's reply to Prof. Hollick in the November number of the *American Journal of Science*, are of interest to all workers in American Mesozoic formations.

Prof. Marsh, in his early papers on the vertebrates of the Atlantosaurus beds of the age of Colorado and the Potomac beds, has referred both of these to the Wealden epoch. American geologists * do not assert the existence, in this country along the present Atlantic slope, of Jurassic beds of Atlantic sedimentation representing the whole or part of that vast period of time below the Wealden. In view of these facts, it is no inference to state that the broad generic term 'Jurassic period,' as applied by Prof. Marsh to this portion of our country, is a synonym for the term Wealden epoch, as used by others. Hence that part of the controversy, so far as it involves the oldest or Potomac beds, narrows down to the question of whether the beds of the Wealden epoch should be classified as the top of the Jurassic or the base of the Cretaceous period of geologic time.

* With the exception of Prof. Jules Marcou, who originally maintained that the Middle and Lower Cretaceous of Texas and the Plains Tertiary were Jurassic, and who still maintains the Jurassic age of the Middle Cretaceous beds of New Mexico and the Lower Cretaceous of Texas. This position has been disproved by research.

This is an old and much discussed question of English geology. It would be impossible here to give even brief reference to the extensive literature of the question. It is sufficient to say that, after the most thorough sifting of the evidence pro and con, European opinion and usage of to-day uphold the Cretaceous age of the Wealden beds. Against the opinions of a few who hold to the contrary, a volume could be filled with the data of eminent European authorities who maintain the Cretaceous age of the Wealden, including L. Agassiz, Lyell, Jukes, Prestwich, Zittel, Etheridge, Woodward, Pavlow, Fischer and others. Even as I write these lines the mail brings, fresh from the press of the official Geological Survey of Great Britain, an elaborate monograph of five volumes on the English Jurassic by H. B. Woodward, which excludes the Wealden from the Jurassic and places it at the base of the Cretaceous period. Furthermore, the consensus of opinion in all the reports of the meetings of the International Congress of Geologists places the Wealden as the base of the Cretaceous system.

Prof. Marsh, however, has assumed the position in several writings that the Wealden epoch belongs to the Jurassic period and not to the Cretaceous, and this opinion explains his use of the term Jurassic in this country. On the other hand, all the able authorities of this country, except Prof. Marsh, who have studied or reviewed the Potomac and allied formations of Wealden affinities have reached the final conclusion that they are of Cretaceous age. Among these may be mentioned Dana, Newberry, Ward, McGee, Hollick and others. The U. S. Geological Survey has also mapped these formations as Cretaceous upon its latest atlas sheets.

The controversy, in part, thus narrows down to the problem of the age of the beds of the Wealden epoch, and naturally arouses an inquiry as to what criteria can be depended upon to settle the limitations of the geologic periods. There are three plausible methods that suggest themselves : (1) precedents and usage ; (2) correspondence of the rock of each period with great cycles of sedimentation, and (3) the presence of characteristic, distinguishing fossils.

The weight of precedent and usage, as shown by the eminent authorities cited, undoubtedly assigns the Wealden beds to the base of the Cretaceous. In view of this almost unanimous opinion of the ablest individual authorities, the established usage of the official surveys of Great Britain and the United States, and the expression of the representative International Congresses of Geologists, to the effect that the Wealden is the base of the Cretaceous system, it will require more than the assertion of one savant, however eminent in research, to change the accepted geologic classification. At least some preconcerted action and international agreement on the part of the geologic societies should be had before one would be justified in using the broad term Jurassic for beds which at the utmost could only doubtfully be referred to it, and which, if so referred, would represent only a minute fraction of the great time period of the Jurassic.

Periods of geologic time usually correspond with one or more great oscillations of land and accompanying migration of the marine shore lines, producing cycles of sedimentation. These cycles are recorded by successive variations in the character of the sediments manifested: First, by estuarine and other unsorted marginal deposits, representing the beginning of the subsidence. In turn these are succeeded by more finely sorted and deeper-water or off-shore beds, as subsidence of bottom and landward migration of shore progresses. The Wealden in England and the Potomac in America most clearly represent the basement littorals of the Lower Cretaceous epochs of sedimentation, belonging by every physical affinity and gradation with the overlying beds.

Furthermore, the Potomac from New Jersey nearly to the Rio Grande is undoubtedly a marginal, land-derived formation, laid down at oceanic deposition level, and one which marks the initiation of the great cycle of Lower Cretaceous sedimentation, recording the encroachment of the Cretaceous sea upon the pre-existing Jurassic continent. In Texas these beds certainly lie unconformably alike upon Algonkian, Silurian, Carboniferous, Permian and alleged Triassic, and there is not a trace of pre-existing Jurassic sediments.

The third method, based upon the presence of characteristic fossils, is likewise valuable, but least trustworthy. The land and fresh-water animals, land plants and marine mollusks each present a widely varying standard, and leave room for differences of opinion upon the part of their respective students. While each of these (except the fresh-water mollusks, which seem of little diagnostic value) has peculiar characteristics for each of the great periods, there is no reason to presume that research may not often lead to the discovery of the persistence of supposed characteristic Jurassic forms into the Cretaceous, or Cretaceous forms into the Tertiary, as has been done in some instances. In such cases, however, no one has ever changed the period designation of the beds. For instance, ammonites were once reported to be found in the Eocene of India, but no one has transposed the Eocene epoch from the Tertiary to the Cretaceous on that account, and even if Prof. Marsh has found Jurassic land vertebrates in the Wealden it is doubtful if he would be justified, in face of the opposing evidence of the plants, mollusks and sediments, in making such a radical step as transferring the Wealden beds from the Cretaceous to the Jurassic period. It would be far more logical, in my opinion, to consider that the vertebrate life of the Jurassic land has persisted slightly into the Cretaceous period.

Regardless of European analogy, however, there is every stratigraphic and paleontologic reason for placing the Potomac-Trinity formations of America as the base of the Cretaceous. In Texas, plants, vertebrates and marine mollusks are found associated in the basement Trinity beds, the equivalent of the lowest Potomac. The plant life and molluscan life which have been most thoroughly studied show no more Jurassic characters than are usually found in these basement beds.

With all due deference to the opinion of others, there are reasons for suspecting that no marine Jurassic formations of Atlantic sedimentation have as yet been discovered north of Argentina on the present Atlantic slope of the American hemisphere, and furthermore I hold that there are strong reasons for believing that this absence is due to the fact that the continental expansion towards the east was far greater in Jurassic time than now, especially in the tropical and South American regions. That lacustral deposits of the alleged nature of Prof. Marsh's Atlantosaurus beds of Wyoming and Colorado may have been made upon this Jurassic land mass is not only possible but plausible, but Jurassic deposits at marine sedimentation level are undoubtedly missing or undiscovered upon the Atlantic slopes of both American continents. Robt. T. Hill.

U. S. Geological Survey.

Since the above was written, Prof. Marsh has published another contribution upon 'The Jurassic Formation of the Atlantic Coast.'* This contains many statements with which American geologists will differ, and conflicts more or less directly the results of others, who for years have carefully explored and described the Mesozoic formations of this country.

Prof. Marsh, in his previous papers, has transferred the Wealden epoch from the base of the Lower Cretaceous to the top of the Jurassic; and the tenor of the present article is to repudiate the Lower Cretaceous entirely, as is shown in the diagram of the 'Geologic Horizons of Vertebrate Fossils,' and in the many places where he makes the Dakota Formation the base of the Cretaceous. Upon the evidence of plants, vertebrates and mollusks, all other students place the Dakota Formation in the middle of our American Upper Cretaceous and at the base only of the upper of the two great series into which the Cretaceous of this country is divided. It is considered also as the time equivalent to the Middle Cretaceous of Europe. Between the Dakota and Jurassic time positions, both in this country and Europe, there are extensive series of sediments representing the great interval of the Lower Cretaceous time. Even Prof. Jules Marcou, who has here alone upheld the Jurassic age of the Lower Cretaceous formations in part, admits that there are extensive Lower Cretaceous beds below the Dakota. These Lower Cretaceous beds, to which the Potomac belongs, and not the Dakota, as alleged by Prof. Marsh, are the true base of the Cretaceous system in the Rocky Mountain region, at least in the Trans-Pecos, Texas and Mexican portions of the Rocky Mountains. Neither is it improbable that they are the true base of the Cretaceous in the Colorado region, if the Atlantosaurus beds are of the Lower Cretaceous series. The latter clearly occupy the stratigraphic position where the Lower Cretaceous beds ought to be, lying beneath the Dakota and above the last determinable Jurassic. For years students of American stratigraphy have desired to know the relationship between these Atlantosaurus beds of Colorado and the nearest allied Potomac-like formations of undoubted Atlantic sedimentation. Some have even suspected that they might ultimately prove to be a part of the great basement littoral of the Lower Cretaceous of the Texas and Potomac regions. In a previous paper I have suggested that there might be stratigraphic relationship between the Trinity-like sands at the base of the Tucumcari series of New Mexico and the Atlantosaurus beds of Colorado. An attempt to trace this connection, however, resulted in the conclusion that it would be impossible to prove it, owing to discontinuity of outcrop along the flanks of the Rocky Mountains in New Mexico. Prof. Marsh, however, now assures us that the Atlantosaurus beds are the western extension of the Potomac formation of the Atlantic coast, and hence those who still believe in the Lower Cretaceous position of the latter, would hereafter be justified by his correlation in mapping the Atlantosaurus beds as Cretaceous.

An impression is obtained from Prof. Marsh's writings that his deductions are based entirely upon the vertebrates, and that he has not fully considered the correlative testimony of other life forms the species of which occur in greater abundance and have a more world-wide distribution than the vertebrates. In discussing the relative merits of plants and vertebrates as stratigraphic criteria, he even states that the attempt to make out the age of formations by the use of fossil plants is too often labor lost. Whatever may heretofore have been the diagnostic value of paleobotany in stratigraphic determination, the recent detailed researches in this country have created for it a position that com-

* This Journal, December 5, 1896, and *American Journal of Science*, December, 1896.

mands respect. On the other hand, the discovery and description of vertebrates in America has been accomplished by so little stratigraphic and comparative data that the exact value of these forms as aids in stratigraphic interpretation is uncertain. A single contribution to the stratigraphy of the vertebrate beds, or critical comparison of the forms with European affinities, such as Prof. Ward has recently given us of the plants of the Potomac formation,* would be a most welcome contribution to American geology. In any event, ridicule cannot overcome the fact that research has not as yet shown the existence in the Jurassic of dicotyledonous plants, such as the Cretaceous beds of the Atlantic coast contain.

The following statements in Prof. Marsh's paper are also of interest: "The invertebrates known from these strata are few in number, but some of the mollusks among them point to the Jurassic age, as Whitfield has shown." "There is now positive proof that the southern end of this series is Jurassic, and it is certainly a fair conclusion that the remainder is of the same age. The burden of proof will rest upon those who hold to the contrary." The writer has been studying the southern extension of the Potomac formation in Arkansas and Texas for many years, but is not aware of Prof. Marsh's having ever examined the beds at all. There the continued Potomac beds, as above stated, contain plants, vertebrates and mollusks in intimate association. The counsel of the ablest authorities and specialists has been sought in the interpretation of these invertebrate fossils. With the exception of Prof. Ferdinand Roemer,† and Prof. Heilprin, who maintained that the beds were Upper Cretaceous, and Prof. Jules Marcou, who still believes them Jurassic, the Lower Cretaceous position of the beds is maintained by all other later authorities who have studied the plants, vertebrates and invertebrates. It is true that invertebrates are few in number in the North Atlantic States, but in the Texas-Arkansas region, 'the southern end of this series,' which Prof. Marsh says is also Jurassic, over 300 species have been noted from the beds below the Dakota which, as a whole, clearly testify to the Lower Cretaceous positions of the beds. In describing the New Jersey forms to which Prof. Marsh refers, Prof. Whitfield, instead of referring them positively to the Jurassic, clearly says: "We get no help of sufficient value to establish the geologic horizon of the beds from these molluscan remains, and aside from the evidence furnished by the plant remains we must rely entirely upon their stratigraphic position."*

It is strange that Prof. Marsh, while discussing the invertebrates and paleobotany, makes no mention of the true Lower Cretaceous vertebrates, and omits them from his 'Horizons of Vertebrate Fossils.' It is true that the vertebrates are rare and have been less fully studied than the plants and invertebrates, but Prof. Cope has already described five species of fishes from the Southwestern beds, and has referred them all to the Cretaceous. Williston† has likewise published several vertebrates from the Lower Cretaceous of Kansas, including turtles, fishes, saurians and crocodiles.

Prof. Marsh's views of continuous sedimentation along the Atlantic coast through the various periods of geologic time are also peculiar. He says: "To place the strata in question in the Jurassic section of the Atlantic coast at once removes many difficulties that have hitherto perplexed students of the Mesozoic of this region. It completes the series, and shows in part at least what was done in deposition during that long interval between the end of Triassic and the beginning of Cretaceous time." It is not exactly clear how the geologic series of the Atlantic coast will be completed by restoring the Jurassic sediments, as he proposes to do, at the expense of the

*Some Analogies in the Lower Cretaceous of Europe and America, by Lester Frank Ward. Extract from the Sixteenth Annual Report of the U. S. Geological Survey, 1894–95, Part I., Director's Report and Papers of a Theoretic Nature, 1896.

†Prof. Marsh lays stress upon the fact that Prof. Roemer told him to look out for the Jurassic in America. It may interest him to know that the writer has a letter from Prof. Roemer, written just before his death, in which he insists upon the Upper Cretaceous age of the Lower Cretaceous beds which Prof. Marsh is now including in the Jurassic.

*Monograph IX., U. S. Geol. Survey, p. 23, 1885.

† Kansas University Quarterly, July, 1894.

Lower Cretaceous beds, which are left out of the geologic column. A great break in the sedimentary sequence would still exist between the Wealden and Dakota. In the light of the testimony of structure and paleontology, the current hypothesis that land conditions prevailed in Jurassic time makes a much more harmonious and acceptable geologic record.

Personally, while differing with Prof. Marsh, the writer feels grateful that he has reopened this question, for we believe it will result in a more thorough understanding and appreciation of the Lower Cretaceous epoch and its influence in the making of our continental history. In conclusion, however, we must confess our inability to see that Prof. Marsh has submitted sufficient proof to maintain his proposition or to upset the accepted results of the minute geologic research throughout the Atlantic Coastal Plain. To prove these beds Jurassic by moving the boundary between periods is not an altogether satisfactory method, nor in harmony with geologic usage. Neither will the testimony of a few vertebrates in beds abounding in Cretaceous-like plants and invertebrates be of sufficient weight to upset the accepted nomenclature, especially when the time position of these vertebrates in the European standard to which they are referred is unknown.

Inasmuch as the evidence contrary to Prof. Marsh's position has all been brought out in accepted scientific literature, and he, as yet, has presented no detailed evidence to maintain his unique position, it is difficult to appreciate his statement that the burden of proof 'belongs upon those who hold contrary opinions' to himself. It appears instead that he is submitting data which may be used to advantage by those who might believe in the Cretaceous age of the beds which he has so long called Jurassic.

R. T. H.

PROFFESSOR WILSON'S ADDRESS AT THE PRINCETON SESQUICENTENNIAL CELEBRATION.

The concluding part of Professor Woodrow Wilson's oration at the Princeton sesquicentennial celebration has been received with general applause by literary and religious journals. The occasion of its delivery made it more than an individual utterance, for the speaker and the hearers must have understood it to present a program for Princeton University. Men of science should, therefore, read Professor Wilson's words in order that they may know of the existence of a point of view which they may have thought obsolete.

Professor Wilsou holds that the scientific spirit of the age is 'doing us a great disservice, working in us a certain great degeneracy,' that the limitations of science are known to its own masters, who 'have eschewed sense and confined themselves to sensation.' He is indeed prepared to acknowledge certain achievements of science, but for him 'the scientist' seems to be the man who invents the steam engine or the sewing machine. The practical applications of physical science have, it is true, reformed the world. They have answered with facts Professor Wilson's predecessor whose *a priori* arguments claimed that population must increase more rapidly than the means of subsistence. They have made possible a civilization in which each man may have not only physical well-being, but also time and means for thought and culture. But I believe that science has done more than this; it has not only given opportunity for education and culture; it also offers the best means of culture and the truest standpoint from which to view the world. Keats might see no beauty in the rainbow after its causes had been explained to him, and Professor Wilson may think Phœbus and his horses a nobler conception than those of modern astronomy. But the man of science does not find that the beauty of the world becomes less, as he learns more of its order.

Scepticism, pessimism and the like are much older than the present century; they do not result from scientific study, as Professor Wilson claims, but are rather literary products. It is not the student of science, but Professor Wilson, who 'cowers' 'in an age of change.' If, as Professor Wilson says, classical studies make a boy a gentleman, scientific studies may make him a man. The present writer does not undervalue classical studies, but finds the difficulty to be that in a college such as Princeton the work with grammar and dictionary is a somewhat trivial science and the student does not go on far enough to appreciate classical literature and art or to undertake the scientific study of the causes of the development of civilization. But Professor Wilson holds that science should confine itself to counting the chemical elements and becomes a 'noxious, intoxicating gas' when its methods are applied to the study of the development of society.

Views such as Professor Wilson offers on the limitations and evil effects of science seem like a survival from the denominational college of fifty years ago, and I regard it as unfortunate that they should have been presented in an official address at the inauguration of Princeton University. J. McKeen Cattell.

SCIENTIFIC LITERATURE.

Monograph of the Bombycine Moths of America, North of Mexico, including their Transformations and Origin of the Larval Markings and Armature. Part I., Family 1, the Notodontidæ. By Alpheus S. Packard. Nat. Acad. of Sci., Vol. VII., First Memoir. 1895. Pp. 291, 4to, plates 49, many colored, and 10 maps.

"I am greatly pleased," writes Dr. A. Spuler, of Erlangen, "when I note how much, in these latter days, the study of entomology in America is pursued by true zoologists, and not by mere dillettants." Dr. Spuler and other exponents of scientific entomology will be convinced in this belief if American entomology maintains the standard set for it by Dr. Packard's latest important work, the first part of his monograph of the Bombycine moths of North America.

It is with the chapters of the book included in its first eighty pages that my brief criticism will chiefly have to do. These introductory chapters present a discussion of the present knowledge of the phylogeny of the Lepidoptera, a knowledge to which Dr. Packard has been a conspicuous contributor, and with the details of which he is thoroughly conversant.

Since there have been students of insects there has been classification of insects. There have been pre-Darwinian and post-Darwinian classifications. But not until very recent years has there been much of a revealed phylogeny of insects. However fully and unreservedly we have, for years now, accepted the theory of descent, we have been, speaking for the while only of entomologists, very slow to align our work with our beliefs. We have been content w th Linnæan classifications. We have been inconsistent. We have let phylogeny and ontogeny mean to us—if, haply, they had any meaning for us—problems for the 'general zoologists,' the German morphologists and embryologists. But if we are Darwinians our systematic entomology must take on the aspect of phyletic study, and drop its too long persistent Linnæan character.

