THURSDAY, OCTOBER 1, 1885

NORTH AMERICAN WATER-BIRDS

The Water-Birds of North America. By S. F. Baird, T. M. Brewer, and R. Ridgway. Two Vols., 4to. (Boston: Little, Brown, and Co., 1884.)

EXPECTATION was roused some years since when tidings came that the "North American Birds" of Prof. Baird, Dr. Brewer, and Mr. Ridgway, of which three volumes had been brought out in 1874, was in process of completion, and at last there appeared two quartos of goodly size under the title of "The Water-Birds of North America," which are not only the sequel to the work just named, but are also issued in continuation of the publications of the Geological Survey of California, of which a single volume on the land-birds of that State, edited by Prof. Baird from the notes of Dr. J. G. Cooper, saw the light in 1870. But, to complicate the matter further, the two quartos now before us form vols. xii. and xiii. of the "Memoirs of the Museum of Comparative Zoology" at Harvard. How all this came about is explained in the introduction by Prof. Whitney, the Californian State Geologist; but the only part that need concern us is the not surprising but still much-to-be-regretted fact that the cost of bringing out the volumes treating of the land-birds of North America was so great as to deter the publishers from continuing the work at their own risk. Most fortunately, then, the combination just mentioned was effected with the result we now see; but it still remains a reproach and humiliation to those interested in birds—not only in North America alone but all the world over—that so excellent a performance was not more encouraged by them. The obstinacy of the public in preferring a bad book to a good one is perhaps observable in almost every science, but that this obstinacy is nowhere more marked than in the case of natural history, and of ornithology in particular may be because it is one of the most popular branches of science, and because nine-tenths of those who pursue it hardly realise the fact that it is capable of serious study. Howbeit we may be sure that the old adage, "*Populus vult decipi*," was not first uttered by a man without worldly knowledge, and to this day experience tells us that it is as true as ever. It will take a long time yet to persuade people that they had better be well informed by an author who writes a book because he knows his subject, than by a badly-informed one who gets up his subject in order to write a book about it—though even this is perhaps saying too much, for many an author, on ornithology at least, has never taken the trouble to learn the rudiments of what he pretends to teach, and if he have but enough self-assurance he will get his claim to instruct allowed by those who are more ignorant than he is.

To all who have been concerned in the production of the text of the two volumes before us we must offer our hearty congratulations, as it is impossible for us to apportion to each anything like his proper share of merit. Besides the naturalists already named, Prof. Whitney states, in his introduction, that in revising the not wholly completed manuscript he has had the assistance of Mr. Allen, so long known as head of the ornithological department of the Harvard Museum, and that gentleman is therefore entitled to our thanks as much as any one of the others; but moreover it is also advisable to look back to the original preface of Prof. Baird, in which he states that "the most productive source" of the new information published in this work "has been the great amount of manuscript contained in the archives of the Smithsonian Institution in the form of correspondence, elaborate reports and the field-notes of collectors and travellers." The most important of these, he goes on to say, are those by the late Mr. Kennicott, and several residents in the then Hudson's Bay Company's Territory—Messrs. MacFarlane, Ross, Lawrence Clark, Strachan Jones, and others—besides Messrs. Dale, Bannister, and Henry Elliott in regard to Alaska and its islands. Now this being the case with respect to the former volume, which treated of the land-birds only, the importance of the labours of these gentlemen ought to be far more manifest in the present volumes, which deal with the water-birds, since an overwhelming majority of them have their home in the vast northern regions of the continent, and are only winter-visitants to most of the States and Territories of the Union. A good deal to our disappointment we find it otherwise. It may be that the late Dr. Brewer, who is believed to have been responsible for the "biographical" portion of these as of the former volumes, had not at his death completed the examination of the unpublished materials at his disposal; but certainly there is not so much information from American sources as we had hoped or even expected. On the other hand, European authors are freely, not to say redundantly, laid under contribution for such species as are common to the two continents, which it is needless to say are many. Of this we do not complain, though we confess we should rather have learned how these species behave themselves on the other side of the Atlantic; but there is a want of discrimination as to the opportunities possessed by the different observers quoted, and a lack of proportion as to the value of their observations. We do not say that this is not pardonable, perhaps it was unavoidable; but it is unfortunately no less a drawback; and, to make it worse, several instances might be cited in which absolutely contradictory assertions are reprinted without any attempt to indicate which is thought to be the more worthy of belief; while a good many of the statements to which this objection does not apply are but vain repetitions.

Passing to the descriptive part of the work, we do not hesitate to declare that, so far as we have been able to test it, it is excellent. The "specific characters" given seem really to deserve their name, since they indicate the species, and are not, as has lately become so common, drawn from an individual example. Moreover, they are sufficiently brief to be useful, for we have unfortunately entered upon days when specimens are described at a length that absolutely precludes the practical application of the description. Nothing marks more distinctly the difference between a naturalist and a book-maker than the being able to perceive and to tersely express the characters that are essential to the differentiation of a species. Among ornithologists, merely to cite the example of one who is gone, it seems to have been this faculty that gave the late Mr. Gould such a wonderful pre-eminence among his contemporaries. Others unquestionably far surpassed him as scientific ornithologists, indeed the scientific value of his works is very slight; but hardly any one had such an eye for a species, or could in a dozen words or so point out how it could be recognised. It is no doubt in consequence of this that so few of the species described by him have failed to be considered good by his successors.

The ornithologists of the New World are in one respect very fortunate. They are not encumbered by the enormous dead weight of synonomy that is so burdensome to their brethren of effete Europe; and, thanks to the steadfastness with which the North Americans follow the use of a nomenclature fixed by authority, they will probably be for ever exempt from much of the evil which afflicts the more independent writers of the Old World, almost each of whom likes to be a law unto himself. Whether the nomenclature now accepted in the United States and in Canada be founded on the best principle is a matter that need not be here discussed. It has been reduced to a practice the real advantage of which none can doubt. But that this state of things is possible arises in great measure from the fact that in one sense a very small number of North American birds have an ancient history such as is possessed by nearly all the European species, though of this ancient history the compilers of synonymy in general give but a feeble notion. Few things are more misleading than a long list of synonyms, such as is too often regarded as a test of an author's industry and knowledge. It almost always happens that in a list of this kind bad accounts and good are made to appear as though they stood, as it were, on an equal footing, and it not unfrequently occurs that a reference to the best account of a species may be wholly omitted, while a fantastic name introduced by some compiler or cataloguemaker, who perhaps never examined or even set eyes on a specimen, receives notice as if it were an important contribution to the history of the creature. If Americans suffered from this grievance to the same extent as Europeans do, we suspect that the ingenuity of the former would lead them to find some remedy for it, but they may bless their stars that they are comparatively free from it.

Every well-informed ornithologist knows that the systematic arrangement of birds presents a series of puzzles which as yet defy solution. Still, some steps towards the clearing away of the old trammels have been taken by various persons, and a few positions that may be looked upon as established have been gained. We are sorry to find so little in these volumes suggestive of further advance. The writers seem to be still enchained in the toils which the artificial system of Sundevall drew around the subject, and in the very brief space—barely two pages—thereto devoted, we have "altricial" and "præcocial," "gymnopædic," and "dasypædic" groups spoken of as if they were to be believed in. It is true that the arrangement adopted is said to be "not strictly natural;" but in the same paragraph are some other statements as to affinities or the reverse that we hope the author may live to repent. However we freely admit that the main object of these volumes is not to teach systematic ornithology, and therefore perhaps the less said on that contentious subject the better. They will, there can be no doubt, admirably fulfill the chief purpose for which they are intended, and enormously further the study of birds in English-speaking America. It would be out of place here to enter upon any minute criticism of their contents, and, while indicating in a general way, as we have attempted to do and as we conceive we are in duty bound, some of their shortcomings, we can strongly recommend them as on the whole justifying the high degree of expectation that had prevailed concerning them prior to their publication. Assuredly we shall have to wait long before another so comprehensive and, taking it all in all, so excellent an account of "The Water Birds of North America" is likely to make its appearance, and once more we tender our thanks to each and every one of those who have been concerned in the work, though we may perhaps make a reservation in regard to the woodengraver.

LETTERS TO THE EDITOR

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

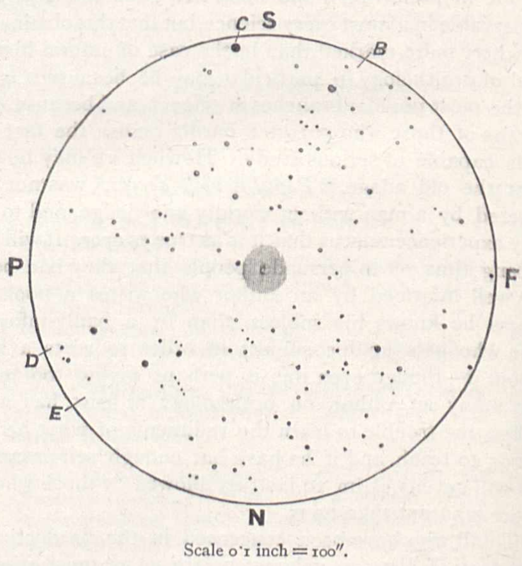
[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The New Star in Andromeda

THE information furnished by a photograph of the Great Nebula in Andromeda taken last year may be of value, particularly in relation to the presumed variability of the new star. An examination shows that no star brighter than about the 15th magnitude was then in the position now occupied by the new star.

This photograph was a trial plate taken on August 16 between 10h. and 11h., with an exposure of 30 minutes of the 3-foot reflector. With this exposure the impression of the nebula is very

FIG. 1.



Scale 0·1 inch = 100″.