Of late, fortunately, there has appeared an awakening among American entomologists, and some notable progress has been made toward an appreciative recognition of the demands made upon us by our beliefs. This welcome beginning o the phylogenetic study of insects is specially noticeable in the treatment of the Lepidoptera. The recent studies of Comstock and Dyar, of Chapman (England) and of Spuler and Walter (Germany), combined with his own, have enabled Dr. Packard to present in the preliminary chapters of this monograph a suggestive and reasonable discussion of the phylogeny of the moths and butterflies. It would be ill advised to attempt to refer here to the details of this discussion; many of these details are yet moot points, most of them, indeed. There is yet no consensus of authority to refer to on these questions. There are not enough men competently familiar with the matters at issue to form a consensus of authority, if one may so put it. It is a bold undertaking, perhaps, to attempt, as yet, to arrange phyletically the species of a family of insects; but it is a praiseworthy undertaking, because it is consistency. Dr. Packard is a Neo-Lamarckian. He believes that he finds much evidence for Neo-Lamarckism in the adaptational characters of the larvæ and pupæ. A Neo-Darwinian might affirm that the author has assumed the truth of Neo-Lamarckism and has explained the origin and development of these characters in accordance with his belief. There is an unsatisfying character about the treatment of the interpolated adaptive characters of the immature stages. The categorical distinguishing between the adaptational and the congenital characters seems arbitrary. But any questioning of the interpretations or dissent from the conclusions contained in these chapters on the phylogeny of the Lepidotera cannot lessen our enthusiastic appreciation of the character of the discussion. There is much inspiration for the right sort of entomology to be got from reading these eighty and odd pages.

It is that part of the work as yet unreferred to which alone is indicated by the title of the book. Much of the inspiration gained from the perusal of the introductory chapters would be lost if the purely systematic part of the work were not treated consistently with the author's beliefs. But the treatment is consistent. The Bombycine family Notodontidæ, including, according to Dr. Packard's delimitation of the group, '21 genera and about 78 species,' found in America, north of Mexico, is the subject of a careful monograph. The biology of each species is given as fully as known, a special attention being paid to the details of larval markings and armature. It is hardly necessary to say that careful descriptions of immature stages "in the light of the recent very suggestive and stimulating work of Weismann, entitled 'Studies in the Theory of Descent,'" are not so common in monographs of Lepidopterous families that, met with, they should pass without comment. Such treatment is distinctly rare. The detailed descriptions of these immature stages are supplemented by a splendid series of colored plates of larval forms. There are also a series of plates of wing venation, some figures of the external anatomy of the heads of imagines and a number of maps showing the geographical distribution of the family.

The book is a valuable one for its point of view as well as for the actual matter of it. American entomology will be helped by it in reputation and in inspiration.

Vernon L. Kellogg.
Stanford University, Calif.

Determinative Mineralogy and Blowpipe Analysis. By George J. Brush. Revised and enlarged by Samuel L. Penfield. New York, John Wiley & Sons. 1896. Pp. 163 and 33 double pages of tables. $3.50.

Mineralogists, metallurgists and students in these branches of science, who have been using the former edition of this book, on accoun of the value of text and tables, will gladly welcome this revised edition.

In this new edition, the text has been thoroughly revised and for the most part new material has been substituted. The work has been greatly enlarged by the addition of a new chapter and by the expansion of the chapter on 'The Reactions of the Elements.'

In the introductory chapter, the author has very clearly and concisely explained and defined the commoner terms and names used in mineralogy and also those in chemistry, necessitated by the study of the chemical character of the minerals.

The second chapter has been devoted, (1) to a description of the blowpipe apparatus "which is necessary or convenient for making the simple tests for the identification of the elements and the determination of the minerals;" (2) to the reagents commonly employed in the study of minerals; (3) 'to the nature and use of flames.' There is here a very full and clear description of the character and use of the different flames, well illustrated with cuts and descriptions of experiments on the composition and use of the different parts of the flame.

In the chapter on the reactions of the elements, which occupies nearly one hundred pages of the text, the elements have been taken up alphabetically, for convenience of reference. In connection with each of the elements, a short description is given of their occurrence and rarity. The tests described, which include a great many new ones especially devised for this work, have all been carefully verified by the author, and are applicable for the elements in their many forms of combination. Many of the old tests have been simplified and improved, and details are given concerning methods of manipulation in making many of the tests, which will be found exceedingly useful. This part of the book will be greatly appreciated by mineralogists on account of the thorough and exhaustive work that has been done in bringing the text up to date. In connection with most of the elements, experiments are very carefully described, by which the tests can be very characteristically illustrated. This adds greatly to the value of the work as a text-book. To facilitate the use of the work as such and also as a book of reference, the descriptions of the rarer elements are given in fine print, as well as the experiments and "conspicuous headlines and catchwords have been freely used."

Another part of the work that has been most conveniently and systematically arranged is the chapter on 'The Important Blowpipe and Chemical Reactions.' It consists of a tabulated arrangement of the reactions observed and is 'intended to be used especially for the interpretation of unknown reactions which are encountered in blowpipe analysis,' and it can be made to serve as a course in qualitative blowpipe analysis in examining unknown substances.

The chapter introductory to the tables as well as the tables are the same as in the former edition, but as stated by the author in the preface: "A complete revision of the tables for the determination of minerals will be made as soon as possible, and a short chapter on crystallography and the physical properties of minerals will be prepared."

One feature of the book that especially commends it to the mineralogist is that in the tests taken up, no one arbitrary method is employed, but the best ones, whatever their character, are described, thus making the work general and covering all the physical, chemical and blowpipe tests useful for the identification of the elements and minerals. J. H. PRATT.

YALE UNIVERSITY.

SOCIETIES AND ACADEMIES.

ENTOMOLOGICAL SOCIETY OF WASHINGTON.

DECEMBER 3, 1896.

R. H. PETTIT, St. Anthony Park, Minn., and F. A. Sirrine, Jamaica, N. Y., were elected Corresponding Members.

Under the head of exhibition of specimens, Mr. J. D. Patten showed living examples of *Lasioderma serricorne*, and exhibited a cigar from which the beetles had emerged. Mr. Ashmead exhibited a small collection of micro-Hymenoptera, made by Mr. Townsend at San Rafael, Mexico. Mr. Howard exhibited specimens of two new Coccidæ allied to *Icerya*.

A paper by Mr. T. D. A. Cockerell was read which consisted of notes on the recently published No. 1, Volume IV., of the Proceedings of the Society.

In the discussion of this paper the fact was brought out by Messrs. Ashmead and Schwarz that *Eciton* and *Labidus* are unquestionably distinct and that the true female of *Eciton* has been found in North Carolina by the Rev. P. Jerome Schmidt, who has had a good drawing of it in his possession for at least two years.

Mr. Schwarz presented some notes on the 'Lerp Insects' (Psyllidæ) of Australia. After reviewing the literature on the subject he discussed the various forms of cases spun by these Psyllid larvæ on the leaves of Eucalyptus trees, illustrating his remarks with drawings and exhibition of specimens. For the more or less conical larval cases which on the surface are provided with longitudinal ribs Signoret's generic name, *Spondyliaspis*, has to be accepted and includes the *Psylla eucalypti*, described by Dobson. The remarkable structure of the first joint of hind tarsi already observed by Dobson as well as the structure of the hind tibiæ, the posterior apical edge of which is produced into a stout mucro, fully justify the erection of a new sub-family under the name Spondyliaspinæ for *P. eucalypti* and congeneric species. Another Psyllid, the larvæ of which weaves the beautiful shell-like structures described by Dobson as his third form of lerp, was made by Mr. Schwarz the type of a new genus and species under the name *Cardiaspis artifex*.

This paper gave rise to an animated discussion participated in by Messrs. Gill, Stiles, Howard and Schwarz, on the advisability or necessity of the adoption of generic and other names based upon excretions of or structures formed by insects or their larvæ and by other animals, the animals themselves being unknown. The general opinion seemed to be that where such a structure or secretion is an expression of morphological character it has sufficient taxonomic value to carry the name.

L. O. HOWARD,
Secretary.

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 254th regular meeting of the Anthropological Society was held Tuesday evening, December 1, 1896.

The first paper, by Mr. Arthur Bibbins, Professor of Geology of the Women's College of

Baltimore, Maryland, entitled 'Some Paleontologic Folk-Lore of Maryland,' illustrated by a collection of fossil cycads of the Potomac formation.

The ideas of the residents of the rural and mining districts of the Potomac formation of Maryland, respecting the nature of fossil cycadean trunks were reviewed. One of the more notable conceptions was to the effect that they were a sort of stone plant endowed with a kind of life and the capacity in a marked degree, for *growth*. It was claimed by the owner of one of the trunks, and generally believed in the neighborhood, that when found, in 1830, it was a small stone, and was carried in the apron of Aunt Polly Jones, its discoverer, a distance of not less than two miles, and that since that date it had increased in dimensions until it now weighs 121½ pounds.

Discussed by Prof. Ward relative to geologic and paleontologic character and identification of the specimens; also by Prof. McGee and Dr. J. H. McCormick.

The second communication was entitled 'Seri Stone Art,' by W J McGee. About a score of more or less artificialized pebbles and bowlders were exhibited. Two of these were naturally shaped angular masses of stone, which had been used as metates or nether millstones in simple grinding operations, one so far as to slightly polish the surface, and the other so long as to produce a basin-shape depression nearly an inch deep, in one side; and there were three or four cobblestones which had been used as anvils in simple domestic operations. The greater part of the collection consisted of natural pebbles, more or less completely worn and shaped by use as hammers, manos (or grinding stones), etc.; none of these were differentiated, but all bore marks of use for the various purposes required in the simple domestic art of the Seri Indians. The process of manufacture, or more properly evolution, of the implements, as observed among the Indians and studied in the contents of scores of their rancherias, was described: The Seri matron, requiring implements to crush and grind mesquite beans or to crush bones and sever tendons of turtle or deer, selects a suitable pebble for use as hammer or grinder, with a larger stone which serves as metate or anvil; commonly both are abandoned after a single use, but if the smaller stone is found especially convenient it is preserved for future use, while the larger is used again only if it is near a rancheria; in use the stones are worn, and if improved thereby they are retained and the smaller is carried about by the matron as a part of her domestic paraphernalia; and occasionally a pebble is so satisfactory at the outset and so far improved by gradual reshaping in use that it is completely artificialized, though still used for various purposes, especially grinding and crushing. Eventually the form assumed by such pebbles is a flattened ellipsoid, the sides of which are smoothed and polished by use in grinding, while the ends and perhaps the edges are roughened by battering in the use as a hammer. It was pointed out that even the best worn examples are not the product of purposive manufacture, in accordance with preconceived design, but are simply natural pebbles modified by wear in use, and thus that they cannot be regarded as representing either the neolithic or paleolithic types of many archeologists; and it was suggested that the class be distinguished as protolithic. It was observed that the Seri Indians do not habitually chip stone, and that their stone chipping is limited to the manufacture of arrow-points of a common pattern, and was probably acquired from neighboring tribes, through contact in warfare.

J. H. McCormick,
Secretary.

GEOLOGICAL SOCIETY OF WASHINGTON.

At the 53d meeting of the Geological Society, held on November 25th, 1896, Mr. Arthur Keith, of the United States Geological Survey, gave a resumé of the essential features of a communication presented by him at the previous meeting on the structure of the Cranberry district.

The district lies mainly in the northwestern corner of North Carolina. It extends into Tennessee to the northwest, but the formations under consideration lie entirely within North Carolina. The district consists almost entirely of metamorphic rocks, the great body being gneisses, hornblende schists and allied rocks. All the ordinary features of Appalachian structure are developed. The rocks are very much deformed, by folding, faulting and metamorphism. The two former are as extreme as in any part of the Appalachians, and the metamorphism is unusually developed. The principal fault, which constitutes the essential feature to be considered, almost encircles an area of Cambrian rocks which are overthrust by granite. The positions and relations of the formations were pointed out on a map of the district. Mr. Keith stated that in the processes of metamorphism the diabases became schists and the granites gneisses. One of the chief features developed is the offsetting of the different formations on opposite sides of a shear zone extending nearly west across the strike.

The great question was, how the deformation of the basement rocks occurred. He mentioned two theories. One is that the sediments above were thrust and defined against the crystallines. This theory he combatted as being untenable. The other theory is that the force that produced the deformation originated in the crystallines and was propagated toward the northwest.

The subject was discussed by Messrs. Hayes and Willis.

Mr. George F. Becker read a paper, entitled 'Some Queries on Rock Differentiation.' The theory now almost generally received ascribes the origin of many igneous rock species to the segregation of a single homogeneous magma under differing physical conditions. Mr. Becker considered segregations due to differences of temperature (Ludwig's or less properly Soret's method) and segregation caused by varying pressure. The active force in these processes is osmotic pressure and this produces segregation by 'molecular flow.' Molecular flow, one case of which is ordinary diffusion, is an exceedingly slow process when the distances involved are considerable; even an aqueous solution of copper sulphate diffuses in sensible quantity to no more than 35 cm. in a year and to ten times this distance in 100 years. Temperature in underground strata diffuses more than 4,000 times as fast as this sulphate. Mr. Becker thinks the process of segregation too slow to produce the observed rock differences. Ludwig's method involves the heating of masses of magma from the top. If such a case were to occur in nature, and this could only be under very exceptional conditions, the temperature would be equalized by conduction through the walls before considerable segregation had had time to take place. Differences of pressure would produce only a very slight segregation even after an infinite time. The separation of a magma into immiscible fractions under changes of temperature was also considered. This involves a superheating of the magma, which seems impossible in the presence of solid rock. It also implies very fluid magmas; too fluid, for example, to hold phenocrysts in suspension. In a superheated magma a decrease of pressure would promote miscibility, not separation. Mr. Becker suspects that the differences between the main rock types is due to the original heterogeneity of the solar nebula, and that many rocks are mere fortuitous mixtures originating at the contacts of primordial masses.

The paper will be printed in the January number of the *American Journal of Science.*

Mr. Whitman Cross was on the program of the meeting for a communication on Landslides in Colorado, but for lack of time the paper was deferred until the next meeting.

W. F. MORSELL.

UNITED STATES GEOLOGICAL SURVEY.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, NOVEMBER 24.

MR. J. H. HAMILTON recorded his recent discovery of what may prove to be an undescribed trap dyke in Fairmont Park, on the line of the newly opened trolley railway, about 175 feet from the Elm Avenue entrance. The trend of the trap is N. by 5°E.

Mr. Richardson stated that he had found, detached, not *in situ*, masses of zoosite at the same locality.

December 1, 1896. Mr. Theodore D. Rand gave an account of a recent trip made to the Wilmington gabbro region, and described the distribution of the quarries as reported by Prof. Chester and as throwing light on the geology of Delaware and Pennsylvania. He referred specially to a mass of the gabbro on the Brandywine Creek, just below the Jessup and Moore paper mills. In the middle of it is to be observed a distinct schistose structure.

Mr. Edw. Goldsmith described a similar deposit two miles north of that referred to. The masses of the rock which had been mined are so resonant as to merit the name gabbro-phonolite.

Mr. H. A. Pilsbry described a collection of mollusks obtained by himself and Mr. C. W. Johnson in Florida in 1894. Their main object had been to determine the relation of existing mollusks to those of the shell heaps. *Vivipara georgiana* was one of the commonest of the latter, associated with *Unio* and *Ampullaria.* Certain forms of *V. georgiana* from the shell heaps have the spire extremely high. He had called this variety *altior.* The distribution of this form was indicated as being confined to a short stretch of the River St. John's.

He believed that the shell heap *Viviparas* belonged to a race which is now extinct. Another variety of *Vivipara* from the same region was extremely flattened and broadly shouldered. This he had called *limnothauma.* He considered its peculiarity a mechanical result of an acceleration of the reproductive process. This form is also extinct, although some were found more recent than those of the mounds. The characters of both these varieties had appeared during the human period.

Ampullaria depressa was found in the mound three times the size of the living shell. The *Unios* did not vary.

EDW. J. NOLAN,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON. 267TH MEETING, SATURDAY, DECEMBER 5TH.

THE evening was devoted to the address of the President, Surgeon General Geo. M. Sternberg, who spoke of 'The Malarial Parasite and other Pathogenic Protozoa.'

F. A. LUCAS,
Secretary.

NORTHWESTERN UNIVERSITY SCIENCE CLUB.

AT the November meeting Prof. Jos. P. Iddings presented the topic 'Petrology as related to other branches of Natural Science.' The outline of his address was as follows:

Petrology deals with theories regarding the origin and formation of rocks, as well as the facts of their existence, and the alteration they may undergo. From geology, as generally defined petrology derives data concerning the occurrence of rock bodies as part of the earth's crust; establishing their formal and quantitative relations, and also their age and time relations. It also derives from geology conceptions of their sources and of the processes of their formation and alteration in general terms. Petrology contributes to geology conceptions of the possible condition of the interior of the earth and of its constitution, and also of the processes of molecular change taking place within it.

From mineralogy petrology derives data cencerning the form, constitution and composition of the mineral components of rocks, which furnish the internal evidence regarding the mode of formation of and the mechanical and chemical changes that take place within rocks. Microscopical study of rocks involves intimate knowledge of geometrical and physical crystallography. While research into the nature and crystallization of igneous rocks necessitates excursions into the realm of molecular physics and chemistry; having to do with the physics of molten rock magmas, and their behavior as solutions in which the dissolved salts are in various molecular conditions, and are capable of diffusion and differentiation. Saturation and crystallization from solution must also be considered, together with the formation of simple and of mixed salts. Chemistry is also called upon to furnish a means of analysis, and to explain processes by which many mineralogical alterations take place. While physics further supplies the laws controlling the transportation and deposition of sediments, and the conceptions of rigidity and plasticity, of stress and strain, of fracturing and shearing that constitute factors of dynamic metamorphism.

To biology petrology is indebted for data regarding the source of material forming certain kinds of rocks. But the processes of growth in the biologic kingdom and those in the mineral realm are strongly contrasted, and the character of an organism and that of a crystal are totally different.

A. R. CROOK,
Secretary.

EVANSTON, ILL.

SCIENCE

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SCIENCE

FRIDAY, DECEMBER 25, 1896.

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

SCIENCE IN COLLEGE ENTRANCE EXAMINATIONS.

THE advancement of science is so intimately related to the study of science in schools and colleges that the recent efforts to improve and unify college entrance requirements deserve consideration. At the meeting of the National Educational Association in 1895 a committee of ten was appointed, in which secondary and higher education were equally represented, and this committee has prepared tables (published in *The School Review*) giving the subjects required in sixty selected colleges and universities.

Courses leading to the degrees of A.B., Ph.B. and B.S. are considered separately. The multiplication of degrees seems to be needless. In the great universities of Germany and Great Britain the same degrees are given for classical, literary, historical, philosophical and scientific studies, and there is no good reason why the confused American system should not be simplified, as has been done at Johns Hopkins, Columbia and Stanford Universities, by giving only the degrees of A.B. and Ph.D. for suitable courses of liberal study. With our present elective system a degree may represent a given amount of culture, but it is absurd to devise degrees for each kind of information. We may regard the Ph.B. degree as already antiquated, but we must for the present consider the courses leading to the degrees of A.B. and B.S.