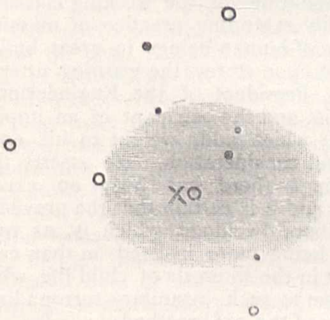
small for such a bright object as it appears in the telescope, being limited to about 2 minutes of arc around the nucleus (which was bright and round), not much more than is shown on a photograph of the Crab nebula with the same exposure, and not nearly so much as, though a little brighter than, a photograph of the Dumb-bell nebula taken a few days after. A great number of stars are to be seen. A defect in the apparatus then being used for the first time has caused a tilt of the plate and a consequent want of sharpness on one side, but the definition in the centre of the field is not injured.

To give some idea of the stars that can be seen and the value that may be given to photographic evidence of the existence or non-existence of faint stars, I give some particulars of this photograph. Without a magnifier 124 stars are to be seen within a radius of twenty minutes of arc from the nucleus.

I have traced these (see Fig. 1) so that they can be identified in the telescope; some of them may not be less than 13th magnitude, possibly fainter; the bright stars marked B, C, D, and E being shown in Argelander's maps of the Northern Heavens. B and C are at the present time about the same brightness as the new star, and can be well used to watch any variation in its light (when first seen by me on September 3 the new star was very much brighter than B or C, almost as bright as a star I have called A in my note-book that is just beyond the smaller nebula).

Using a magnifier to detect any fainter stars I find six near the nucleus: these I have shown as black dots on Fig. 2, using a

FIG. 2.



Scale 0·4 inch = 100″.

circle to show the stars near the nucleus that appear on Fig. 1, and a cross (×) to indicate the place of the new star. At this particular place there is not the slightest indication of any difference in the regular shading of the deposited silver from the denser part of the nucleus to the faint edge. The six stars indicated are extremely faint in the photograph and difficult to see, but I have no doubt of their real existence; from a comparison with other photographs I estimate them of about 15th magnitude, perhaps fainter. It may be that some of these may be identified at Birr Castle. From the absence of scale and orientation of the sketch given by Lord Rosse on p. 465 comparisons cannot be made, but a reference to the note-books would enable this to be done. A. A. COMMON

DURING last week I examined on three evenings the spectrum of this star apparently in the nebula. It appears to be continuous, extending from about D, as far as, or perhaps a little past F. Both Mr. Percy Smith and I are able to confirm Lord Rosse's conviction of the existence of a bright line or band. We compared its position with spark spectra, and feel satisfied that its position is not far from the bright line of the spark in air near to, and on the more refrangible side of D. The slit was of course necessarily wide, and the spectrum faint, so that this must only be considered as approximate.

GEO. M. SEABROKE

Temple Observatory, Rugby, September 29

IN the first evenings of September I observed the new nucleus of the nebula in Andromeda: I find it of the 8th magnitude. With a little Maclean's star spectroscope applied to the 10-inch refractor the spectrum of the nucleus is continuous, with suspected brighter bands. On the nights of Sept. 14 to 16, with 340 and 470 enlargements, I found to the east of the nucleus, and 15″ to 18″ distant from it, a faint object, probably a second nucleus, of 12th to 13th magnitudes. A. RICCO

Palermo Observatory

The Proposed Change in the Astronomical Day

IN your account of the proceedings at the recent meeting of the Astronomische Gesellschaft at Geneva (NATURE, vol. xxxii. p. 517) Dr. Struve is reported to have stated "that in the Royal Astronomical Society the majority were in favour of the universal day." There appears to be some mistake here: the Royal Astronomical Society as a body has not expressed any opinion on the subject. And, judging from the individual expressions of opinion which have been published, I should imagine that here, as at Geneva, the majority of real workers in our science (with the probable exception of those engaged on solar work) would be opposed to the proposed change. But how the majority of the Fellows of the Royal Astronomical Society could vote on the question it is impossible to say. My desire that a wrong impression on this subject, arising from a statement reported to have been made by such a high authority as Dr. Struve, should not be spread abroad, must be my excuse for trespassing thus far on your space.

A. M. D. DOWNING

Royal Observatory, Greenwich, S.E., September 26

A Tertiary Rainbow

PROF. TAIT remarks, in his recently-published work on "Light," that rainbows due to three or more internal reflections "are too feeble to be observed." It may therefore be worth recording that a tertiary bow was clearly visible from Thandiani Hill, Punjab, one evening last week (August 17). The bow extended over an arc greater than a semicircle, but was broken in two places. The colours were as distinct as in many an ordinary bow.

The condition of the sky was specially favourable for seeing a tertiary bow. The sun was low, and on nearly the same level with it there were several horizontal layers of cloud of considerable extent, whose nearer, unilluminated sides were therefore dark enough to serve as a good background for the bow. There was also a cloud in front of the sun itself, partially reducing its brightness. T. C. LEWIS

August 25

A White Swallow

ON August 3 I saw a white swallow flying among its fellows over a mill-pond at Garioch's Ford, Auchterless, Aberdeenshire. When I repassed on the following day it was still there, and it appeared to my brother and to me to be *entirely* white: otherwise I should suggest that the one seen in Westmoreland on September 4 (NATURE, No. 830, p. 500) might be the same bird on its southward pilgrimage. If it is true that the albino bird is never courted or paired ("Descent of Man," chap. xiv.) we are not likely ever to see many white swallows.

Mirfield, Yorks, September 28 ALEX. ANDERSON

THE enclosed paragraph from Yarmouth, in the *Norfolk News* of this day, will have interest for your correspondent at Milnethorpe. HUBERT AIRY

Stoke House, Woodbridge, September 26

Rara Avis.—A cream-coloured specimen of the swallow (*Hirundo urbica*) was shot on Caister Road, on Monday morning last, by Mr. A. Patterson. It is now in the hands of Mr. B. Dye of Row 60 for preservation.

DURING the summer of 1883 Mr. Cooper, of Bromwich, observed a white swallow throughout the season at a place within the city on the banks of the Severn. J. LL. BOZWARD

Worcester, September 28

THE ANNUAL CONGRESS OF THE SANITARY INSTITUTE OF GREAT BRITAIN

THE subjects dealt with by the Sanitary Institute of Great Britain at its annual meetings cover a wide field, and the Leicester gathering of this year, under the presidency of Prof. de Chaumont, F.R.S., forms no exception to the rule. The first aim of the Institute is, through its various agencies, to assist and indeed to lead in the improvement of public health, and the President did well to prove, by mortality statistics, how great a saving of life can be effected by the adoption of efficient sanitary measures, and how remunerative expenditure in this direction proves itself to be. The result of the sanitation carried out in the Army, and which is so much due to the labours of the late Dr. Parkes and to those of his successor, Dr. de Chaumont, is that, comparing the results of thirty years ago with those which now obtain, there is a saving in the home Army of two battalions per annum. Some substantial progress is also being made in the same direction as regards the general public, and when it is more fully understood that preventible diseases as a rule destroy those members of the population who are most remunerative in so far as the State is concerned, and that, speaking generally, each such premature death means a loss of at least 100*l.*, even parsimonious members of sanitary authorities will not mind expending a little more of the public money in so good a cause.

Leicester was well chosen for this year's gathering, for in many respects the town has acquired some reputation in health matters. It may be regarded as the head-quarters of the anti-vaccination party; it prides itself, not without cause, on the efforts it has made to control the spread of infectious diseases; and it takes precedence amongst those English towns in which autumnal diarrhœa is so fatal to the infantile population. As regards the question of vaccination it would be premature to draw any general inferences from the Leicester results, for although during recent years only a comparatively small portion of the infantile population have been vaccinated, yet a vast majority of the inhabitants are fairly well protected against small-pox, and it is by no means so very strange that a disease which usually recurs in an epidemic form only after a lapse of years, should for a time remain absent from Leicester. Still, we frankly admit that the day of reckoning has been somewhat long in coming; but there are exceptional reasons for this. And in the first place we would note that Leicester is not so free from small-pox as is generally imagined. The Registrar-General's returns have, it is true, long shown an almost absolute blank as regards small-pox mortality there, but it must be remembered that the Leicester Small-pox Hospital, where the deaths from this disease take place, is not in the borough, and hence that the mortality occasioned is registered in altogether another district. Then again, the sanitary authority of Leicester, by the aid of a system of compulsory notification of infectious diseases, acquire the earliest knowledge as to the existence of cases of small-pox, and having provided themselves with an isolation hospital, the patients are at once removed, and their houses and clothing are efficiently disinfected. It may be said that any other town could do the same, and so vaccination would become unnecessary. But this is not so. Removal to hospital is only compulsory under conditions which, were objection raised to it by the people, would make this early isolation impracticable, and all populations are not so proud of their defiance of one of the laws of the country as to submit without resistance to the steps which are held necessary in order to prove that this law is a superfluous one. But Leicester goes much further than this. The authorities not only remove the sick, but they remove the healthy members of the sick person's family, and hold them in a species of quarantine until they know that they have escaped infection. Such a step may be very desirable from a health point of view, but it is altogether illegal, and it is quite certain that if any attempt were made to enforce such a system in other parts of the kingdom it would be resisted. The majority of the nation would also hold it to be unnecessary; and the recent publication by the German Government of the Report of a Commission showing that since re-vaccination was made compulsory in 1874 not a single death from small-pox has occurred in their Army, affords ample evidence that the simple operation of vaccination can fully meet all the difficulty.