It appears that of fifty-six institutions, eighteen, including, we regret to say, several leading universities, neither require nor allow entrance examinations in science. To offer courses leading to the degree of B.S., and not encourage the preliminary study of science, seems unreasonable. Under such conditions it is not surprising that the degree should be commonly regarded as of less value than the A.B. Strange as it may appear, seven leading scientific and technical schools unite in requiring history for admission, but only three allow any science, and of these the Sheffield Scientific School of Yale University only asks for botany. These schools all want modern languages, and propose to examine students on Chamisso, Schiller, Corneille and George Sand, but do not recognize the importance of reading scientific texts in French and German.

Among the colleges requiring or permitting entrance examination in science, 32 propose physics, 24 chemistry, 22 biological subjects, and 16 physiographic subjects. These figures, however, refer to the three degrees; only 21 institutions offer examinations in science for the course in arts. It must be remembered that even these scant requirements relate, in many cases, to the superficial memorizing of a text-book. Those universities that recognize a proper preparation in physical and natural science deserve to be enumerated; they are Harvard, Johns Hopkins, Chicago and Stanford Universities and the State Universities of Michigan, Wisconsin, Minnesota, Illinois, Colorado, California, Nebraska and Indiana. While we regret that our roll of honor is so short, we regard the names on it with satisfaction. Harvard has always led in educational progress; Johns Hopkins, Chicago and Stanford have planned their courses and not inherited them; the great State universities have developed in touch with the public schools and the needs of the people.

While the present state of affairs is very bad, the outlook is not at all discouraging. Every change is in the direction of increased recognition of the sciences. Since the report of the N. E. A. Committee was prepared, Columbia has joined Harvard and Johns Hopkins, leaving Pennsylvania, Princeton and Yale in the rear. Further the causes of the present discrimination against the sciences are fortunately such as can be and are being removed. One of these is the difficulty of teaching science adequately in the high school and in the private preparatory school. There has been a lack of proper teachers, proper text-books and proper laboratory equipment. But in all these respects there has recently been great improvement; and it seems likely that the school will lead the way, forcing the college to accept the preparation of which the community approves. If the boy likes to study science better than Latin grammer, and if the Latin of the school is unprofitable to the great majority of boys who never go to college, it would seem to be only a question of time when facts will take the place of argument and compel all colleges to acknowledge preparatory study in science.

A second obstacle has been the lack of agreement among educators and men of science as to what science should be taught in the school and how it should be taught. Even the quasi official report of the member representing science on the Committee of the N. E. A. states that physiography is not a fundamental disciplinary study, calls the study of natural history sham biology, and says that neither physiography nor biology can be studied without previous training in physics and chemistry. But we think that partial points of view will supplement each other as the subject is discussed in journals and in meetings such as that of the department of Natural Science Instruction of the N. E. A., and that of the recently organized New York State Science Teachers' Association. We believe that courses can be arranged extending from the kindergarten to the college that will not only supply the student with information of enduring practical value, but will also give him a training and a culture not otherwise attainable.

The most serious obstacle in the way of science in college entrance examinations is, however, tradition, and this is an obstacle that consumes itself. For centuries the classics were a necessity and there was no science. A certain amount of conservatism is always desirable ; we want growth rather than revolution. It is probable, however, that there are some college presidents who do not know that at Cambridge University most of the students take the B. A. degree without studying a word of Latin or Greek at the University. We believe that the survival of the fittest is the best method of development. We do not ask that science be required in entrance examinations neither do we wish to see classical studies excluded, but we think it reasonable that science and classics should be treated with equal fairness.

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*THE AIM OF PHYSICAL CHEMISTRY.**

A PAPER bearing the above title was read by Prof. Nernst at the opening of the new laboratory for physical chemistry and electro-chemistry at the University of Göttingen, on the second of June last. This is the third chair that Germany has devoted to the study of that region, which lies intermediate between physics and chemistry. First, in point of time must be mentioned that of Landolt in Berlin, while the laboratory of Ostwald, in Leipsic, is more directly connected with the newer developments in that field which has been systematized into a distinct science largely by Ostwald himself. Indeed, much of the best work of Arrhenius and Nernst was done while they were associated with Ostwald, so that the title 'Leipsic school,' has come to have a definite significance. It is now well known that Leipsic will soon be provided with a physico-chemical building and equipment which, in point of completeness, will have no rival.

The new structure in Göttingen has been erected to meet the growing demands of physical chemistry in that university, under the guidance of Prof. Nernst. At the formal opening there were present such men as Arrhenius, Beckmann, Borschers, van't Hoff and others. Ostwald and Landolt were prevented from attending. The following are some of the more important points which were brought out by Nernst on that occasion.

To-day we are furnished with new evidence that an intimate reunion is being effected between two branches of science

* Published by Vanderhoeck and Ruprecht. Göttingen, 1896.

which have become separated. A reunion, since a separation, which does not date from a very early period, took place. Newton, the Father of modern physics, wished to apply his law of force to cosmic phenomena as well as to chemical. Even at the beginning of this century we find men like Dalton, Wollaston, Ampère, Davy, Dulong, Gay Lussac and others, who have simultaneously enriched both physics and chemistry. The separation came later and we recognize Weber, Helmholtz, Kirchhoff, Clausius, Fr. Neumann, Kundt, Hertz, as distinctly physicists, while Berzelius, Dumas, Liebig, Wöhler, Hofmann, are as distinctly chemists. It is also true that there were a few, contemporary with the above named, whose work enriched both physics and chemistry, notably, Faraday, Hittorf, Horstmann, J. W. Gibbs and the cooperation of Kirchhoff and Bunsen, and Guldberg and Waage. But that a marked separation of physics from chemistry had taken place is beyond question.

The time at which this began to be pronounced was about the year 1835. A decided tendency to reunite was observed in the year 1885. It was at this latter date that van't Hoff's epoch-making work on solutions appeared, and in the same year Ostwald published the first volume of his *Lehrbuch*. Since that time the number of those who are at once physicists and chemists has greatly increased.

If we ask what is the difference between physics and chemistry it is generally replied that chemistry has to do with the composition and structure of the molecules, while physics deals with the molecules already made, but this distinction is founded on a special hypothesis, the atomic hypothesis, which cannot be regarded as a general principle on which to base such a division. If we state that physics investigates those natural phenomena in which the properties of matter remain unchanged, while chemistry studies the transformations of matter, the distinction does not always agree with the facts.

On the other hand, physics and chemistry have much in common which is distinctive. The other branches of natural science find the objects of their investigations existing in the external world. The zoologist, the physiologist, the astronomer, have their material already prepared for them. Their work is *descriptive*. The chemist and physicist prepare their own materials, and their science is *constructive*. But what is the real difference between physics and chemistry, which are taught in separate laboratories and by specialists in each branch? The distinction is one which is deeply imbedded in the mind of the investigator. He who would become a physicist must acquire a good mathematical training, while a chemist must be acquainted somewhat with mineralogy, physiology and botany. Further, it is difficult to preserve physical apparatus in the presence of the destructive fumes of the chemical laboratory, and consequently such apparatus is usually absent from, or in poor condition in, the chemical laboratory. For the same reason the physicist avoids the 'chemical kitchen' in his apartments. Thus the distinction which existed between physics and chemistry for a half-century (1835–1885) was a necessity and contributed largely to the advance of our knowledge of the natural sciences. And those same causes which have made the separation of physics from chemistry a necessity are still operative to some extent, so that no one thinks at the present day of combining the physical and chemical laboratories into one. But like two great nations which have been brought more closely together by common interests, physics and chemistry will have more and more points in common the further investigation is carried. Physical chemistry is the diplomatic agent to effect this. "If the physicists and the chemists work each in their own field and with their own methods, a large area between the two will remain untilled, viz., all that which can be cultivated only by the simultaneous application of both methods of work. That physical chemistry finds here an enormously large and fruitful field for activity is distinctly shown by the scientific advances of the last decade."

One may fairly ask why has this point of view presented itself for the first time, in the last few years? This is the answer: "*In the fifty years previously referred to, there were discovered a number of general natural laws, which were particularly important and useful because of their simplicity. These made it possible for the investigator to comprehend a very large number of facts in a few words or formulæ.*" It has thus become relatively easier for the physicist and chemist to know something of that science which belongs more directly to the other. In reality, such knowledge has become necessary on the part of both. The physicist cannot understand electrical phenomena and thermodynamics without a knowledge of the law of chemical mass action and an intelligent comprehension of purely chemical phenomena. The chemist, in turn, must have a fair knowledge of electricity in order to comprehend electro-chemical processes. Indeed the inter-relation of physics and chemistry has become so pronounced that a specialist in each can work over only a limited range without having to take the other into account. The remainder of this interesting address is devoted more particularly to a discussion of the nature of the work which it is proposed to carry on in the new laboratory in Göttingen.

In connection with what has already been accomplished by physical chemists since their branch has become a distinct science (which is hardly more than a decade), it seems desirable to call attention to some of the generalizations which have been reached by them; and what is so important in physics, and especially in chemistry, as a generalization, which brings together and interprets at least a few out of that chaos of facts whose real significance and meaning are for the most part unknown.

The generalization of van't Hoff that 'optical activity' is due to the presence of an asymmetric carbon atom, was the foundation for all the recent developments in stereochemistry in the hands of Wislicenus, Hantzsch, Werner, V. Meyer, Auwers and others. His application of the gas laws to solutions, and its counterpart, the Arrhenius theory of electrolytic dissociation, have a significance the breadth and depth of which are just beginning to become apparent. Further, his studies in chemical dynamics, though less known, are probably his greatest achievements. The work of Ostwald is of too general a character to specify details. We owe to him preeminently the systematic classification, into a science, of those facts which it required a century to ascertain. Scarcely less interesting are the theoretical deductions of Nernst, who has pointed out the real source of the electromotive force in Voltaic and other elements, so clearly and correctly that our ideas in regard to primary batteries have been largely revolutionized since the appearance of his well known paper in 1889. From the theoretical side we must not forget the application of thermodynamics to physics and chemistry by Horstmann and J. W. Gibbs, and the wide significance of the law of Mass Action, even should they date from a slightly earlier time. And hardly less important than the theoretical advances which we owe already to physical chemistry are the experimental. One need mention only the work of Raoult and Beckmann on freezing points and vapor tensions, of Le Blanc on polarization, of Ramsay and Shields on surface tension, or of Ostwald on conductivity, to verify this statement.

If in so short a time such advances have been made, it seems reasonable to expect much from work in this very imperfectly explored field, which belongs neither to physics nor chemistry, but is a distinct region, lying between these two, and employs, in addition to its own, some of the theoretical and experimental methods belonging to both.

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TAPIRS PAST AND PRESENT.

An important contribution to our knowledge of the structure and origin of the tapirs has recently been made by Mr. J. B. Hatcher,* of Princeton University. The distribution of the recent tapirs remained an enigma until the discoveries by paleontologists solved the problem. We now know that in former geological epochs, and as early as the Oligocene, the true tapirs were generally distributed over the northern hemisphere of both continents, and that probably owing to geographical and climatic changes the present tapirs were stranded as it were in two widely separated areas of the the globe, that is to say, in the Malay Archipelago and in South America.

In a number of the mammalian orders, there are types of great interest to the morphologist, which are called generalized or collective types. These forms include many characters in their structure which are primitive, and they are of great assistance in unravelling the phylogenetic history of the mammalia. The tapir is such a generalized member of the perissodactyle division of the ungulates, and it represents in a certain degree, especially in the structure of the feet, the ancestral type from which arose all the modern odd-toed ungulates.

* Recent and Fossil Tapirs, by J. B. Hatcher, Am. Jour. Sci., March, 1896.

It is surprising how little change the tapir has undergone since the Oligocene, and the genus *Protapirus* based upon the dental characters alone can hardly be separated generically from the recent tapir. The structure of the skull in *Protapirus* is decidedly more primitive than that of any of the living tapirs. In *Protapirus validus*, of the White River Oligocene of the United States, the skull is elongated and compressed, in contrast with recent species the nasals project farther forward, and consequently the proboscis in this ancient tapir was probably much smaller than in recent forms. The shape of the nasal bones is quite different from that of recent tapirs, as in these the nasals are deeply excavated proximally into fossæ which lodge the large air sinuses. In *Protapirus*, however, these fossæ are represented by two long and narrow grooves, one on each side of the nasals, and these grooves extend farther forward on the skull than in the living tapirs.

In *Protapirus validus* the cranial portion of the skull is much elongated and the sagittal crest is prominent; on the other hand, the postglenoid and paroccipital processes are united and close the external auditory meatus inferiorly. This is decidedly a specialized character of *Protapirus* and is not found in the skull of any of the existing tapirs. In comparing the recent with the fossil tapirs Mr. Hatcher finds that the skull of *Tapirus roulini* (Syn. *T. pinchacus*) more closely resembles that of the fossil *Protapirus validus* than any other of the living tapirs. *Tapirus roulini* is rather aberrant in its distribution, as it is found in the high latitudes of the Andes. The osteology of this species has been very fully described by Döderlein.*

I see no use in reviving the generic name *Elasmognathus* Gill. The ossification of the mesethmoid in this form is not considered

* Über das skelet des Tapirus Pinchacus, Inaugural Dissertation, Bonn, 1877.

a valid generic character by most authorities. The absence of a sagittal crest in *Tapirus bairdii* and the molariform structure of the second superior premolar, a character which is found in other species of *Tapirus*, can hardly be considered of generic value.

The relations of the American and European species of fossil tapir have been very fully discussed by Wortman * and Earle, and since their paper was written I have studied the original types of *Protapirus* occurring in the Eocene and Oligocene of France. I see no reason in changing the conclusions stated by these authors. The opinion † has been advanced that the fossil tapir from the Lower Miocene of St. Gérand-le-Puy, in France, was really a species of the American genus *Colodon*. I strongly dissent from this idea, as, after having examined the original type of *Protapirus douvillei*, I can confidently state that it is a true tapir and not very closely related to *Colodon*. Again, *Protapirus priscus* of the Phosphorites belongs in the same genus as the remains of the animal from St. Gérand-le-Puy. As the Phosphorites is 'un grand mélange,' the position stratigraphically of the French species of *Protapirus* is about the same ; the Phosphorites probably including the space of time, between the Upper Eocene, Gypse de Paris, and the Lower Miocene or Oligocene, of St. Gérand-le-Puy. As the evidence now stands I can see no reason for burdening paleontological literature with another new name for the American forms of *Protapirus*.

In my opinion there is ample proof to show that the American genus *Hyrachyus* occurs in the Middle Eocene of France, Argenton. Monsieur Filhol ‡ has described a lower jaw with complete dentition and also isolated upper molars, which agree structurally with those of the typical *Hyrachyus* of the Bridger.

In conclusion I do not see that Mr. Hatcher brings forward any new evidence to prove that the line of the true tapirs was not already in the Middle Eocene, Bridger, perfectly distinct from that of the pseudo-tapirs.

Osborn and Wortman have described the structure of the feet in *Heptodon calciculus* of the Wind River Eocene, and these authors have shown that in *Heptodon* the middle metapodial was already enlarged, as compared with the lateral metapodials, and this increase in size, tending to monodactylism, culminated in the genus *Colodon* of the White River Oligocene.

The ancestral form of the true tapir from the Bridger is not yet clearly made out, as the relationship of the two species of *Isectolophus* to the tapir phylum is rather obscure.

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* Bull. Am. Mus. Nat. Hist., Aug., 1893.

† Bull. Am. Mus. Nat. Hist., Dec., 1895, p. 362.

‡ Mém. sur Lophiodon, Mém. Soc. Géol. de France, 1888, Tome V.

ON THE OCCURRENCE OF TROCHOSPHÆRA SOLSTITIALIS IN THE ILLINOIS RIVER.

This interesting and remarkable rotifer occurred sparingly in collections made at the biological station of the University of Illinois during the months of June, July and August, in the summer of 1896, in the Illinois River at Havana, and in a permanent marsh in the adjacent bottom-lands locally known as Flag Lake. The species was described by Surgeon Thorpe, R. N., from collections made in August, 1892, in a pond near Wuhu, on the Yangstze-Kiang River. As its specific name indicates, it differs from *T. æquatorialis* Semper, in the position of the girdle of cilia. Semper's species, found in 1859 in the rice fields of the Phillipine Islands, was also rediscovered by Thorpe in 1889 in ponds of the Acclimatization Society at Brisbane, Australia. Of its occurrence elsewhere nothing is known. The distribution of this genus, as hitherto reported, is thus clearly antipodal, and its occurrence in our inland waters is, therefore, of more than passing interest.

It is well known that many of our rotifers are cosmopolitan. Thus, at least two-thirds of the thirty-one species reported from Wuhu as associated with *Trochosphæra* are also found at Havana. Again, *Notholca longispina*, originally described by Prof. D. S. Kellicott, from the Niagara River, has since been found to have a wide distribution in Europe; *Rotifer mento* and Anderson, discovered at Calcutta in 1889, was found by Dr. Jennings in 1893 in great abundance in Lake St. Clair. It may then be that *Trochosphæra* also is a cosmopolitan form.

One circumstance, however, seems to militate against this view. *Trochosphæra* was not reported from any one of our 505 collections made from April 1, 1894, to May 13, 1896, in the Illinois River or its adjacent waters. A re-examination of the river collections prior to June, 1896, made especially for *Trochophæra*, has been fruitless. Importation is thus suggested to account for its sudden appearance this year in the river at Havana. Rice straw and bamboo from the Orient were not uncommon at the World's Fair in Chicago in 1893, and it may be that they smuggled in our visitor from China. Mr. Thorpe, in a discussion this year before the Royal Microscopical Society of London, maintained that rotifers, in their distribution, seemed to follow the footsteps of man, and that those found in foreign countries which had been colonized were frequently of the same kind as those of the countries whence the immigrants originally came. He had found, in Australia, for example, "the most abundant material always in ornamental waters in botanical gardens and in the immediate precincts of civilization, and the forms were such as left no doubt that in some way or other they had been introduced by the agency of man, for, as Dr. Hudson had remarked, a foot of salt water was as great a barrier to rotifers as an ocean."

Other agencies than the movements of man are beyond question active in the distribution of these minute members of the aquatic fauna. Their winter eggs are blown about in dust, it may be for considerable distances; or they may take passage on the feet or plumage of water-birds from distant lands. It is therefore but the merest conjecture to attribute the occurrence of *Trochosphæra* at Havana to introduction by man, especially in view of the paucity of information in regard to the minute fauna of our inland waters.

This preliminary note is published in the hope that it may lead to a wider knowledge of the distribution of this interesting member of the river plankton.

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CURRENT NOTES ON ANTHROPOLOGY.

THE ENGLISH 'ROUND BARROW' STOCK.

FEW questions in English archæology are more difficult, and at the same time more important in the light their solution would throw on proto-history, than that relating to the people who built the 'round barrows' or graves. Their skulls are very much alike, highly brachycephalic, the parietal eminences projecting, the glabella and chin prominent.

Mr. C. S. Myers discusses them in an article on some old skulls from Suffolk, in the Journal of the Anthropological Institute, November, 1896. He says they were certainly not the Belgian Celts, as some have maintained. Possibly they were the neolithic Danes. But this only removes the difficulty, because we do not know to what stock these belonged. They might have been a branch of the round-headed 'Celts' of central France, but the cranial type in other respects is not the same.

DISTRIBUTION OF ARCHÆOLOGICAL ARTEFACTS IN AMERICA.