But little further light was thrown, at the meeting, upon that obscure zymotic diarrhœa which annually causes so large a mortality in Leicester. But Dr. E. W. Buck, who has made the subject a special study, probably pointed out the essential cause of this fatality by showing how a large portion of the population of Leicester was exposed to the influence of a water-logged soil charged with decomposing organic matter. Temperature so largely influences this mortality that it was at one time regarded as its sole cause; but it is certain that a high temperature alone is powerless to produce it, whereas the effect of temperature on such conditions as obtain in Leicester must be very potent in favouring the development of organic germs, such as are now supposed to lie at the root of the evil. Extensive inquiry is needed as to this subject, and we hope that the results of the investigation which have been conducted for some years past by the Medical Department of the Local Government Board will soon be made public.

Amongst the many other matters of interest which were dealt with at the Congress is that of the provision of dwelling-accommodation for the working classes, and in view of the steadily extending practice of massing together vast numbers of human beings in great buildings where storey is piled upon storey, the warning uttered by Mr. Gordon Smith, President of the Engineering and Architectural Section, and the occupant of an important official appointment which adds weight to his opinion, should receive careful consideration. He asserts that in this class of buildings there has been an excessive infantile death-rate, and it is certain that the provision of ample open space about dwellings, which is, as regards ordinary dwellings, being more insisted on than ever, is especially necessary in the interests of child-life, which is so extremely sensitive to such insanitary surroundings as influence the quality of the air breathed.

The question of a rational system of burial was discussed at the last meeting of the Congress in connection with a paper by the Rev. F. Lawrence, who quoted the authority of the burial service of the Church of England as suggesting a system which would allow of the rapid action of the soil upon the dead, and who advocated burial at a depth of three or four feet only in coffins designed to ensure speedy perishability, and laid singly at a depth of three or four feet only from the surface. The advocates of cremation were naturally represented, but the progress of this method for the disposal of the dead is hindered by considerations which it is not easy to overcome. Foremost amongst these stands the difficulty of tracing cases of poisoning, and, even if the public were ready to assent generally to post-mortem examinations before the cremation was carried into effect, no such examination as is usually carried out could be trusted to decide whether this species of crime was the cause of death or not. Indeeed, in many cases of poisoning the most skilled pathological and chemical knowledge is required in order to avoid error. On the whole, such discussions as have taken place at Leicester tend to improvement in matters where change is desirable in the interests of public health, and the Institute may be congratulated on the results of their recent meeting.

INSECT RAVAGES

THE preservation of our garden and field crops from the attacks of injurious and destructive insects is a study which Miss E. A. Ormerod has made specially her own and which she has carried out with such signal success. Miss Ormerod's labours in popularising the subject so as to bring it within the knowledge of all classes in any way connected with agricultural and gardening pursuits are too well known to need even a reference, so thoroughly has she at heart the welfare of our food crops and field produce that she has taken other steps, besides the dissemination of her well known books, to bring the importance of the subject before those who are not likely to be reached by the works in question. We refer to the prize offered by her at an agricultural show held at Frome last year, the result of which was satisfactory in drawing a considerable amount of attention to the subject, and one of the outcomes of which has been the preparation of a series of object lessons, so to speak, which have been elaborated from the plan of Mr. W. H. Haley, who took the prize at Frome last year. The plan of these lessons is as follows:—One insect is taken as an example and the life-history of this particular insect is illustrated by showing the creature in all its stages of development where practicable, or by neat and accurate-coloured drawings of pupa, larva, and perfect insect, each stage of which is carefully labelled, then a spray or twig of the plant attacked, or a model showing the insect's ravages is given, and in many cases also the parasites which attack the insect itself. Beneath this is carefully printed the life-history of the particular insect, and an enumeration of the plants upon which it feeds; and, finally, under the head of "Prevention and Remedies," some brief but concise instructions how to proceed to rid one's crops of the pest. All this is arranged on a cardboard mount 12 inches long by 8 inches wide, and placed in a box with a glass cover, so that one insect only is treated of in one case, thus making the information imparted very clear, and preventing all confusion. Of the insects treated in this way are the turnip and cabbage gall weevil, turnip moth, turnip fly, cabbage aphis, large white cabbage butterfly, cabbage moth, vine beetle, bean beetle, pea and bean weevil, winter moth, American blight on apple, magpie moth on gooseberry, celery-leaf miner, silver moth, beet or mangold fly, click beetle and wireworms, goat moth, lacky moth, daddy-long-legs, and onion fly.

Twenty of these cases have recently been prepared by Mr. Mosley, of Huddersfield, under the superintendence of Miss Ormerod, and are now in the museum at Kew, and a set of ten of a similar character are to be placed in the Aldersey School of the Haberdashers' Company at Bunbury, Cheshire, where plain teaching on such subjects is being satisfactorily carried on. J. R. J.

AMERICAN AGRICULTURAL GRASSES[1]

HOWEVER complicated the systematic synonymy of the Gramineæ may be, the popular nomenclature of the grasses is probably in an even more unsatisfactory state. In the former case the name of the author appended to the scientific name of the plant is usually sufficient to dispel any ambiguity as to what particular plant is meant, even though that plant may have received half a dozen systematic names from as many different botanists. In the case of the trivial name, however, even this means of identification is lacking, and it is no uncommon circumstance to find the same name applied to several different grasses, each one of which may, moreover, have one or two additional names. To those who are studying the grasses in their agricultural aspect this confusion is very perplexing, particularly as both the English and the American agricultural journals usually refer to a grass by its trivial name. The difficulties which surround this subject are well exemplified in the volume before us. For example, in American agricultural publications the term "salt-grass" is frequently met with, and we searched this volume in the hope of finding out the species so denominated. But instead of one we find no less than four distinct species, in as many genera, called "salt-grass," namely, *Vilfa depauperata*, *Sporobolus airoides*, *Brizopyrum spicatum* (*Distichlis maritima*), and *Spartina juncea*. To an English agriculturist foxtail means *Alopecurus pratensis* only, whereas in America the name is also given to *A. geniculatus*, *Hordeum murinum*, *H. jubatum*, and *Setaria setosa*. Rye-grass in England is *Lolium perenne*; in America the term is applied in addition to four species of Elymus. Blue grass is the name given to four distinct species of Poa, varying considerably in their agricultural value, and one of these, *P. pratensis*, often spoken of as Kentucky blue-grass, is also called "June grass," "spear grass," and "red top," the last name being equally applied to *Agrostis vulgaris*. Bunch grass is more vague in its application, for it embraces at least six species in five genera, while in Canada the same name is given to two other grasses, *Elymus condensatus* and *Kœleria cristata*, the former of which is known in the United States as "giant rye grass." The term "goose grass," which in England is restricted to the rubiaceous hedgerow weed *Galium Aparine*, is, in America, applied to *Poa annua*, which is also called annual spear grass, and to *Panicum Texanum*, further known as Texas millet. The grass *Holcus lanatus*, which to all English farmers is known as Yorkshire fog, is variously termed velvet grass, velvet mesquite, satin grass, and meadow soft grass, this last term being also current in England.

There are about 600 species of grasses in the United States, a few only of these having been introduced. The work under notice embraces descriptions of 120 species, each accompanied by a plate. Of these, about forty, included under twenty-six genera, are identical with British species. Five additional British genera are represented, but not by British species; these are Elymus, Melica, Spartina, Stipa, Triodia. About a dozen British genera do not appear, the most noteworthy among these being, perhaps, Brachypodium, Briza, and Cynosurus. Two dozen of the genera enumerated are extra-British; the chief ones are Andropogon, Aristida, Bouteloua, Buchloë, Danthonia, Muhlenbergia, Paspalum, Sorghum, Sporobolus, and Zizania. The so-called buffalo grasses are *Bouteloua oligostachya*, *Stipa spartea*, and *Buchloë dactyloides*; the first two may be gathered in quantity by any one who travels across the Canadian prairies, but the last-named, which is regarded as the true buffalo grass, does not extend into Canada.

In upwards of 100 pages of text we find collected much information both of botanical and of agricultural interest. The structural and economic characters of each grass figured are detailed at some length, but Dr. Vasey has, perhaps wisely in a work of this kind, made no attempt at classification. Though systematic synonyms are seldom given, there is a lavish display of trivial ones, for which the agricultural reader, at all events, will be grateful. Orthographic blunders are rather numerous, and the index might be more complete. The term *chartaceous* ("the texture resembling paper or parchment in thickness") is, we believe, not current on this side of the Atlantic; let us hope we may do without it.

The chemical analyses are of much agricultural interest, and readers should compare the results here given with those obtained by Wolff in his analyses of German grasses. The figures before us serve to show how considerably the same gramineous species may vary in composition according to the soil and climate in which it is grown, this point being specially illustrated by analyses of *Phleum pratense* and *Dactylis glomerata*, each from half a dozen different localities. How variable is the composition of gramineous herbage generally is well shown in the following table, in which are given the highest and lowest percentages of the constituents named, obtained in 136 analyses of different species of grasses:—

Dry substance	Highest	Lowest
Ash	19·24	3·57
Fat	5·77	1·48
Nitrogen free extract	66·01	34·01
Crude fibre	37·72	17·68
Albuminoids	23·13	2·80

[1] "The Agricultural Grasses of the United States." By Dr. George Vasey, Botanist of the Department of Agriculture; also, "The Chemical Composition of American Grasses," by Clifford Richardson, Assistant Chemist. (Washington: Department of Agriculture, 1884.)

A process which has been the means of throwing much light on problems in vegetable physiology and agricultural chemistry, namely, a comparison of the analyses of a plant and of its separate members in different stages of growth, has been applied to fifteen familiar species of grasses, and the results are tabulated and briefly discussed.