A VALUABLE article by Mr. A. E. Douglass appears in the *Bulletin* of the American Museum of Natural History for October 26th. It explains the arrangement adopted by him for his extensive collection of American aboriginal relics. The aim is "to enable the students to determine with the least labor to what class any object in his possession properly belongs, and, by comparative study, to decide how it was used."

The geographical distribution of the various forms is discussed at length, and presented at the close of the paper in an elaborate table.

Mr. Douglass calls especial attention to the need of a uniform nomenclature for American archæology, and adds, "a point has been reached when this matter could and should be definitely settled," and offers the valuable suggestion that the Anthropological Section of the American Association for the Advancement of Science should appoint a committee for the purpose.

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CURRENT NOTES ON METEOROLOGY.

THE MONTHLY WEATHER REVIEW.

THERE was a time when the *Monthly Weather Review* of our Weather Bureau was anything but an interesting publication, for it contained little besides meteorological summaries and statistics. During the past two years, however, under the editorship of Prof. Cleveland Abbe, to whom meteorology in this country owes so much, the *Review* has taken on more of a popular character, and it now presents every month not only the usual tables and summaries, but a considerable number of longer or shorter papers and notes on different meteorological subjects. These papers come mostly from the professors and observers of the Bureau, although outsiders also contribute. Prof. Abbe himself prepares each month a set of 'Notes by the Editor.' The *Monthly Weather Review*, with the strong backing of the Weather Bureau, is doing successfully a good share of the work which the *American Meteorological Journal* carried on in this country for twelve years and which, as it did not receive sufficient financial support, it was obliged to discontinue last April. The September number of the *Review* presents an unusually large number of interesting articles, and an idea of their scope may be obtained by noting some of their titles and authors, which follow: S. P. Fergusson: 'Kite Experiments at the Blue Hill Meteorological Observatory' and 'A High Kite Ascension at Blue Hill' (an account of the kite work at Blue Hill, already referred to in these notes, which has given a large number of valuable records from the free air at heights up to over 9,000 feet); A. J. Henry: 'Progressive Movement of Thunderstorms;' Julius Baier: 'Low Presure in the St. Louis Tornado' (the readings of an aneroid give 26.94 in., with an uncertainty of .20 in., as the minimum at the center); Robert H. Scott: 'The International Meteorological Conference at Paris;' Prof. C. Abbe: 'Espy and the Franklin Kite Club,' 'Isobars and their Accuracy,' 'The First Attempt to Measure Wind Force' (Sir Isaac Newton, in 1658, determined the force of a gale by jumping in the direction in which the wind was blowing and then in the opposite direction, and measuring the length of the leap in both directions).

CLOUD OBSERVATIONS IN TROPICAL PLANTS.

A RECENT paper by H. B. Boyer, Observer of the Weather Bureau at Key West, Fla., deals with *Atmospheric Circulation in Tropical Cyclones as shown by Movements of Clouds.* The author's main conclusions are as follows: In tropical cyclones, perfectly formed, the currents of the lower cloud level move in a circle, while from the alto-cumulus to the cirrus level the currents diverge from the center, the divergence increasing up to the cirrus clouds, which move directly from the center. If, when within the direct influence of tropical cyclones, it is found that the lower currents do not conform strictly to cyclonic formation, the high-current angles should be used to locate the bearing of the center, for the upper currents are not influenced by local conditions. When the upper clouds show any marked departure from the regular cyclonic current angles, there is little need of apprehending danger from storm winds, for there is then imperfect formation of the cyclone.

KITE METEOROLOGY AND WEATHER FORECASTS.

THAT meteorological observations made in the free air by the use of kites seem destined soon to play an important part in the making of weather forecasts has already been suggested in these notes, and is further indicated in a short paper by Hammon in the *Monthly Weather Review* for August. On August 28th two kites were flown in San Francisco during the prevalence of a moderate west wind (14 miles an hour). After an elevation of 1,000 feet was reached, the kites drifted more and more to the northward. On the next day another ascent was made and the southerly current was met at a height of 1,200 feet. On this day a very marked electrification of the air was noted. During the following night and the succeeding day a general rain fell throughout northern California, the heaviest August rain of which there is record in many places. That the unusual southerly current and the electrification of the air were associated with the rain seems evident.

REPORT OF THE CHICAGO METEOROLOGICAL CONGRESS.

PART III. of the 'Report of the International Meteorological Congress held at Chicago, August 21–24, 1893, under the auspices of the Congress Auxiliary of the World's Columbian Expedition,' has just been issued. Parts I. and II. were published some time ago. It is always a matter of regret that such a publication should be so long delayed, as it loses much of its interest on that account. The Chicago Meteorological Congress, although attended by few persons from this country and by still fewer from abroad, was the means of bringing together a large number of valuable papers, written by the leading meteorologists of the world, on all manner of topics connected with meteorology and related sciences. Our Weather Bureau has had in charge the translation and publication of these articles, and they have appeared as Bulletin No. 11, Parts I., II. and III. The present part contains the papers on climatology and on instruments and methods of investigation, prepared for Sections VII. and VIII. of the Congress.

METEOROLOGICAL WORK IN SOUTHWESTERN RUSSIA.

THE admirable work done during the ten years (1886–1895) in southwestern Russia, under the direction of Dr. Klossovsky, is set forth in a publication entitled *Travaux du Réseau météorologique du sud-ouest de la Russie. Dix Ans d'Existence, 1886–1895.* The activities of this meteorological service have been varied and the results obtained have been of great value. Apart from the regular observations, extended studies have been made of the climate, agricultural and soil conditions, thunderstorms and hailstorms, distribution of rainfall, etc. Dr. Klossovsky's recent map showing the distribution of thunderstorms over the earth's surface is the first of the kind ever published.

NOTES.

WORD has been received of the death, on October 25th, of Dr. Alberto Sanchez, director of the Meteorological and Astronomical Observatory of San Salvador.

A PAPER on Climate was read by Dines before Section III. of the Sanitary Institute, at its meeting at Newcastle-on-Tyne last summer, and has been separately published as a reprint from Vol. XVII., Part III., of the Journal of the Sanitary Institute.

R. DEC. WARD.

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NOTES ON INORGANIC CHEMISTRY.

IN the last number of the *Chemical News*, Prof. Crookes describes an examination of the alleged new element 'Lucium' which was patented by Barrière. The lucium was furnished by M. Barrière, and after both spectroscopic and chemical investigation was found to be impure yttrium. Didymium, erbium and ytterbium were also found to be present, which may account for the atomic weight given for lucium, 104, that of yttrium being 89. Prof. Crookes also worked up a specimen of monazite according to Barrière's patent and found that the 'lucium' obtained was the same impure yttrium.

In the same number of the *Chemical News*, Prof. Fresenius makes a disclaimer of any confirmation of Barrière's discovery of lucium.

THE constitution of the so-called nitrogen-iodid is the title of a paper in the Proceedings of the Chemical Society (London) by F. D. Chattaway. This explosive substance, the exhibition of which is familiar to every student of elementary chemistry, has had several different formulæ assigned to it, but its composition has never been satisfactorily settled, in spite of the numerous chemists who have studied it. The author concludes that it is not a mixture, and that its formula is either NHI_2 or NH_3I_2, most probably the latter, which would make it an additive and not a substitution product. This suggestion appears never to have been put forward before, and accounts well for many of the reactions of the substance.

S. HAGA in the same Proceedings considers how mercurous and mercuric salts change into each other. In general mercuric salts are changed into the mercurous when in contact with mercury and water. Mercurous salts in solution or moist when exposed to strong daylight are dissociated even at ordinary temperature into mercury and mercuric salts. In boiling water the change takes place more readily, the mercury distilling with the steam. Only at a higher temperature than boiling water are mercurous salts oxidized to mercuric, at lower temperatures the change being a dissociation. This would seem to offer an explanation of the darkening which sometimes takes place in calomel. Exposed to sunlight when slightly moist it would dissociate into mercury (occasioning the darkening) and corrosive sublimate. Old calomel is sometimes considered to be dangerously active. The physiological action of calomel would also seem to be due, not to an oxidation to the bichlorid, but to a slow solubility of the calomel in the fluids of the stomach and intestine.

J. L. H.

PSYCHOLOGICAL NOTES.

THE January number of the *American Journal of Psychology* will contain a characteristic and very interesting article by President G. Stanley Hall entitled 'A Study of Fear.' President Hall sent out from Clark University thirty-two questionnaires relating to the child's mind and its development, and has secured in answer to these an enormous mass of material. He has worked over the data of one of the syllabi only, that concerned with fear, and though the exposition is condensed it will occupy one hundred large pages. Psychology may have been lacking in concrete facts until recently, but now it seems in danger from a plethora of facts. The nearly 2,000 people who have sent in returns have described 6,456 fears. It seems that thunderstorms are feared most frequently and next reptiles; then follow strangers, darkness, fire and death. Boys report on the average 2.21 fears, while girls report 3.55. There is an increase in the number of fears up to the age of fifteen for boys and up to the age of eighteen for girls, but this is probably due to fuller descriptions from those who are older. President Hall classifies the kinds of fears, and under each heading gives a number of examples followed by a discussion. Some of the fears, such as those connected with high places, with loss of orientation and with being shut in, are psychologically of much interest. President Hall adopts an extreme genetic standpoint. He holds that "the conscious ego is but a very inadequate and partial manifestation of the soul, that it is a feeble, flickering taper in a vast factory full of machinery and operatives, each doing its work in unobserved silence." Instinct is much older than intelligence; it is inherited not only from our anthropoid ancestors, but from remotest times, associated with the persistency of cells or protoplasm rather than with a developed nervous system. The fear of high places, President Hall thinks, is a vestigal trace, like the gill slits under the skin of our necks, antedating limbs and inherited from our swimming and floating ancestors. It would be difficult to disprove President Hall's theory, but it does not seem to follow from his facts. Many prevalent fears, as of weather and serpents, are not in accord with our urban civilization, but I doubt if they will persist a century hence, let alone through millions of years. The three children of which the present writer knows most have not shown the slightest fear of thunderstorms, and had to be taught to fear snakes owing to the presence of poisonous species. Fears of death, of disease and of the end of the world are among the common ones, and these are not inherent in protoplasm. Children undoubtedly show instinctive fears, but I believe that most of their fears are learned and not inherited.

The forthcoming number of *The Psychological Review* will contain an experimental study of the physiology and psychology of the telegraphic language, by Prof. W. L. Bryan and Mr. Noble Harter, of Indiana University. Mr. Harter is himself an expert telegrapher, and has examined the methods and results of several hundred operatives, making special experiments on a large number. The highest sending record so far as known is forty-nine words per minute, by the Morse code, which would be about eight taps in each second. With those unskilled the ability to send is greater than the ability to receive, but with experts the reverse is generally the case. Twenty to twenty-four words of four letters each may be taken as an ordinary rate. Elaborate curves are given in the paper showing improvement with practice week by week. The sending curve rises more rapidly and more uniformly than does the receiving curve from the beginning of practice to the learner's maximum ability. The receiving curve rises more slowly and irregularly and shows a failure to rise for several months in two places. The curves may represent the rate of other acquisitions and show interesting differences between motor and apperceptive processes. Each operator has an individual language and none conforms exactly to the type. In order to appreciate the extensive results and many inferences drawn from them the reader must refer to the paper which is a contribution of value to the motor problems now prominent in psychology.

WHILE experimental psychology has been successful in extending its work from sensation to movement, it has found great difficulty in devising suitable experiments on the feelings. We may, therefore, welcome a paper by Prof. Joseph Jastrow, which will appear in the January number of the *Popular Science Monthly*, entitled 'The Popular Æsthetics of Color.' At the Columbian Exposition Prof. Jastrow arranged a psychological laboratory and many visitors were tested. The results have not yet been published, but the preferences of 4,500 people for color were separately determined, and these have now been collated with interesting results. J. McK. C.

SCIENTIFIC NOTES AND NEWS.

PROF. G. SCHIAPARELLI, the Italian astronomer; Prof. A. Heim, the Swiss geologist; Prof. G. Lippmann, the French physicist, and Prof. G. Mittag-Leffler, the Swedish mathematician, have been elected foreign members of the Royal Society.

THE subject of the lecture by Mr. Alexander Agassiz before the American Society of Naturalists will be 'Methods and Problems of Deep Sea Investigation.'

DR. FRITZ WESTHOFF, docent in zoology in the Academy at Münster, died on November 12th at the age of forty years. He had published several works on the natural history of Westphalia. Dr. Strauss, professor of pathology at the Paris Medical School, known for his writings on tuberculosis and cholera, has died at the age of fifty-one. Dr. Ernst Engel, formerly director of the Prussian Statistical Bureau, has died at Lössnitz at the age of seventy-six. The death is also reported of M. Alfred Nobel, the inventor of dynamite.

LORD RAYLEIGH and Prof. W. Ramsay have been elected corresponding members of the Berlin Academy of Sciences.

THE celebration of Lord Kelvin's jubilee as professor of natural philosophy in the University has been followed, says the *Lancet*, by the recognition of his jubilee as a member of the Glasgow Philosophical Society. The society have presented Lord Kelvin with an address and elected him an honorary member. A bust, subscribed for by the members, has been placed in the Society's rooms and a replica presented to Lady Kelvin. The proceedings in connection with these events were presided over by Dr. Ebenezer Duncan, the president of the Society, and the address was read by Dr. Freeland Fergus, the honorary secretary.

A MONUMENT in honor of the engineer Grashof was unveiled at Karlsruhe on October 26th. An address was made by Prof. J. Hart, giving an account of Grashof's contributions to Science.

THE annual *Fest Sitzung*, of the Munich Academy of Science was held on November 14th. Prof. Walther Dyck made an address on the relations between pure and applied mathematics.

THE German Geographical Congress will hold its eleventh meeting at Jena on April 21st, 22d and 23d. Among the subjects proposed for discussion are polar investigations, physical questions (earthquakes, etc.), biological geography, the topography and natural history of Thuringia, and the teaching of geography in schools.

THE celebration at Lisbon of the fourth centenary of the discovery of the maritime route to India, by Vasco da Gama, has been postponed from July, 1897, the anniversary of his sailing from Lisbon, until May, 1898, the anniversary of his arrival at Calicut.

UNDER the auspices of the Academy of Science, Letters and Arts of Rovereto, a committee has been appointed which is making arrangements to celebrate at Rovereto, in the spring of 1897, the centenary of the birth of the eminent philosopher, Antonio Rosmini.

THE *Lancet* states that there will be held in Berlin in October, 1897, a conference of delegates of different Governments to discuss the steady increase of leprosy and the apparent failure of all measures to check this plague. The date of the conference had been fixed for the month of March, but Prof. Koch's absence necessitated a postponement, it being decided to await his return. The organizing committee comprises the following names: A. Hansen, Bergen, Norway; Robert Koch and O. Lassar, Berlin, and Edward Ehlers, Copenhagen (secretary).

At the 111th meeting of the American Institute of Electrical Engineers, held at New York on December 16th, a discussion on the Röntgen rays was opened by Prof. Rowland.

The American Historical Association holds its twelfth annual meeting at Columbia University, New York, December 29th–31st.

It is proposed, says *Nature*, to hold an international electrical exhibition at Turin in 1898. The Executive Committee and the Special Commission invite exhibits from all parts of the world, and the exhibition will comprise the following classes: (1) Apparatus for teaching electro-technics; (2) materials for the conduction of electricity; (3) instruments for electric and magnetic measurements; (4) telegraphs and telephones; (5) signalling apparatus and safety appliances on railways, lighting and heating of carriages; (6) dynamos and motors; (7) mechanical appliances and electric traction; (8) electric lighting; (9) electro-chemistry and electro-metallurgy; (10) miscellaneous; (11) apparatus of historic interest. Signor Galileo Ferraris has been appointed President of the Commission.

The College of Physicians of Philadelphia announces that the next award of the Alvarenga Prize, being the income for one year of the bequest of the late Señor Alvarenga, and amounting to about one hundred and eighty dollars, will be made on July 14, 1897, provided that an essay deemed by the Committee of Award to be worthy of the prize shall have been offered. Essays intended for competition may be upon any subject in medicine, but cannot have been published, and must be received by the secretary of the College on or before May 1, 1897.

The Walsingham gold medal, Cambridge University, has been awarded to W. McDougall, B. A., of St. John's College and St. Thomas's Hospital, for original researches in physiology.

We learn from *Natural Science* that a memorial statute to Dr. H. Burmeister is being erected by subscription in Buenos Ayres to commemorate his long and important services to science, and especially to the National Museum. The Argentine government is said to have refused permission for it to be set up in a public place, because Dr. Burmeister was a foreigner, and it will occupy a position in the hall of the University.

It is reported that Mrs. H. M. Converse, of New York City, will present to the State Regents Department, Albany, her fine collection of Indian relics. The State Legislature last winter appropriated $5,000 to classify and arrange the relics now in the State Museum.

Col. Coleridge Grove has given the Royal Institution, London, a bust of his father, the late Sir William Grove.

Nature quotes from the *Daily Chronicle* news of a meteorological observatory to be placed by Italian men of science on the summit of Monte Rosa. Queen Margherita, herself an expert mountaineer, supports the project by a donation of 160*l.*, the Duke of the Abruzzi gives 200*l.*, and the Italian Alpine Club, the Ministers in their private capacity, and the physical faculty of the University of Turin, figure among its chief contributors. It is intended to utilize the hut on the Gniffetti peak, built three years ago as a shelter for climbers. Situated at a height of about 14,000 feet above sea-level, the observatory will, as regards elevation, rank fourth among the twenty-seven mountain observatories of the world, being surpassed in altitude only by those of Arequipa, Mont Blanc and Pike's Peak.

Cablegrams to the daily papers report earthquake shocks throughout Great Britain occurring at 5:30 a. m. on December 17th. The shocks lasted from 4 to 30 seconds and are said to have been the most violent experienced in England.

The Association of American Steel Manufactures, at a meeting held in New York on October 23d, adopted resolutions endorsing the decimal system as the proper standard for measuring all materials. The British Chamber of Commerce of Alexandria are unanimously of the opinion that it would be an advantage for commerce with Great Britain, should the metric system be adopted by that country.

THE *Medical Record* states that Dr. Luys, of the Salpêtrière Hospital, Paris, has presented the Faculty of Medicine with his collection of twenty-two hundred brains, carefully prepared and catalogued. The collection is the result of thirty years' investigations, and includes the brains of idiots, of blind persons, of persons who had undergone amputation, and of those who had suffered from various forms of mental disorders.

BY a vote of 196 to 41 the congregation of Cambridge University passed a grace, on December 10th, setting aside a portion of the Downing College site, recently acquired by the university, for the Sedgwick Memorial Museum.

PROF. ANGELO HEILPRIN will contribute to the January number of *Appleton's Popular Science Monthly* a summary of our present knowledge of the Antarctic region, with a sketch map giving the more important points that have been named by navigators.