Many useful suggestions, some of them of the highest practical importance, are to be met with in these pages. Here is one by Prof. Asa Gray which refers to the Teosinte, or Guatemala grass, *Euchlæna luxurians*, a native of Mexico and Central America, and has the true ring of progress about it:—

"To make the *Teosinte* a most useful plant in Texas and along our whole south-western border the one thing needful is to develop early-flowering varieties, so as to get seed before frost. And this could be done without doubt if some one in Texas or Florida would set about it. What it has taken ages to do in the case of Indian corn, in an unconscious way, might be mainly done in a human lifetime by rightly directed care and vigorous selection."

This volume is highly creditable to its authors, and it adds one more to the many useful publications which have emanated from the United States Department of Agriculture. W. FREAM

THE DEVELOPMENT OF THE CÆCILIANS

IN a letter recently published in the *Arbeiten aus dem zoologisch-zootomischen Institut in Würzburg*, Messrs. P. B. and C. F. Sarasin give a preliminary account of the development of *Epicrium glutinosum* as observed at Peraderinia in Ceylon, where these naturalists have taken up their quarters near the celebrated Botanical Gardens. Since the original discovery by Johannes Müller of the larval form of the Cæcilians, almost the only information obtained on this important subject is a short account of the gilled larvæ of *Cæcilia compressicauda* by Peters, founded on specimens procured by Jelski in Cayenne.

The brothers Sarasin show that *Epicrium* is not viviparous, as is *Cæcilia*, but oviparous. In the most advanced stage before hatching the embryo is provided with very long blood-red external gill-filaments, and has also a distinct tail with a strong fin. The gill-filaments are shed previous to the hatching, after which the young Cæcilians make their way to the neighbouring stream, and live in the water, breathing by means of gill-slits. After they leave the water their gill-slits close up, and they breathe by lungs. The brothers Sarasin compare these Cæcilians to Urodeles, in that they pass through the perennibranchiate stage in the egg. As larvæ they are derotrematous, and in the adult stage become true land-animals like Salamanders. Our authors also show that the spermatozoon has a spiral filament, and that there is a fourth gill-arch, from which the pulmonary artery is given off. Both these facts tend to show that the Cæcilians are more nearly allied to the Urodeles than to the Anurous Amphibians.

THE BRITISH ASSOCIATION

REPORTS

Fifth Report of the Committee, consisting of Mr. R Etheridge, Mr. Thomas Gray, and Prof. John Milne (Secretary), appointed for the purpose of investigating the Earthquake Phenomena of Japan. (Drawn up by the Secretary).—On account of an excursion which I have the intention of making during the coming summer to Australia and New Zealand, I am compelled to draw up this report a month earlier than usual. As the only time when the work of attending to observations and experiments repays itself is during the winter months, I may safely say that my intention of shortening the time usually devoted to earthquake observations is not likely to involve any serious loss. The number of earthquakes felt during corresponding periods in two previous years and this last year were respectively twenty-six, thirty-nine, and eighty, and not only have the earthquakes been numerous, but some of them have been pretty stiff, as is testified by the fact that on several occasions chimneys fell and walls were cracked. The work done during the last year is briefly as follows:—

Seismic Experiments.—Seismic experiments were commenced in conjunction with Mr. T. Gray in 1880. The movements then recorded were produced by allowing a heavy ball, 1710 lbs. in weight, to fall from various heights up to thirty-five feet. Subsequently many experiments were made by exploding charges of dynamite and gunpowder placed in bore-holes. During the last year, whilst working up the long series of records which accumulated, several laboratory experiments were made to investigate the methods to be employed when analysing the diagrams of earth motion. The first of these experiments consisted in projecting a small ball from the top of a tall flat vertically-placed spring, and at the same time causing the spring to draw a diagram of its motion. From the distance the ball was thrown its initial velocity could be calculated. From the diagram, either by calculation on the assumption of simple harmonic motion or by direct measurement, the maximum velocity of movement could be obtained. These three quantities practically agreed. The most important result obtained by these experiments was that they indicated an important element to be calculated in earthquake or dynamite diagrams, and, further, that in these diagrams the first sudden movement, which invariably has the appearance of a quarter-oscillation, ought apparently to be considered as a semi-oscillation. The second set of experiments consisted in determining the quantity to be calculated from an earthquake diagram which would give a measure of the overturning or shattering power of a disturbance. For this purpose a light strip of wood was caused by means of a strong spiral spring and a heavy weight to move horizontally back and forth with the period of the spring. On this strip small columns of wood were stood on end, and it was determined how far the spring had to be deflected and then suddenly released to cause overturning. The more important results of all these experiments are:—

I. *Effect of Ground on Vibration.*—(1) Hills have but little effect in stopping vibrations. (2) Excavations exert considerable influence in stopping vibrations. (3) In soft damp ground it is easy to produce vibrations of large amplitude and considerable duration. (4) In loose dry ground an explosion of dynamite yields a disturbance of large amplitude but of short duration. (5) In soft rock it is difficult to produce a disturbance the amplitude of which is sufficiently great to be recorded on an ordinary seismograph.