A PRELIMINARY meeting, with the object of founding a memorial to Edward Jenner, was held at St. George's Hospital, London, on December 7th, under the presidency of Sir Joseph Lister. According to the report in the London *Times* the chairman said that it was hardly creditable to England that, while other nations were in different ways celebrating the centenary of Jenner's great discovery, we in his own country should not be doing so in any adequate manner. It had been suggested that the statue of Jenner in Kensington gardens might be moved to the open space in front of the hospital, to correspond with the Wellington statue. The cost would be very slight in comparison with the funds which they might fairly hope to collect. The Bishop of Rochester, in moving "That the present year, being the centenary of the first successful vaccination, is a proper time to inaugurate a work of national utility in honor of Edward Jenner," said that it was a matter of general human and national concern, and if there was any profession which was bound to seize opportunities of going along with the medical profession in a matter of that kind it was the profession to which he belonged. The resolution was carried after speeches from Lord Reay, Sir R. Quain and Prof. M. Foster. Lord Glenesk moved "That a subscription be set on foot with the view of founding some institution, of a nature to be hereafter determined, in connection with the British Institute of Preventive Medicine, to be distinguished by Jenner's name." The resolution was supported by a number of speakers and the nature of the memorial was discussed. It was finally decided that a public meeting be called early in 1897 to decide on the form of memorial.

WE quoted recently from an article by Prof. D. T. MacDougal, recommending the establishment of an American tropical laboratory for botanical research. The last number of the *Botanical Gazette* also urges in an editorial article the establishment of such a laboratory. It is suggested that this might be accomplished most easily by the cooperation of several universities. "Perhaps the original cost should be borne by private subscription, and the running expenses met by the different universities pledging themselves for so many tables. At least the subject deserves to be taken in hand by a committee of botanists and investigated in all of its bearings. A study of the map will show that the conditions to be met favor either the east coast of Mexico or the islands near the Caribbean Sea. It is estimated that a trial station might be maintained on one of these islands for one year at a cost of $5,000; and after the selection of a permanent station the laboratory buildings might be constructed and extended according to the demand. The use of grounds necessary could be obtained from the government, and the area should embrace all levels so far as possible, a feature at Buitenzorg which is nearly ideal. It is to be hoped that a reconnoissance party of American botanists will soon visit the region proposed and report as to possible sites. Such a visit should be made before the botanical meetings of next summer, to which the report would be most appropriately made."

AMONG the lectures to be given during the winter at the Royal Institution are the following: Prof. Augustus D. Waller, twelve lectures on 'Animal Electricity;' Prof. Henry A. Miers, three lectures on 'Some Secrets of Crystals;' Dr. J. W. Gregory, three lectures on 'The

Problems of Arctic Geology;' Prof. W. Boyd Dawkins, three lectures on 'The Relation of Geology to History;' Mr. Walter Frewen Lord, three lectures on 'The Growth of the Mediterranean Route to the East,' and Lord Rayleigh, six lectures on 'Electricity and Electrical Vibrations.' The Friday evening meetings will begin on January 22d, when a lecture will be given by Prof. Dewar.

According to a note in *Natural Science* the report of the trustees of the Australian Museum, Sydney, is chiefly remarkable for the record of 2,231 mollusca added to the collections in 1895. Among the donors, the chief was Mr. W. A. Horn. A large collection of fossil Bryozoa was presented by Mr. R. Etheridge, jr. The usual want of funds has prevented the trustees from acquiring many specimens of great value, and this same want has seriously stopped collecting work, from which alone one can acquire duplicates to exchange with other institutions. One of the most important acquisitions during the year was one of Captain Cook's original MS. journals, the Log of the 'Endeavor,' presented by Mr. F. H. Danger. A curious and unfortunate event was the destruction of the entire roof over the central part of the main building by white ants. This had to be shored up immediately on discovery, and the erection of a new roof will at once be proceeded with.

In a recent issue *Nature* gives a detailed account of the report of the royal commission on vaccination. As to the effect of vaccination in reducing the prevalence of, and mortality from, small-pox, they conclude: (1) that it diminishes the liability to be attacked by the disease; (2) that it modifies the character of the disease, and renders it (*a*) less fatal, and (*b*) of a milder or less severe type; (3) that the protection it affords against attacks of the disease is greatest during the years immediately succeeding the operation of vaccination. It is impossible to fix with precision the length of this period of highest protection. Though not in all cases the same, if a period is to be fixed, it might, we think, fairly be said to cover in general a period of nine or ten years; (4) that after the lapse of the period of highest protective potency the efficacy of vaccination to protect against attack rapidly diminishes, but that it is still considerable in the next quinquennium, and probably never altogether ceases; (5) that its power to modify the character of the disease is also greatest in the period in which its power to protect from attack is greatest, but that its power thus to modify the disease does not diminish as rapidly as its protective influence against attacks, and its efficacy during the later periods of life to modify the disease is still very considerable; (6) that re-vaccination restores the protection which lapse of time has diminished, but the evidence shows that this protection again diminishes, and that, to ensure the highest degree of protection which vaccination can give, the operation should be at intervals repeated; (7) that the beneficial effects of vaccination are most experienced by those in whose case it has been most thorough. We think it may fairly be concluded that where the vaccine matter is inserted in three or four places it is more effectual than when introduced into one or two places only, and that if the vaccination marks are of an area of half a square inch they indicate a better state of protection than if their area be at all considerably below this."

UNIVERSITY AND EDUCATIONAL NEWS.

Dr. E. N. Potter has resigned from the presidency of Hobart College.

Dr. W. E. Castle has been appointed instructor in biology in Knox College, Galesburg, Ill.

Dr. F. B. Peck has been made associate professor of geology and paleontology at Lafayette College.

Dr. G. A. Tawney, assistant in Princeton University, has been appointed to the chair of philosophy in Beloit College, vacant by the death of Prof. Blaisdell.

At Cornell University an Oliver Graduate Scholarship in Mathematics, of the annual value of $300, has been founded in memory of James Edward Oliver.

The number of students registered in the College of Physicians and Surgeons, Columbia University, up to November 1st, were 625, of whom there are in the first year 279, in the second year 158 and in the third year 147. There will be no regular class graduated this year, it being the first in which the four years course has taken effect. The temporary decrease due to the lengthening of the course has this year been made up, and next year with the four classes the attendence will be very large.

THE Cornell University Register for 1896–7 has already been issued ; it shows a registration of 1763 compared with 1684 at the same time last year, this being the largest registration hitherto recorded. The faculty also shows an increase, the total number of instructors now being 175. The Library records a gain of 12,890 books and 1200 pamphlets since last year.

AT Cambridge University Dr. L. E. Shore, of St John's College, has been appointed a university lecturer, and Mr. Eichholz, of Emmanuel College, an additional demonstrator in physiology.

MISS KNIGHT, M. B. Lond., has been appointed professor of anatomy and pathology to the Lhudiana Medical School, North West Provinces, India.

THE eighth University Extension Summer Meeting will be held at Oxford, July 31–August 25, 1897.

DISCUSSION AND CORRESPONDENCE.

THE JURA IN THE UNITED STATES.

'THE Jurassic formation on the Atlantic Coast' (SCIENCE, Dec. 1, pp. 805–816) is the most important paper on practical geology and classification published yet by Prof. O. C. Marsh. The conclusions arrived at are excellent, and the proofs given, although necessarily summary, are sufficient to warrant the exactness of the classification of the Potomac formation as belonging to the Upper Jura.

A few remarks on the history as well as on the geologic chronology may be acceptable, for, without detracting anything from the merit and great value of the memoir of Prof. Marsh, some points can be rendered more clear and easily understood, at the same time more exact.

We read : "Until a comparatively modern date, this supposed absence of Jurassic deposits was thought to be true, also, for the rest of this country. I well remember the parting advice given me by an eminent professor of geology, with whom I studied in Germany (Ferdinand Romer), 'The first thing you should do on your return to America is: look for the Jurassic formation. I am sure it is there ; full of fossils.' " (SCIENCE, p. 805.) The choice of Ferdinand Romer as an adviser on the Jurassic formation in America is unfortunate, for Prof. F. Romer, during his stay in Texas, remained several months at Fredericburg, which lay on the Jurassic formation ; besides he explored, in some detail, the valley of the Trinity River, where the Jura exists also, and not only did he not recognize the Jurassic formation in Texas, but by a wrong determination of a *Gryphoa*, which he identified with the *Gryphea Pitcheri*, he helped greatly the confusion created a few years later by a paleontologist who denied the existence of the Jurassic deposits of New Mexico, near the Texas line, made in 1853, by the geologist of the Pacific Railroad exploration by the thirty-fifth parallel of latitude, commanded by Lieutenant A. W. Whipple. As Prof. Marsh says, "Ferdinand Romer added much to our knowledge of the geology and paleontology of this country," for he published the first essay of a geological map of Texas in 1849, and three volumes of paleontology on Texas and Tennessee in 1852, 1860 and 1889 ; but at the same time it is important to notice that he did not recognize in Texas the Permian, the Trias nor the Jura ; and as to the Cretaceous he failed to recognize the Lower Cretaceous, or Neocomian, going so far in his erroneous determination of age of strata as to place the Lower Cretaceous above the Upper Cretaceous, or Chalk. It is impossible to say that Romer was a good practical geologist when in the field in an unexplored country ; but as a paleontologist he was more successful, although he made conspicuous errors, and displayed a want of knowledge in ignoring the Primordial fauna of Texas, which he referred to the second fauna.

The figure 1—'Geological Horizons of Vertebrate Fossils' (SCIENCE, p. 806), is rather incomplete in some important points ; for instance, the Cretaceous beginning with the 'Dakota group,' which truly is only the lower division of the Upper Cretaceous, or true Chalk, and the Lower Cretaceous, or Neocomian, so well developed in Texas (Comet Creek, Fort Washita, Comanche, etc.), is completely ignored. By *contra*, Prof. Marsh places the Laramie series in the Cretaceous. As he says, "that vertebrates afford the most reliable evidence of climate and other geological changes," it is somewhat surprising to see him put aside the beautiful discovery of an important and rather rich vertebrate fauna near Reims, in France, by M. le Docteur V. Lemoine, at Cernay and Aï, or Ay, in Champagne, absolutely identical as regards the forms and genera with what Prof. Marsh has imprudently called 'a Cretaceous Mammalian fauna' in the Laramie formation, showing 'how difficult it is to lay aside preconceived opinions,' according to his own phraseology. The Cernayrian fauna, as it is called by Dr. Lemoine and Prof. Gaudry, is Tertiary * and not Cretaceous.

The stratigraphic position of the first mammal *Dromatherium* in the Trias, according to Fig. 1 of Prof. Marsh's paper, is contrary to the opinion of the discoverer, Dr. E. Emmons, who has always referred it to the Permian, for he finds it far below the true Trias of North Carolina and Virginia.

Prof. Marsh insists on the variety of colors in the plastic clays of the Jura at Gay Head, in the Maryland, Wyoming and Colorado, saying: "Brilliant red, green and yellow tints are especially prominent, yet the white and black shades are equally noticeable" (SCIENCE, p. 812). This is very true and I saw the same striking colors in New Mexico, calling attention, as far back as 1853, to the colors of the sandstone with a remarkable yellow-citron tint and the brilliant white of other beds of sandstone at Tucumcari, Cañon Blanco and Laguna Colorado, and the blue of the *Gryphea Tucumcarii* marls at Pyramid Mount.

* SCIENCE, p. 835, in 'Scientific Notes and News,' we read that Dr. Lemoine has exhibited photographs obtained by Röntgen's rays, of fossils embedded in the *chalk* strata of Reims. The error of calling the strata near Reims, at Cernay and Aï in which Dr. Lemoine has collected fossil bones of mammals, birds and reptiles is difficult to understand, for he called them, not *chalk*, but *Tertiary* or *Lower Eocene* (*Bull. Soc. Géol. France*, 1 Nov., 1896, pp. cxciii–cxcv).

In regard to early investigations, Prof. Marsh has the kindness to recall my contribution of 1853 in the Rocky Mountain region, when I found the Jura at the Tucumcari Mounts, Cañon Blanco, Laguna Colorado, and in the vicinity of Zuni (New Mexico and Arizona), in 1853, the Jurassic formation had not been truly recognized yet in North America, for the only indication of Prof. W. B. Rogers of the Oolitic age for the coal of the vicinity of Richmond, Virginia, was proved as early as 1849, as belonging truly to the Trias and not to the Jura.

Prof. Phillip T. Tyson, of Baltimore, after referring the red plastic clay of Maryland first to the Cretaceous in 1860, changed his view in finding specimens of *Cycadea*, and in 1862 called it Jurassic. In 1863 I saw the same formation in the vicinity of Washington and did not hesitate to call it Jurassic; but I published nothing about it, until 1888, in my paper 'American classification and nomenclature,' pp. 36–37, Cambridge, saying: "During the Civil War (November, 1863), when visiting some friends in camp around Washington, I was shown a fossil 'pineapple' found on the farm of Dr. Jenkins, one mile south of the Baltimore and Washington railroad, sixteen miles from Washington, Prince George County, Maryland. I recognized at once a well preserved Purbeck's *Cycadea* and referred the red and gray mark, in which it was found in company with pieces of petrified wood and broken pieces of indeterminable bones, to the Purbeck formation of England. The little of what I saw there reminds me of the Purbeck group, as I saw it at Portland Island and Durlstone Bay, near Weymouth, England, where so many specimens of mammalia (marsupial), reptiles, birds, turtles, fishes and *Cycadea* have been found in its celebrated 'dirt bed.'

"Lately the United States Geological Survey have called those white, red and bluish gray clays and sands *Potomac formation.* It is a fresh water deposit contemporaneous with the Purbeck strata of Swanage and vicinity, Dorsetshire, England, which represent in North America that most important upper part of the Jurassic system called now on the continent of Europe the *Purbeckian.*" So the Potomac formation as defined by the United States Geological Survey was referred as far back as 1888, as Jurassic formation.

JULES MARCOU.

CAMBRIDGE, MASS., December, 1896.

SOME NEURAL AND DESCRIPTIVE TERMS.

TO THE EDITOR OF SCENCE: In a recent circular asking the opinions of experts as to the prevailing and preferred usage of anatomic and neurologic terms in behalf of the projected Dictionary of Philosophy and Psychology, Dr. C. L. Herrick mentions certain terms and principles which have been either proposed or adopted by me.

But for the request to 'respond as early as possible,' I should suggest that replies be either delayed or regarded as provisional until after the appearance of my paper, 'Neural Terms, International and National,' *Journal of Comparative Neurology*, VI., pp. 216–340, December, 1896), wherein the general subject is discussed at length, and in parallel columns are given the neuronyms adopted by the Anatomische Gesellschaft in 1895 and those now preferred by me. But for the remoteness of Dr. Herrick's present address the following comments would be submitted to him first.

3 (b). For the part now called by the Gesellschaft 'Subtantia perforata lateralis' I formerly proposed *præperforata*, but since 1889 have employed *præcribrum*.

4 (e). *Metencephalon*, as employed in the last three editions of 'Quain' and adopted by me in 1881, designates the last definitive encephalic segment, *i. e.*, between the cerebellar segment (our epencephalon) and the myelon or spinal cord. As given in the circular it has two other usages, viz., either for the cerebellar segment alone (His) or for both regions (some authors). The encephalic segments will form the subject of a paper at the coming meeting of the Association of American Anatomists.

(g). *Metencoele* is doubtless a misprint for *metacoele*. The Latin (international) forms are *metacoelia* and *mesocoelia*; the national English forms *metacele* and *mesocele*.

(j). As to *Neuron* (proposed by me in 1884 as a mononym for *axis cerebro-spinalis*) see 'Reference Handbook, IX., 100, and *Proceedings Assoc. Amer. Anat.*, 1895, 44–45. Indirect endorsement of it is contained in such compounds as *neuromere*, *neurenteric*, etc. It like manner *myelencephalon* (for either the entire cerebrospinal axis or for the last encephalic segment) embodies indirect endorsement of *myelon* for *medulla spinalis*.

As to *cephalic* and *caudal*, *cephalad* and *caudad*, during an experience of sixteen years no actual instance of misapprehension has been observed. But since they evidently are not acceptable to some, might not the increasing employment of *præ* and *post* in composition with the force of adjectives, justify taking these prepositions as the bases of adjectives, viz. *præalis*, *postalis*, England, *præal* and *postal*; adverbs, *præad* and *postad*. As mere vocables the last two are no more objectionable than *quoad*. Classic precedents for the derivation of adjectives from prepositions or adverbs are *contrarius*, *extraneus*, *proprius*, *crastinus*, *pristinus*, *interior*, *supernus*, and ἀηώτερος.

BURT G. WILDER.

ITHACA, N. Y., December 19, 1896.

SCIENTIFIC LITERATURE.

CARL VOGT.

La Vie d'un Homme, Carl Vogt. Par William Vogt. Avec deux portraits par Otto Vautier. Paris, Libraire C. Reinwald; Stuttgart, E. Nägele. 1896. 4°. Pp. 265.

The life of this well-known naturalist was stormy and eventful, in a degree momentous to science, and also to the political and philosophical history of his time. His son has given us a vivid portrait of an interesting character—a very positive one—who, besides leaving his imprint on the science of his day, was in some respects a many-sided man, not only being an eminent investigator, a teacher, a founder of scientific societies, a popular lecturer, a brilliant caustic writer and controversialist, but also a man of great public spirit, an active republican, almost a revolutionist, protesting and fighting during the middle of this century for right and justice against the ultra-conservative, reactionary forces in State and Church.

Carl Vogt was born in 1817 at Giessen. He was by extraction a Celt, rather than a German, and this may account for his turbulent, combative, revolutionary nature, while his protesting spirit and rebellion against the theological trammels of his time betray an infusion of German blood. His materialism he inherited from his father, and the son never deviated from the anti-theological training received under the paternal roof. His biographer writes from the same ultra-materialistic point of view, one scarcely justified in these days of broader and more liberal thought.

Vogt entered the laboratory of Liebig at Giessen, in what year his biographer does not state. Here he began his life-long friendships with Woehler, Bunsen, Hofmann, Kopp, Keculé and other chemists. His first scientific paper (1837) gave the results of a comparative analysis of the water of the amnion at different periods of fœtal life. His father, disgusted with the narrow governmental restrictions of the Grand Duke of Hesse, moved to Berne. Meanwhile at Geissen Vogt had concealed an insurgent in his room, thus risking the penalty of five years' imprisonment in a fortress. The young medical candidate escaped to Strasburg, where he soon neglected medicine and politics, devoting himself to zoology and paleontology. He then studied physiology with Valentin, and thus took his doctor's degree at the age of 21. In this year (1839) his first zoological paper, on the nervous system of Python, appeared.

Meanwhile Agassiz, already distinguished, went in June, 1838, from Neuchâtel to Berne to confer with Prof. William Vogt, the uncle of Carl, who recommended as his assistants Desor and Vogt. The former was at once invited to Neuchâtel, his comrade Vogt joining him a few months after. At this time, as is well known, Vogt wrote the 'Embryogenie et Anatomie des Salmones,' a masterly work. Here Agassiz, '*le chef inconteste*,' worked, housing, clothing and feeding his suite of proletariat collaborators, in the fashion so well known to all the world.

During this life of plain living and high thinking at Neuchâtel, from 1839 to 1844, Vogt published numerous memoirs. He also formed one of the rare spirits who tabernacled for the four summers of 1839 to 1843 on the glacier of the Aar, in the famous *Hôtel des Neuchâtelois*, 8,000 feet above the level of the sea. Here, as Blanchard wrote :

"*Agassiz ne perd jamais sa bonne humeur. Desor s'abandonne volontiers à la plaisanterie, Carl Vogt, toujours petillant d'esprit et capable de mettre en gaieté une assemblée de Trappistes, ne laisse à personne le droit de s'ennuyer.*"

For his gruff but hearty manner, Vogt received the nickname of 'Mutz,' or the bear of Berne.

In 1841, at the meeting of the German naturalists, Vogt supported, against Van Buch, the new theory of Venetz, Charpentier and Agassiz on the former extension of glaciers, and the next year appeared his *Im Gebirg und auf den Gletschern.*

In 1844 we see Vogt at Paris living in the room on the fourth story once occupied by Von Baer, his fellow lodger being Quetelet. They attended the lectures of Arago, Milne-Edwards, Brongniart and Leverrier, his evenings being passed with his fellow students Doyère, Quatrefages, Charles Martins, Bertrand, Sainte-Claire Deville, Würtz, Dumas, Vulpian, Broca and others destined to become distinguished in science and literature.

The three years spent in Paris were busy, prolific, fecund. His vacations were spent partly at St. Malo, where he worked on the embryology of gastropods ; other summers were spent in Brittany, in the Black Forest and in the Vosges, and a winter in Italy; afterwards he worked at Nice, and finally at Villefranche. In 1846 appeared his Lehrbuch der Geologie und Petrefactenkunde, which went through five editions; discarding the theory universally held as to the molten interior of the earth, Vogt boldly claimed that the heat was due to metamorphism.

The Physiologische Briefe (1847), in two volumes, with its audacious views and uncompromising materialism, its caustic irony and thrusts at everything venerated by the clerical circles, made a great stir. It was widely read in the German universities and translated into various languages. It treated, for the first time, of the embryonic development of the human body, showing to the laity that man's development is like that of the brutes. Vogt's famous definition of thought has scarcely yet ceased to be criticised and execrated in some quarters. He wrote : "*Toutes les proprietés que nous desig-*

nons sous le nom d'activité de l' âme, ne sont que les fonctions de la substance cérébrale, et pour nous exprimer d' une façon plus grossière, la pensée est à peu pres au cerveau ce que la bile est au foie et l' urine au rein. Il est absurde d' admettre une âme indépendante qui se serve du cervelet comme d'un instrument avec lequelle travaillerait comme il lui plait."* But, through Du Bois-Reymond, many have been led to believe that it has a basis of truth, and now nobody is shocked, it may serve as a working hypothesis for the psychologist. Its lack of reserve on philosophical and theological points, its outspoken denial of the immortality of the soul, and other rude and unnecessary thrusts at what was and is held dear by all Christendom, led to the general condemnation of the book.

As late as 1875 the Bishop of Orleans, criticising the review of the French translation of this book, claimed that the 'honteuses et funestes doctrines' expressed in it afforded a basis for the revival of communism in Paris. Even on May 8, 1895, a French Catholic writer ranked Vogt as a moral monster, even claiming that he was as bad as some of the noted murderers of the age.

He also horrified all Europe in another way. Up to 1848 custom demanded the use of the razor. Vogt was the first man in Germany to wear a beard.

He applied for the professorship of zoology at Giessen, the place of his birth, for which he was warmly recommended by Arago, Agassiz, Liebig and others, and despite the detraction and gossip of his opponents he was elected. He arrived at Giessen in April, 1847. The opening address of the new professor electrified the students, who were struck, as his biographer says, by the elevation of his instruction, the ascendency of his amiable spirit and his simple unpretending manner. He had added the last details to the construction of a laboratory of zoology when rumors of the revolutionary movements of 1848, which shook the continent to its foundations, spread through the country and entered the university town of Giessen. Vogt was a republican, but not of the red shade of the French school. He detested Robespierre and his allies. In later times he showed no sympathy with socialists or anarchists. He simply strove for freedom of thought and for justice to the middle classes, such as is now enjoyed, and opposed the reactionary spirit of the wealthy aristocratic and ultra-clerical circles. He was sent to the Parliament and directed the radical left. His polemical spirit, his incisive, caustic raillery, with his persuasive eloquence, his sincerity of conviction and his civic courage, coupled with his lack of pessimistic spirit, made him conspicuous and obnoxious. He was, in consequence of the rising of the republican element, of which he was a natural leader, unseated from his chair at Giessen, in which he was succeeded by R. Leuckart, the 'Nestor of German zoology,' now the distinguished teacher of so many distinguished zoologists at Leipzig. He fled with other refugees to Switzerland, settling down at Berne, but soon went thence to Nice and resumed his former quiet life as an investigator and writer. In 1851 he translated the 'Vestiges of Creation.' The '*Recherches sur les Siphonophores de la mer de Nice*' appeared in 1852.

This volume with his embryology of the salmon, placed him in the first rank of gifted investigators, such as Huxley, Kölliker, Leuckart, Gegenbaur and Milne-Edwards. His sketches were beautifully drawn, his talent for observation had now greatly developed and matured, and his views were original. Meanwhile, he put out a popular work, characterized as before by a trenchant, iconoclastic, uncompromising hostility to the prevailing philosophy and theology. His *Recherches sur les Colonies Animales*, a philippic bristling with political illusions, was placed on the index by the Prussian government, and a writer of the day, on account of the 'hercsies and blasphemies of this frivolous and trivial book,' stigmatised it as 'an eternal stain on the zoological literature of Germany.' One of his most successful and widely read books was his '*Zoologischer Briefe*,' sent to the printer in 1851.

*This expression is substantially in Cabanis, who says: The brain produces 'la sécrétion de la penseé (Rapports du Physique et du Moral de l' Homme, Paris, 1844, p. 138). See Lange, ii., p. 312, foot-note, who adds, the editor, L. Peisse, remarks on it: 'Cette phase est restée célèbre.'

Like his other books the style is clear, forcible, piquant, sometimes highly colored, but solid in its facts.

After his acceptance of the chair of geology and zoology at Geneva, which he was at first unwilling to take, Vogt rendered, besides his academic work, public services to his adopted country, aiding with his geological knowledge in the building of railroads, reporting on the geology of the Credo tunnel. He was a member of the Grand Council of the Canton of Geneva from 1856 to 1862, and at other periods until 1880, and of the National Council from 1878 to 1881, and showed his public spirit in other ways, at times when the calm of public life was not always serene and perfect.

His ability and foresight as a man of affairs of the liberal or even radical school, is shown in his open letter in 1859, when he demanded the freedom of Italy and of Hungary, and the unity of Germany. Again, after the Franco-German War of 1870, he suggested that as a means of lasting peace Alsace be given up to the French, truly a statesman-like proposition.

With Sars, Agassiz and Quatrefages, Vogt was one of the first to study living animals at the seashore in an improvised laboratory ; but while at Villefranche, in 1850, working on the Siphonophores, he insisted on the importance of laboratories of marine zoology, and the part they should take in the progress of this science, and brought all the influence he could to bear on the Minister of Public Instruction of Austria, to establish a zoological station on the Adriatic sea, at Misamar. Three years later he labored with the Minister of Public Instruction of France to establish such a station at Nice, and recommended as professors, MM. Lacaze-Duthiers and Blanchard. He exerted all possible pressure, says his biographer, on his influential friends in France, Spain, Austria, Germany and Italy to bring about this end, and, we are told by his biographer, it was at his instance and at his instigation that Dr. Anton Dohrn, then (in 1868) at the Congress of Naturalists at Innsbruck, decided to found, at his own expense, the zoological station of Naples, now so successful and magnificent in all its arrangements. He also rendered disinterested services to Lacaze-Duthiers in establishing the admirable station at Roscoff, where he spent several summers, working up there his *Recherches cotières*, and seconded, according to his means and influence, the station of Marion at Marseilles, of Giard at Wimereux, and of Sabatier at Cette. Of late years and up to the year of his death, Vogt worked with his students at the Russian station at Villefranche.

We now have to consider Vogt as an evolutionist. His antipathy to metaphysics and to the philosophy taught when he was young was pronounced. But from the first he sympathized with evolutionary philosophy, and before the time of Haeckel was the leading propagandist of the theory of descent in Germany, and for his active warfare in this direction has been called the Huxley of Germany and Switzerland. He translated the 'Vestiges of Creation' soon after it appeared. With Claparède and DeCandolle, the Gevenese zoologist at once accepted the principles set forth in Darwin's Origin of Species. Even to Vogt it was a revelation.

As early as 1843, in his Embryologie des Salmones, Vogt wrote : "*Le developpement d'une classe dans l'histoire de la terre offre, à divers égards, la plus grande analogie avec le dévelopment d'un individu aux differentes époques de sa vie. La démonstration de cette vérité est un des plus beaux résultat de la paléontologie moderne.*"

In 1851 in his *Zoologische Briefe* he thus expressed himself: "The species is the reunion of all the individuals which derive their origin from the same parents and which become again by themselves or by their descendants like their first ancestors." In his lectures on man, delivered in 1862, he defined a species as a compound of individuals whose characters show that they are the genuine or possible descendants from a common source. In this work he insisted that man had descended from the apes, though he wrongly maintained that the few cases of microcephalous monsters known are cases of reversion to the ape condition. He now actively spread evolutionary views, and in a letter to Huxley, dated March, 1863, he wrote that the doctrine was making "de grand progrès en Allemagne. Une foule de jeunes savants se présentent," that Virchow (now regarded as very conservative in his views) added fuel to the flames in an article on heredity 'which is very explicit in this sense.' At the same time the radical uncompromising Vogt, when confronted with what was called Haeckelism, for once, and we believe only once, in his life took a conservative stand. The advanced views of Haeckel, then the 'enfant terrible' of Darwinism, with his genealogic tree of the whole animal kingdom, where the vague hypotheses and assertions of the Schöpfunggeschichte and Anthropogenie were treated as if generally received truths, were too much even for Vogt. His mind, so well trained in ascertaining and observing facts and in drawing safe deductions, though accustomed to give hypotheses due regard, led him to believe also that the building of genealogical trees was too premature in the biological science of that date. Vogt rebelled, and for a while a coolness sprang up between the *demi-dieu d'Jena* and himself. Vogt also apparently for the first time felt the influence of the university spirit, and, unconsciously as regards extreme evolutional views, the hair of this republican and ultra radical in religion actually stood on end, and his bold aggressive spirit became reactionary and cautious. Vogt wrote in 1877, under the title 'Apostel-, Propheten-und Orakelthum in der Wissenschaft,' a sharp criticism of Häckelismus; in a moment of genuine indignation, though with its comical side, pronouncing the views of the Jena professor as *haarstraubend.* The daring opinions of Haeckel at that time not only excited the derision of laymen, but biologists of equal rank with Vogt, among them Semper, were astonished at the lengths to which Haeckel allowed his vivid imagination to carry him, and yet at the present day Haeckel's views are moderate compared with those of some biologists. In fact, biology has shifted its methods, and a shoal of hypotheses, some probable and others incapable of proof, now occupy the field.

It was the extreme views of Haeckel against which Agassiz in the United States fought, and though he was the leader of the anti-evolution forces, he and Vogt stood on common ground, *i. e.*, of well ascertained facts, in opposing what they believed to be unsound scientific methods.

Vogt did not, however, like Fritz Müller, whose 'Für Darwin' is a classical work, make any notable contribution to the evolution theory, though upholding the doctrine of descent in its widest acceptation. He, however, did little to broaden it, nor did he, so far as we know, take up the questions now dividing evolutionists into neo-Lamarckians and neo-Darwinians. The scientific criticism of natural selection, the revival and rehabilitation of Lamarckian views, the rise of Weismannism and the search for the physical base of heredity, are the products of a later generation than that of Vogt.

In the summer of 1861 Vogt went as one of the guests of Dr. Berna to the North Cape and Jan Mayen, visiting on the way the eminent naturalist, Sars, and at Bergen Danielssen and Koren, and by the succeeding year (1862) the facile pen of Vogt had thrown off his *Nord-Fahrt entlang der Norwegischen Küste nach dem Nordkap, den Inseln Jan Mayen und Island.*

In the rise of the young science of anthropology, early in the sixties, due to the discoveries of Schmerling, of Boucher de Perthes, of Christy and Lartet, in France; of Thomsen, Nilsson, Steenstrup, Foschhammer, Gabriel de Mortillet, Capellini and others, with the works of Huxley, of Lyell and Lubbock, and the papers of Ecker, Vogt actively participated, and his lectures on man, which appeared in 1863, was a notable work. Aggressive, polemic, unlike the English and others, instead of confining himself to the subject in hand, going out of his way to attack those who differed from him on theological and philosophic subjects, the work made a great stir, perhaps more than its merits really deserved.

Vogt's opinion that microcephalous idiots are cases of reversion to their ape ancestors fell flat on the scientific ear, and indeed the fact was that Vogt himself never saw more than three perfect examples of undeniable microcephals. But the German public was profoundly moved by the popular lectures which the author of *Microcéphales ou Hommes-singes* delivered from 1867 to 1869, in the larger cities of the German Confederation, in Hamburg, Brussels, Antwerp, as well as Vienna and Buda-Pesth. In the Catholic cities he was almost mobbed; the children in the streets would run after him crying '*Assen Vogt! Assen Vogt!*' On one occasion, while lecturing in a German city, the fanaticism of the lower classes rose to such a pitch that the windows were smashed in by a volley of stones. Vogt, without losing his presence of mind, went on to show his audience the means taken to close the road to the young science already difficult to tread, when a large pebble fell on his desk; he took it and held it up before the assembly and exclaimed: "*Je vous parlais hier des sauvages ancêtres de l'âge de la pierre; vous vous rendrez facilement compte, en ce moment, que cet âge lá n'est par encore tout à fait terminé.*" It is said that Broca labored in vain to persuade him to respect the feelings of the lower orders.

Vogt was prominent in founding the Prehistoric Congress of Anthropology initiated by de Mortillet; read a number of papers before it, presenting at the Bologna meeting his paper, *Anthropophagie et les Sacrifices humains*, which contained some extreme conclusions as to the universality of this custom.

In 1870, during the Franco-Prussian War appeared his '*Lettres politiques*,' claimed by his biographer to be 'a fiery and eloquent protest in the name of right, justice and liberty against brutal conquest and unrighteous war,' which were widely read. He warned the French not to underrate the strength of their enemy, and *apropos* of the seizure, by Germany, of Alsace and Lorraine explained what the result has well shown, that this conquest would for a long time prevent any possible reconciliation between the two nations. He deplored the spirit of militarism, which he believed to be the cause of all the evils afflicting Europe, and longed for the suppression of great standing armies.

After this the busy student returned once more to zoology. He translated Gegenbaur's Anatomy, some of Darwin's works, and in 1875 published an *Atlas der Zoologie*. He even printed a study entitled *Structure microscopique des roches volcaniques*, and on volcanoes, and communicated these and other papers to the first meeting of the French Association for the Advancement of Science, which he was specially invited to attend. In his study of the Berlin Archæopteryx (1879), which he vainly tried to obtain for the Geneva museum, he maintained that it was neither a bird or reptile, but formed 'une type intermediaire des plus caractérisés et confirmes, d'une manière éclatante, les vues de M. Huxley.'

In 1879, when the anti-Semitic persecutions arose in Germany, he was among the first to defend the oppressed and plead for just and fair treatment of the Jews, and in 1893, when the anti-Semitic views penetrated into Switzerland, the last public address of the Geneva professor was read by a Federal Councillor before the National Council at Berne.

A characteristic of Vogt, showing his freedom from petty vanity, was his declination of Austrian, Spanish, Danish or Italian decorations, but he gladly accepted the cross of the Chevalier de la Légion d'honneur, given him by Gambetta, his friend and admirer.

His last work, *Traite d'anatomie comparée pratique*, written with the cooperation of Emile Yung, begun in 1888, was completed but a year (1894) before his death. He seems to have left unfinished an autobiography begun in June, 1894. Vogt died, his intellect unclouded to the last, in his eightieth year, March 5, 1895, after an illness of a few weeks.

Such is the life of this man. A busy and, for a naturalist and student, an eventful one. He was remarkably many-sided in his interests, and ever ready to drop his scalpel and pencil to take his share in public affairs.

It has been said that had Vogt not spread over so much ground and had confined himself to zoology, and to a single phase of that many-sided science, he would have taken a higher rank as a man of science. It may be said that he belonged to a school now passing away. He was the product of a transition period in the history of biology. Certainly he may be ranked as an embryologist and general zoologist or morphologist next to the best, and he was only inferior to such men as Müller, Owen, Huxley, Agassiz, Milne-Edwards. His best works in zoology were those on the embryology of the Salmonidæ and of the Gastropods, and the morphology of the Siphonophores. His attempts at classification were, however, not always successful, as seen in his separation of the Cephalopods as an independent type from the other molluscs.

He was a leader in founding the science of anthropology, but his *tour de force*, or microcephaly, was generally felt to be a mistake. As a promoter of marine zoological stations he was most useful, and he was no closet and museum naturalist, but was among the first to work by the seaside on living animals. He will be remembered as a leader in establishing the doctrine of evolution, though in advocating it he did not show the reserve as regards the supposed theological and philosophical bearings, nor cultivate the broad statesmanlike methods of Darwin, Lyell and others. As a controversialist his blows were less weighty and telling than those of Huxley, with less of his refinement, clearness and elegance of style, and knowledge and wide reading in philosophical literature. His life, however, was devoted to the good of his race. Though his religious nature was never cultivated, his moral nature was without a stain. His turbulent Celtic blood asserted itself at times, and his large patriotic heart led him to sympathize with the down-trodden and oppressed, and unlike most students he could doff his gown and rush into political struggles and wage effective warfare with voice and pen. Vogt's materialism, as well as Spencer's agnosticism, may answer a temporary purpose for the scientist as such, but not for the philosopher. We have to go outside the material and phenomenal world for an explanation of the universe. Vogt's position as a philosopher of the materialistic school is amply discussed by Lange in his History of Materialism, where he compares him with Moleschott. "Both men," he says, "though not without the stimulus of original research, shine chiefly in their talent for exposition. If Vogt is clearer and sharper in detail, yet Moleschott had given more thought to the rounding of the whole. Vogt more frequently contradicts himself; Moleschott is richer in propositions to which it is impossible to attach any definite meaning" (11, p. 264). But, as Lange well remarks in another place, "the whole cause of materialism is forever lost by the admission of the inexplicableness of all natural occurrences." Vogt's philosophical narrowness and opinionativeness is shown in his never changing his views in the later years of his life, when the occasion, if it ever occurred, for ultra materialistic views had passed away, to be replaced by agnosticism and by the monistic philosophy of Haeckel and others. It is sufficiently obvious that Vogt was unideal and unspiritual, practical and matter of fact, and quite unsuspicious of his own lack of breadth and grasp. His own studies must have constantly led him into the region of insoluble problems, but his modesty and humility was not of the order of Newton's, and he seemed utterly unconscious that he could not with a few words or strokes of the pen settle questions which have, and perhaps always will, baffle the keenest intellects and the most thoughtful minds.

Vogt, with whatever limitations he had, was a genuine man and true to his friends, with no personal enemies. The two portraits well delineate the man; not particularly winning or refined in features, but strong and true, reliable and earnest. The full-length portrait admirably depicts the man as we saw him one Sunday afternoon in 1889 in his laboratory at Villefranche. His students were out for a holiday and the old man was at work alone making a sketch of a jelly fish or some such creature, to be reproduced in his Traité d'anatomie comparée, on which he was then busily engaged. Affable and courteous, he took pleasure in showing us the simple apartments of the station, then under the direction of Prof. Korotneff.

The book is certainly not dull reading; it is enlivened by many characteristic anecdotes; at times it is a grain too eulogistic and uncritical, and the author's extreme radical and materialistic and anti-religious views in a degree warp his judgment and affect the saneness of some of his reflections. It would have been well if the book could have been revised by some scientific friend of the deceased.

We would have liked to see more of Vogt's own letters; remarkably few are given, nor are the summaries of his chief works sufficiently full and complete, or the dates always given, or the quotations accompanied by references to the title and page.

Had the book been written by an American, it is safe to say in these days of bibliographies, that a suitable one would have been added to this life, since Vogt lived in a transition period, his earlier papers being included neither in Agassiz and Strickland's Bibliographia zoologiæ, which ends with 1854; nor in Taschenberg's, which begins with 1861; nor in the catalogue of the Royal Society. A. S. PACKARD.

Number and its Algebra; Syllabus of Lectures on the Theory of Number and its Algebra. By ARTHUR LEFEVRE. Boston, Heath. 1896. pp. 230.

In June, 1891 was published the first piece of a treatise entitled 'Number, Discrete and Continuous,' in which were set forth some doctrines which seemed to the writer, the present reviewer, as new as they were fundamental.

It was there maintained that counting is essentially prior to measuring, but also that the primary number concept is essentially prior to counting and necessary to explain the meaning, cause and aim of counting.

It was there maintained that integral number had not a metric origin, nor was metric in its original purpose; that integral number did not involve the idea of ratio, that in fact it was enormously simpler than that very delicate concept, *ratio*.

Number is primarily a quality of an artificial individual.

The stress laid upon it, the importance attached to this quality, comes first from the advantage of being able to identify one of these artificial individuals. By artificial is meant 'of human make.'

The characteristic of these artificial individuals is that each, though made an individual, is conceived as consisting of other individuals.

This explanation was set forth again concisely in an article entitled 'The Essence of Number,' in SCIENCE, Vol. III., pp. 470, 471.

The primitive function of number is to serve the purposes of identification. But again, counting, which consists in associating with each primitive individual in an artificial individual a distinct primitive individual in a familiar artificial individual, is thus itself essentially the identification, by a one-to-one correspondence, of an unfamiliar with a familiar thing. Thus primitive counting decides which of the familiar groups of fingers is to have its numeric quality attached to the unfamiliar group counted.

This primitive use of number in defining by identification is illustrated by an ordinary pack of playing cards, where the identification of King, Queen and Knave is not more clearly qualitative and opposed to every mode of measurement than is the identification of ace, deuce and tray; and, indeed, that the King outvalues the Knave has more to do with measurement than the fact that the ace outvalues the tray.

Counting implies, first, a known series of groups, mental wholes each made up of distinct wholes; secondly, an unfamiliar mental whole; thirdly, the identification of the unfamiliar group by its one-to-one correspondence with a familiar group of the known series.

Absolutely no idea of a unit, of measurement, of amount, of value, or even of equality, is necessarily involved or, indeed, ordinarily used. One counts when one wishes to find out whether the same group of horses has been driven back at night that were taken out in the morning; where counting is a process of identification which it would seem intentionally humorous or comical to try to connect fundamentally with any idea of a unit of reference or of some *value* to be ascertained, or of the setting off of a horse as a sample unit of value and then equating the total value to the number of such units. Such an *argumentum in circulo* may perhaps be funny, but it is neither fact nor mathematics. Mathematics afterwards defines numerical equality by means of one-to-one correspondence, which is absolutely distinct and away apart from the idea of ratio. We may say with perfect certainty that there is no implicit presence of the ratio idea in primitive number.

From the contemplation of the primitive individual in relation to the artificial individual spring the related ideas 'one' and 'many.' An individual thought of in contrast to 'a many' as not-many gives the idea of 'a one.' A many composed of 'a one' and another 'one' is characterized as 'two.' A many composed of 'a one' and the special many 'a two' is characterized as 'three.'

And so on; at first absolutely without counting, in fact before the invention of that patent process of identification now called counting.

For a considerable period of its early life every child uses a number system consisting of only three terms, *one*, *two*, *many*, and no counting. As datum may be taken a psychical continuum, and distinctness may be found the outcome of a process of differentiation ; but what may be spoken of as the physically originated primitive individuals, however complete in their distinctness, have no numeric suggestion or quality.

The intuitive but creative apperception and synthesis of a manifold must precede its conscious analysis, which alone gives number.

It is only to conceptual unities that the numeric quality pertains. Such conceptual unities are of human make, and in a sense are not in nature, while, on the other hand, though the world we consciously perceive is out and out a mental phenomenon, yet the primitive individuals, distinct things, while forming part of the artificial unities, exist in another way, in that they are subsisting somehow in nature as well as in conscious perception.

With the preceding hints as to the reviewer's position in reference to fundamental matters in regard to which some strange blunders have been made of late by eminent philosophers and teachers, not mathematicians, it will be easy to understand why Lefevre's 'Number and its Algebra,' seems to us of exceptional importance just now to American teachers in general and teachers of pedagogy in particular. It is exceedingly timely, philosophic, bold, yet withal sound.

That the book was written down under exceptional difficulties makes only more noteworthy its general and sustained excellence.

That American teacher who does not read it is certainly doing an injustice to himself. In genuine compliment to the book, some points may be mentioned which the reviewer would have wished otherwise.

The fundamental idea of measurement comes perilously near to being misconceived. Section 12 says: "To the man whose concept of number is only what has been defined as primary number, measurement is hardly to be distinguished from counting. For measurement of discrete magnitude is counting ; and to the intelligence supposed there is no real measurement of continuous magnitude." Now, on the contrary, the number or numeric picture of a group is a selective photograph of the group, which takes or represents only one quality of the group, but takes that all at once.

This picture process only applies primarily to those particular artificial wholes which may be called discrete aggregates. But the overwhelming importance of the number-picture, primarily as a means of identification, led, after centuries of its use, to a human invention as clearly a device of man for himself as is the telephone.

This was a device for making a primitive individual thinkable as a recognizable and recoverable artificial individual of the kind having numeric quality.

This recondite device is measurement. Measurement is an artifice for making a primitive individual conceivable as an artificial individual of the group kind, and so having a number picture. The height of a horse, by use of the unit 'a hand,' is thinkable as a discrete aggregate, and so has a number-picture identifiable by comparison with the standard set of pictures, that is by counting, as say 16.

And directly contrary to the position of Prof. Lefevre, the measurement of continuous magnitude surely came at just the very stage of intelligence to which he denies it, for the fraction had this very origin ; it originated from the invention, the device, measurement.

Number long preceded any measurement, but measurement long preceded any idea of number as continuous.

In fact, measurement suggested not only fractions, but later the finer, more geometric idea, ratio, as is clearly presented in §80.

In Euclid's wonderful Fifth Book a ratio is never a number.

Newton, with the purpose of taking in the so-called surds or irrationals of arithmetic and algebra, assumed a ratio to be a number. Any continuity in his number system comes then from the continuity in the magnitude whose ratio to a chosen unit for that magnitude is taken. He never gave any arithmetical or algebraic proof of the continuity of any number system.

Certain passages in Mr. Lefevre's book might easily suggest that somewhere in it, never cited, he has himself treated this basal problem of modern mathematics, which Newton never touched, and which has only been made imperatively necessary by the discovery of non-Euclidean geometry. As one of many, take this sentence from his introduction, p. 14, "I am well aware that there are other avenues of approach to the thesis here maintained,—that 'various new mathematical conceptions have been employed by Weierstrass, G. Cantor and Dedekind in establishing three independent and equally cogent theories which should prove the continuity of number without borrowing it from space,' to say nothing of such theories (*e. g.*, Fine's *Number-System*) as are 'content to get continuity from the line.' The criticism of Fine, here quoted from Halsted's *Number, Discrete and Continuous*, was acknowledged as valid in a public meeting of the American Mathematical Society, but it applies with equal cogency to Lefevre, who here mentions it. In § 41, page 43, Fine outlines an argument for the continuity of the number system from the assumption of measurement or obtaining ratio by geometric congruence and the assumption that 'the geometric magnitudes are continuous.'

Lefevre does not devote even a single section, nor indeed even a single word, that I can find, to any attempt at proving even any piece of a number system continuous.

Neither Fine nor Lefevre give any hint that they have yet heard of the fact that the non-Euclidean geometry has made it a life-or-death matter for mathematics to have a continuous number system not based in any way upon geometric congruence, and so absolutely independent of measurement and ratio.

But this new problem the book under consideration does not pretend to have attacked. More than justified is its modest claim put forth on page 112: "It seems to me something to put neomonic numbers on the same footing as negative numbers, or even numerical fractions."

GEORGE BRUCE HALSTED.

AUSTIN, TEXAS.

Pioneers of Science in America. With portraits. Edited and revised by WILLIAM JAY YOUMANS, M. D. New York, D. Appleton & Co. 1896.

This octavo volume consists of fifty biographical sketches of early American scientists with descriptions of their scientific work. Originally they appeared in *Appleton's Popular Science Monthly*, but have since been revised, and additions made to them for their present form. The first of these sketches is on Benjamin Franklin, our first great American scientist, and is from the pen of Mr. W. H. Larrabee, of the *Popular Science Monthly* editorial staff. The scientific attainments of Franklin have never yet been fully appreciated and Dr. Youmans, who edited the collection, well says in his preface that the present article 'is the first systematic account of what Franklin did in science that has appeared.' The reference on page 10 to Dr. Goode's paper, read at the time of the commemoration of the centennial of Franklin's death by the American Philosophical Society, is suggestive of the fact that for many years Dr. Goode claimed that the beginnings of science in this country could invariably be traced back to Franklin.

A sketch of the two Bartrams, father and son, follow, and soon after these one of David Rittenhouse, who succeeded Franklin in the presidency of the American Philosophical Society. These, together with the sketches of Benjamin S. Barton, Gerald Troost, Robert Hare and others, make conspicuous the fact that early in the century Philadelphia 'presented more advantages in science than any other place in the country.' And so, according to the sketch of the elder Silliman, he went there for instruction in chemistry to Hare, and took lectures in botany of Barton. Silliman's able pupils, including Edward Hitchcock, Denison Olmsted and Charles U. Shepard, find a place in the book. New York comes in for its full share with the account of Samuel Latham Mitchell, who was the Franklin of the metropolis, so universal was his knowledge. Dr. Francis said of him: "In the morning he might be found composing songs for the nursery; at noon dietetically experimenting and writing on fishes, or unfolding to admiration a new theory on terrane formations; and at evening addressing his fair readers on the healthful influence of the alkalies and the depurative virtues of whitewashing." Nor is David Hosack omitted. It was he who in 1801 founded the Elgin Botanical Garden in New York City, which property afterwards was given to Columbia University. Torrey, who later was called to the Chair of Botany in Columbia University that had been held by Hosack, with his many and valued scientific attainments, is described at length. The early history of geology in New York State is recalled by the sketches of William W. Mather, Timothy A. Conrad, Ebenezer Emmons and Lardner Vanuxem, who with James Hall constituted the chiefs of the first geological survey of the Empire State. The pioneer in science at Harvard was John Winthrop, who was 'better entitled to the character of a universal scholar than any individual of his time in this country.' Other Harvard scientists included in the volume are William C. Bond, who founded its astronomical observatory, and Louis Agassiz, to whom we owe the Museum of Comparative Zoology in Cambridge. Two of Agassiz's associates, Guyot, the geographer, and Lesquereux, the paleobotanist, are appropriately treated. In a popular work, such as the present volume, a sketch of S. F. B. Morse may perhaps be necessary, but when we consider that "the essential features of the telegraph of to-day consist solely of the work of Joseph Henry and Alfred Vail," and to quote from the sketch of Henry (p. 358), "The principles I had developed were applied by Gale to render Morse's machine effective at a distance," it would seem that the space given to Morse could with propriety have been assigned to some other worthy. Of the Washington scientists Bache, Maury and Espy, as well as Henry, have been included. The Espy sketch is somewhat faulty, having been prepared from Mrs Morehead's reminiscences. Prof. Espy's work was chiefly done while in the service of the navy department and at the Smithsonian Institution, of which he was never a regent. The absence of sketches of J. C. Redfield, our greatest meteorologist subsequent to Franklin, and of Henry D. Rogers, the able geologist, is probably explained by the fact mentioned by Doctor Youmans in the preface namely: "Should the book be found of sufficient interest to warrant the venture, a second volume on a similar plan may follow."

Taking the book as a whole, it is almost entirely free from errors and may be regarded as the best contribution to the history of American Science that has yet appeared.

Marcus Benjamin.

Auto-Cars, Cars, Tram-Cars and Small Cars. By D. Farman, M. E., M. I. E. E.; Translated from the French by L. Serraillier. With a preface by Baron de Zuylen de Nyevelt, President of the Automobile Club of France. With 112 illustrations. London, Whittaker & Co.; N. Y., The Macmillan Co. 12mo., pp. 249. $1.50.

This little book presents an excellent discussion of a branch of engineering which has recently assumed great importance in the eye of the public and, perhaps to less extent, in the opinion of the engineering profession. The revival of the once extensively introduced and very successful automobile system of transportation on the highway which, sixty years ago and more, had come to be a well established branch of locomotion, has attracted the attention of the whole world. Steam carriages, petroleum engines, electric apparatus, are coming into view in all civilized countries, and in great number and variety. This volume gives an interesting, an accurate and a very complete account of the 'horseless vehicles' of all classes, and is brought up to date—an unusual and most satisfactory circumstance in technical bookmaking. The introduction includes a well-planned and well-made elementary study of the thermodynamics of the case, and includes the discussion of the cycles of Carnot and of the steam-engine. An historical account succeeds in which the work of the earlier engineers in this field is described; though, singularly enough, nothing is said of the wonderful work, for the time, of Goldsworthy Gurney, of Hancock, of Sir Charles Dance, and of a dozen other inventors who successfully inaugurated this system about 1830. At that time twenty or thirty steam carriages were in regular or experimental operation in and about London, and some of them traversed thousands of miles and were employed on regular routes for months at a time, carrying thousands of passengers. It was then that the laws which have since, until recently, been fatally discriminating against that class of motors, were instituted. The theory of the various types of motor next follows and a brief study is made of the several forms of motor now coming into use, with more or less success, in the impulsion of these 'horseless vehicles.'

The body of the work is devoted to a description of the construction of the new 'automobile' carriages which have within a few years become known on the road, and this includes an account of the forms of American as well as European apparatus which have been brought into competition in long-distance trials and races. Some valuable matter is also given in the form of reports, embodying data of interest and value to the constructing engineer.

The concluding portion of the book deals with details of construction. This is a good time to bring out such a work, and the author appears to have made a success of his part. The book is the work of an expert, and no doubt reliable as to fact as well as correct in its descriptive matter. It is well worth its price.

R. H. THURSTON.

CORNELL UNIVERSITY.

SCIENTIFIC JOURNALS.

AMERICAN CHEMICAL JOURNAL, DECEMBER.

Investigations on the two Isomeric Chlorides of Orthosulphobenzoic acid: By IRA REMSEN, S. R. McKEE, J. R. HUNTER and W. J. KARSLAKE. These articles contain the results of investigations carried on during the last two years on the preparation and behavior of the chlorides of orthosulphobenzoic acid. They have been obtained in pure condition, the high-melting one by treating the mixture with ammonia, which destroys the low-melting one, and crystallizing the product from ligroi ; and the low-melting one by fractional crystallization of the mixture. When treated with water both give the same product, orthosulphobenzoic acid. Phenol and resorcinol were also found to yield the same products with the two chlorides. When treated with aniline the high-melting chloride yields only the fusible anilide, while the low-melting one yields both the fusible and and infusible anilides. When these anilides are treated with phosphorus oxychloride they both yield orthosulphobenzodianil, from which the infusible anilide can be regenerated by boiling with glacial acetic acid, and the anil of orthosulphobenzoic acid by treatment with concentrated hydrochloric acid. The evidence shows that the infusible anilide is derived from the unsymmetrical chloride by the replacement of the two chlorine atoms by the aniline residues. When the high-melting chloride is treated with ammonia the product is the ammonium salt of benzoic sulphinide, while the low-melting one forms ammonium orthocyanbenzenesulphonate. From all the data available it seems to be hardly possible to explain the formation of the latter compound, except from the unsymmetrical chloride. The first action probably leads to the formation of an imide which by an intramolecular change passes over to orthocyanbenzenesulphonic acid. The product formed by the action of benzene and aluminium chloride was the same from both chlorides.

On the Non-existence of two Orthophthalic Acids: By H. L. WHEELER. An article was published, in the May number of this JOURNAL, by W. T. H. Howe, on the existence of two orthophthalic acids. The work has been repeated by H. L. Wheeler, who found it impossible to prepare the new acid described by Howe. He says the experimental work is absolutely incorrect, and that only the ordinary orthophthalic acid was obtained, although the experiments of Howe's were carefully repeated a number of times.

A Pure Carbide of Iron: By E. D. CAMPBELL. The author has succeeded in obtaining a pure carbide of iron of the formula CFe_3 by carefully annealing steel bars and then suspending them in an acid solution and passing a current through the solution. The steel-gray powder formed on the surface was removed each day with an aluminium brush, and washed and analyzed. When treated with hot concentrated hydrochloric acid the substance was dissolved, forming the chloride of iron and hydrocarbons. The latter consisted both of paraffines and olefines; but their exact composition was not determined.

The Alkali Trihalides: By C. H. HERTY and H. V. BLACK. The authors have tested the rubidium trihalides to determine whether they are isomorphous mixtures or true chemical compounds. Repeated crystallizations failed to produce any change in the composition of the crystals, thus showing that the substance belonged to the latter class.

Action of Water of the Hubb Coal Mine upon Cast Iron: By F. W. DURKER. This mine was flooded and was filled with water for several years. When it was pumped out the iron work was found to have undergone a considerable change. The form was the same, but the substance was now porous, soft and easily cut with a knife. The changes which had taken place are explained as follows: the iron pyrites in the coal had been converted into ferrous sulphate, sulphuric acid and sulphur. The acid dissolved in the water and attacked the castings, forming the sulphates of the metals, hydrogen and hydrocarbons. The oxygen and carbon dioxide dissolved in the water formed oxides of iron, and the bars then consisted largely of silicon with oxides of iron on the outside.

The Action of Sulphuric Acid on Anisol: By W. B. SHOBER. Various results are found recorded concerning the action of sulphuric acid on anisol. The author studied the reaction under different conditions and found that anisol disulphonic acid is formed in every case in which anisol and sulphuric acid were heated to 92°; but not if they were heated above 125°. Paranisolmonosulphonic acid was always formed, while the ortho compound was formed when the substances were brought together at the ordinary temperature. This number also contains reviews of the '*Journal of Physical Chemistry;*' '*Jahrbuch der Electrochemie;*' 'Foods, their composition and analysis,' A. W. Blyth; 'The Elements of Electrochemistry,' M. Le Blanc.

J. ELLIOTT GILPIN.

SOCIETIES AND ACADEMIES.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO. MEETING OF DECEMBER 2, 1896.

THE meeting opened with a papr by Dr. O. P. Hay, on 'The Structure and Mode of Development of the Vertebral Column,' of which the following is an abstract:

A vertebra is in most, if not all, animals a composite structure, both in the early stages of ossification and in the preceding cartilaginous stage. The notochord, around which the vertebral centrum is developed, at a very early period secretes two sheaths, an outer one, the elastica, aud an inner thicker one, the proper chordal sheath. Any segmentation of the notochord or of its sheaths is due to the development of structures lying primarily outside of the sheaths and arranged metamerically. The skeletogenous cells arise from the lower half of the protovertebra, Gadow and Abbott to the contrary notwithstanding; from these cells arise the upper and lower arches and the intercalated cartilages. In the sharks, cells from the bases of the arches pierce the elastic and enter the chordal sheath, thus giving rise to the centra of these fishes. In the bony fishes, as Gegenbaur and Balfour have shown in *Lepidosteus*, Lotz in the salmon and Hay in Amia, the elements of the vertebral centra are developed wholly outside of the elastica. In the tail of Amia there are for each myomere eight cartilages resting on the elastica, the two halves of the upper arch, the two halves of the lower arch, the two upper intercalated cartilages, and the two lower intercalated cartilages. In the dorsal region these are all present except the lower intercalated cartilages, which seem to be missing.

A deposit of bone is formed in each of the eight pieces of each segment of the tail. The four bases of the upper and lower arches are thereby joined into one of the two rings found there in each segment, the so-called hypocentrum or intercentrum; similarly the four intercalated cartilages are joined to form the other ring, the so-called pleurocentrum. In the dorsal region the bases of the upper arch take no part in the formation of the centrum, being crowded upward on the top of the enlarged intercalated cartilages. Bone spreading from the latter cartilages meets bone advancing from the bases of the lower arch. Hence the vertebræ of the dorsal region are called pleuro-hypocentra.

In *Lepidosteus* the intercalated cartilages appear to be fused into a ring around the notochord and thus fused with the bases of the upper and lower arches. Later this ring of intercalated cartilages is divided, one-half going to the vertebra behind, the other half to the vertebra in front, and these, becoming ossified, form the articular ends of the adult vertebra.

In the Urodeles the two sheaths of the notochord are enveloped as in bony fishes. Hasse and Field are in error when they affirm that the elastica is pierced by cells from the skeletogenous layer. What they claim as the elastica is not such. The intervertebral ring of cartilage seems to be formed of the fused intercalated cartilages, just as in *Lepidosteus*, and as in this fish becomes cross-segmented to form the articular ends of the adjacent vertebræ.

A paper* by Dr. H. C. Bumpus, giving results of a study on *meristic* and *homœotic* variation in the vertebral axis in Necturus, was briefly referred to by Professor Whitman.

The scope of the paper and method of dealing with the subject will be seen in the following questions raised and answered more or less fully by the author:

1. The per cent. of variation in the attachment of the pelvic arch. Is there meristic variation and is homœotic variation associated with it?

2. Is there a ratio between the absolute length of the animal and the number of vertebræ?

3. Why does the variation tend towards *forward* rather than *backward* homœosis?

4. Occurrence of oblique or unsymmetrical sacra.

5. Is the position of the pelvic arch dependent on the ordinal position of some one segment (sacrum), or is it determined by the location of some topographical point?

6. Are there variations in the position of the pectoral arch? and are these correlated with variations in the pelvic arch?

7. Are there other skeletal variations associated with pelvic variations?

8. Are variations more frequent in males than in females?

9. Are there anatomical grounds for the theory of vertebral intercalation?

These questions and many others raised in connection with them are answered by the conditions presented in one hundred specimens of Necturus.

Dr. Bumpus has used the expressions '*forward*' and '*backward homœosis*' as defined by Bateson ('Materials for the Study of Variation,' p. 111).

The pelvic arch is attached in the majority of cases to the XIX. vertebra. The variation in position in most cases consists in attachment to the XX. vertebra, and this is called *forward* homœosis. The term 'homœosis' is an old one, and Bateson employs it in its strict etymological sense. It is not the term, but the method of defining *direction*, that is open to serious objection. It is decidedly confusing and contrary to general usage to speak of the direction of variation as forward when the homœosis is exhibited in vertebræ lying *behind* the starting point. According to Bateson's definition, if the pelvic arch in Necturus were found as far back of the normal position as the last caudal vertebra it would still be a case of forward homœosis. If the homœosis appeared in successive vertebræ, coming at each step nearer the caudal end, we should still have to defy common sense and call it 'forward.' Proceeding in this wise, we should have to speak of the formation of segments in an embryo as progressing forward, notwithstanding that we know that the development advances in just the opposite direction. From this point of view, the direction of developmental differentiation in general would be forward instead of backward.

"The development of petals in the form of sepals," as Bateson himself suggests, would be "an *outward* homœosis, while the formation of sepaloid petals would thus be called an *inward* homœosis, and so forth."

Is anything gained, except confusion, by adopting such terminology?

Bateson attempts to justify his position in the following words:

"In describing cases of such transformation in the series, it is usual to speak of structures, the pelvis for example, as 'travelling forward,' or 'travelling backward.' These modes of expression are to be avoided as introducing a false and confusing metaphor into the subject, for there is of course no movement of parts in either direction, and the natural process takes place by a development of certain segments in the likeness of structures, which in the type occupy a different ordinal position in the series. In using the expression, homœosis, we may in part avoid this confusion, and we may speak of the *variation as occurring from before backward or from behind forwards, according as the segment to*

* Soon to appear in the *Journal of Morphology*.

whose form an approach is made stands in the normal series behind or in front of the segment whose variation is being considered. The formation of a cervical rib on the seventh vertebra is thus a backward homœosis, for the seventh vertebra thus makes an approach to the characters of the 8th. On the other hand, development of ribs on the 20th vertebra (1st lumbar) is a forward homæosis, for the 20th vertebra then forms itself after the pattern of the normal 19th.''

Curiously enough the main argument is, to avoid confusion. The confusion to be avoided, however, is wholly imported in the word 'travelling.' Drop the idea of movement of parts and use the terms of direction in their usual sense, and there is no confusion. The 'confusion worse confounded' comes in when a backward direction is called a forward one, and *vice versa*. When the 20th vertebra 'becomes like' the normal 19th, the locus of the variation is behind the normal, and the direction should be defined *from*, rather than *to*, the normal. The 20th vertebra 'becomes like' one in front of it, but that does not make the *direction of variation* forward.

NEW YORK ACADEMY OF SCIENCES, BIOLOGICAL SECTION, NOVEMBER 9, 1896.

MEMBERS of the Columbia University Expedition to Puget Sound made reports on the summer's work.

Mr. N. R. Harrington gave a short narrative of the expedition, including a description of the equipment of the laboratory, dredging, investigation and plankton collection. In addition he made a report on the echinoderms, crustaceans and annelids. Mention was made of the relation of the asymmetry in *Scutella excentricus* to its habit of burrowing and its vertical position in the sand. Abundant material, both larval and adult, of *Entoconcha*. This mollusc had been noted by Miller in 1852 and Baur in 1864 in *Synapta digitata* and by Semper in *Holothuria edulis*. The present material was found in an undetermined species of *Holothuria*. About forty species each of crustaceans, annelids and echinoderms have been identified.

Mr. Bradney B. Griffin presented the following report on the platodes, nemerteans and molluscs.

The Platodes and Gephyrea are relatively scarce. They are represented solely by two dendrocoels, and one phymosoma respectively. The nemertines occur very abundantly, fully fifteen different species were obtained, most of which appear to be undescribed, though some seem to approach more or less closely the European forms rather than those of the east coast of America. The Enoplan species are the more numerous. The molluscan fauna is very rich and varied, ninety-three species of sixty-nine genera were collected. These include, among others, the large *Cryptochiton stelleri*, which when alive and expanded measures over 20 cm., besides numerous smaller species of *Mopalia*, *Katherina*, *Tonicella*, etc., that occur in vast numbers on rocks and piles between tides. The nudibranchs are notable from their bright colors and large size. One species of *Dendronotus* attains a length of over 25 cm. Cases of color variation (*Cardium* and *Acmaea*) and color series (*Litorina*) were to be met with as well as color harmonization; many chitons and limpets are colored so as to more or less resemble the speckled and barnacled rocks upon which they occur. A complete series of *Pholadidea penita* (the 'boring clam') was obtained which shows the gradual atrophy of the foot and concrescence of the mantle edges as the adult condition is attained. Specimens of *Zirphæa crispata* were collected, a related form in which the foot remains functional throughout life. A series of maturation and fertilization stages of this form was obtained. *Lepton* is not uncommon, a lamellibranch that lives commensal, attached by its byssus to the abdomen of the crustacean *Gebia*, and has caused the trophy of the first pair of abdominal appendages of its host. It has developed a median furrow on each valve in adaptation to the body form of *Gebia*. An interesting case was observed in which an otherwise nearly smooth *Placuanomia* shell had assumed during its growth the concentric raised lines of a *Saxidomus* valve upon which it was attached.

The insects are not very abundant; they are represented in the collection mainly by a few wood beetles, myriopods (*Julus*, *Polydesmus*), and a species of *Termes*.

Mr. Calkins reported on the protozoa and cœlenterates of Puget Sound and of the Alaskan Bays. The protozoa and cœlenterates collected during the summer by Mr. Calkins belong chiefly to the group flagellata for the former, and to the leptomedusæ for the latter. In addition, there are two species of hydroids—a large number considering the very limited representation of this group in the western waters. Twelve or fourteen species of actinians and about the same number of sponges, and several scyphomedusæ complete the list of cœlenterates.

Dr. Bashford Dean reported on the chordates and protochordates of the collection. The ascidians are represented by about a species, fishes by upwards of forty. The most important part of his work had been the collecting of embryos and larvæ of Chimæra (*Hydrolagus colliei*) and a fairly complete series of embryos of *Bdellostoma*, including upwards of twenty stages from cleavage to hatching. Of *Chimæra* upward of eighty egg cases had been dredged in a single day; but in every case these were found to be empty. The eggs were finally obtained at Pacific Grove, California, from the gravid females and were incubated in submerged cages. It was in this locality that the eggs of *Bdellostoma* were collected.

C. L. BRISTOL,
Secretary.

GEOLOGICAL SOCIETY OF WASHINGTON.

AT the 53d meeting, held in Washington, D. C., December 9, 1896, Mr. Whitman Cross gave an account of some unusually large landslides observed in the Telluride region of Colorado. The slides occur on the western face of the San Juan Mountains, where the San Miguel conglomerate and a thick series of volcanic beds rest upon Cretaceous shales. Water percolating through the upper beds has softened the shales and caused the slides.

It is clear that the slides occurred long ago when the topography of the mountain front was even more rugged than at present. Masses of rock two miles in length and more than 1500 feet in vertical dimension have slipped, apparently as a unit, for several hundred feet. In such cases the bedding of the mass dips toward the mountain from which it was detached. Subsequent slides of portions of the original mass have greatly modified the relationships of the rocks.

Mr. W J McGee detailed certain observations on 'The Formation of Arkose.' The region in which the process was observed is the eastern shore of the Gulf of California or the western coast of the State of Sonora, Mexico, about latitude 29°. The region is one of broad plains, base-leveled by sheetflood erosion, these plains being relieved by notably rugged mesas and sierras. The rocks consist largely of granites and granitoid schists, evidently of considerable antiquity, together with considerable beds of igneous rocks, tuffs, etc., probably ranging from Mesozoic to middle Tertiary in age; in the mesas and sierras the rocks are practically bare, while in the flood-sweep plains they are veneered with a thin sheet of coarse alluvium, ranging from a few inches to a few yards in thickness, which becomes fine and of considerable thickness only in the axes of the greater valley plains. Between Puerto Infierno and Punta Ygnacio (mapped in National Geographic Magazine, Volume VII., 1896, plate xiv.) the gulf shore reveals a section of rocks and overlying mantle in a range of sea cliffs, averaging 30 or 40 feet in height between the lower ranges which jut into the gulf in such manner as to form prominent points; while the shore is skirted by a wave-cut bench or terrace lying slightly below extreme low tide, averaging some 100 yards in width, beyond which the gulf deepens rapidly. The prevailing rocks are slightly schistoid granites, while the alluvial veneer is composed chiefly of granitic products. The region is one of high tides and strong tidal currents, and is subject to strong winds, rising almost daily into gales, induced by general climatic and local topographic conditions; the climate is notably arid, and no fresh waters ever flow into the gulf save locally and for a few hours after the greatest storms. In the course of a visit to the coast in December, 1895, the speaker observed the rapid work of the waves in sapping the cliffs during a gale; and on one occasion, at low tide with an off-shore wind, he passed well toward the outer margin of the wave-cut terrace, examining the débris accumulated in the depressions of the rugged surface; in most cases this was found to be a coarse granular sand, made up of crystals and angular fragments of quartz, felspar, mica, etc., sometimes intermixed or superficially coated with finely comminuted and lixiviated material, but more commonly clean. It was impracticable to trace the character of the detritus below the level of extreme low tide; but everything indicated that examination beneath the waters of the gulf here would reveal considerable deposits, corresponding at least to the volume of material removed in forming the sea cliffs, which would be found to consist of such material as that observed. It was noted that off the prominent granitic points (six or seven of which were studied) the granitoid sand was coarsest and cleanest, while in the reentrants it was mixed with rounded sand and contained a larger element of comminuted material. The freshly-formed granitic sand differs from ordinary arkose, such as that of the Potomac formation, only in the more complete decomposition of the felspar and other constituents in the latter. The observations are considered of value as indicating the conditions under which arkose and mixtures of arkose with ordinary sand are produced.

Mr. Waldemar Lindgren summarized the results of his recent surveys of the mining districts of Nevada City and Grass Valley, in California, discussing the history of mining operations there, the geology, the mode of origin and character of the fissure systems, the products of vein formation, etc.

These important districts are situated on the western slope of the Sierra Nevada, in Nevada county, at an elevation of 2,500 feet, and within them are a great number of important gold deposits, consisting of quartz veins and gravels. The districts have been worked continuously since 1849. At present the quartz mining industries are by far the more important. The districts are estimated to have produced a total of $113,000,000.

These districts together form the subject of a folio of the Geologic Atlas of the United States, but just issued from the press, as well as of a treatise, which will be published within a month as a part of the Seventeenth Annual Report of the Director of the United States Geological Survey.

W. F. MORSELL.

U. S. GEOLOGICAL SURVEY.

BOSTON SOCIETY OF NATURAL HISTORY.

THE first general meeting of the season was held November 4th, one hundred and seventeen persons present.

Prof. George Lincoln Goodale spoke of the reclamation of deserts. The differences between deserts were described and their various aspects noted. The end of Cape Cod was cited as an example of a desert near at hand, and the scanty vegetation of Sable Island and the difficulty of inducing plants to flourish there were mentioned. The distribution of desert plants was noted, and the effects of aridity, the changes brought about by the introduction of water, and the various kinds of water in the soil, were fully described.

Views of typical deserts in Australia, Africa, and in other parts of the world were shown, Prof. Goodale concluding with an account of the effects of irrigation and of some of the practical difficulties arising therefrom.

SAMUEL HENSHAW,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis on the 7th of December, 1896, Prof. H. S. Pritchett presented a paper giving the results of measures of double stars, mostly close binaries, made with the 12½-inch equatorial of the Glasgow Observatory. These observations, compared with similar ones made by him fifteen years earlier, showed some remarkable changes, particularly in the case of 70 Ophiuchi, in which the companion had described an arc of 102°. Others, as Σ 2120, showed that the motion of the companion star was independent of the brighter one. The speaker gave a general statement of the method of measuring double stars and the method of determining the apparent and true orbits.

Mr. Wm. H. Roever presented an abstract of a paper on the geometrical properties of lines of force proceeding from electrical systems, in which he showed:

(a) That the curve representing a line of force proceeding from a system consisting of an electrified plane and an electrified line parallel to the plane, is the locus of the intersection of two straight lines having motions in a plane which is perpendicular to the electrified line; one line having a motion of uniform rotation about the electrified line as an axis, and the other a motion of uniform translation perpendicular to itself and parallel to the electrified plane.

(b) That the curve representing a line of force proceeding from a system consisting of an electrified plane and an electrified point is the locus of intersection of two straight lines having motions in a plane, which passes through the electrified point and is perpendicular to the electrified plane; one line having a motion of rotation about the electrified point and the other a motion of translation perpendicular to itself and parallel to the electrified plane. The rotation is such that the versine of the angle which the rotating line makes with $o\gamma$ (a line which passes through the electrified point and is perpendicular to the electrified plane) changes at a uniform rate, and the translation is such that if the moving line were the meridian line of a cylinder of revolution whose axis is $o\gamma$, the area of cross section of the cylinder would change at a uniform rate.

Mr. Roever also showed other properties of the above lines of force.

One active member was elected.

William Trelease,
Recording Secretary.

SCIENCE CLUB AT THE UNIVERSITY OF WISCONSIN.

The first regular meeting of the Science Club of the University of Wisconsin was held Tuesday, November 10th, the regular programme consisting of a discussion by E. A. Birge on 'The Crustacea of the Open Water of Lake Mendota,' and a paper on 'the Radiophone' by C. M. Smith. Mr. Birge, in speaking of the vertical distribution of the limnetic crustacea, enumerated the factors which effect the distribution, and illustrated the action of each factor by its effect on different species of the crustacea. Especial attention was called to the fact that in summer the crustacea do not descend below the 'Sprungschicht' of temperature, but stop abruptly at that level. This was regarded as due, not to temperature directly, but to the accumulation of decomposition products in the deeper water. Mr. Smith's paper reviewed the principal phenomena which have led to the conclusion that the production of sounds of definite pitch is a general property of all matter, whether solid, liquid or gaseous, when placed in the path of rapidly intermitted heat radiations; the pitch corresponding to the rapidity of interruptions of the rays. He further showed the application of the method to the study of emission and absorption phenomena.

Wm. S. Marshall,
Secretary.

THE BOTANICAL SEMINAR OF THE UNIVERSITY OF NEBRASKA, DECEMBER 5, 1896.

The Polyphyletic Grouping of the Lichens, Mr. Clements. *Mycological Statistics of Nebraska*, Mr. Pound. *The Comparative Anatomy of the Pistil in Apocarpous Families*, Mr. Ernst Bessey. *Phytogeographical Notes from Colorado*, Mr. Shear.

NEW BOOKS.

The Microscope and Microscopical Methods. Simon Henry Gage. Ithaca, Comstock Publishing Co. 1896. Pp. xii+237. $1.50.

The Principles of Sociology. Herbert Spencer. New York, D. Appleton & Co. 1896. Vol. III., pp. x+645. $2.

List of the Vertebrated Animals now or lately living in the Gardens of the Zoological Society of London. London, Longmans, Green & Co. 1896. Pp. xvi+724.

Prehistoric Man and Beast. H. N. Hutchinson, New York, D. Appleton & Co. 1897. Pp. xxi+298. $3.

A Text-book of Special Pathological Anatomy. Ernst Ziegler. Translated and edited from the Eighth German Edition by Donald MacAlister and Henry W. Cattell. New York and London, The Macmillan Co. 1896. Section I.–VIII. Pp. xix+575+xxxii.

Elementary Meteorology for High Schools and Colleges. Frank Waldo. New York, Cincinnati and Chicago, The American Book Company. 1896. Pp. 372.

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