II. *General Character of Motion.*—(1) The pointer of a seismograph with a single index first moves in a normal direction, after which it is suddenly deflected, and the resulting diagram yields a figure partially dependent on the relative phases of the normal and transverse motion. These phases are in turn dependent upon the distance of the seismograph from the origin. (2) A bracket seismograph indicating normal motion at a given station commences its indications before a similar seismograph arranged to write transverse motion. (3) If the diagrams yielded by two such seismographs be compounded, they yield figures containing loops and other irregularities not unlike the figures yielded by the seismograph with the single index. (4) Near to an origin, the first movement will be in a straight line outwards from the origin; subsequently the motion may be elliptical, like a figure 8, and irregular. The general direction of motion, is, however, normal. (5) Two points of ground only a few feet apart may not synchronise in their motions. (6) Earthquake motion is probably not a simple harmonic motion.

III. *Normal Motion.*—(1) Near to an origin the first motion is outwards. At a distance from an origin the first motion may be inwards. (2) At stations near the origin the motion inwards is greater than the motion outwards. At a distance the inwards and outwards motion are practically equal. (3) At a station near the origin, the second or third wave is usually the largest, after which the motion dies down very rapidly in its amplitude, the motion inwards decreasing more rapidly than the motion outwards. (4) Roughly speaking the amplitude of normal motion is inversely as the distance from the origin. (5) At a station near an origin the period of the waves is at first short. It becomes longer as the disturbance dies out. (6) The semioscillations inwards are described more rapidly than those outwards. (7) As a disturbance radiates the period increases. Finally it becomes equal to the period of the transverse motion. From this it may be inferred that the greater the initial disturbance the greater the frequency of waves. (8) Certain of the inward motions of "shock" have the appearance of having been described in less than no time. (9) The first outwards motion, which on diagrams has the appearance of a quarter-wave, must be regarded as a semi-oscillation. (10) The waves on the diagrams taken at different stations do not correspond. (11) At a station near the origin, a notch in the crest of a wave of shock gradually increases as the disturbance spreads, so that at a second station the wave with a notch has split up into two waves. (12) Near the origin the normal motion has a definite commencement. At a distance the motion commences irregularly, the maximum motion being reached gradually.

IV. *Transverse Motion.*—(1) Near to an origin the transverse motion commences definitely but irregularly. (2) Like the normal motion, the first two or three movements are decided, and their amplitude slightly exceeds that of those which follow. (3) The amplitude of transverse motion as the disturbance radiates decreases at a slower rate than that of the normal motion. (4) As a disturbance dies out at any particular station the period decreases. (5) As a disturbances radiates the period increases. This is equivalent to an increase in period as the intensity of the initial disturbance increases. (6) As we recede from an origin the commencement of the transverse motion becomes more indefinite.

V. *Relation of Normal to Transverse Motion.*—(1) Near to an origin the amplitude of normal motion is much greater than that of the transverse motion. (2) As the disturbance radiates, the amplitude of the transverse motion decreases at a slower rate than that of the normal motion, so that at a certain distance they may be equal to each other. (3) Near to an origin the period of the transverse motion may be double that of the normal motion; but as the disturbance dies out at any given station, or as it radiates, the periods of these two sets of vibrations approach each other.

VI. *Maximum Velocity and Intensity of Movement.*—(1) An earth particle usually reaches its maximum velocity during the first inward movement. A high velocity is, however, sometimes attained in the first outward semi-oscillation. (2) The intensity of an earthquake is best measured by its destructive power in overturning, shattering, or projecting various bodies. (3) The value

$$v^2 = \tfrac{4}{3}g\sqrt{a^2 + b^2 \times}\left(\frac{1 - \cos\theta}{\cos^2\theta}\right)$$

used by Mallet and other seismologists to express the velocity of shock as determined from the dimensions of a body which has been overturned, is a quantity not obtainable from an earthquake diagram. It represents the effect of a sudden impulse. (4) In an earthquake a body is overturned or shattered by an acceleration, f, which quantity is calculable for a body of definite dimensions. The quantity f as obtained from an earthquake diagram lies between $\frac{v}{t}$ and $\frac{v^2}{a}$, where v is the maximum velocity, t is the quarter-period, and a is the amplitude. (5) The initial velocity given in the formula $v^2 = \frac{2a^2}{b}$ (for horizontal projection) used by Mallet as identical with v^2 in 3, are not identical quantities. (6) In discussing the intensity of movement I have used the values $\frac{v^2}{a}$. (7) The intensity of an earthquake at first decreases rapidly as the disturbance radiates; subsequently it decreases more slowly. (8) A curve of intensities deduced from observations at a sufficient number of stations would furnish the means of approximately calculating an absolute value for the intensity of an earthquake.

VII. *Vertical Motion.*—(1) In soft ground vertical motion appears to be a free surface-wave which outraces the horizontal component of motion. (2) Vertical motion commences with small rapid vibrations, and ends with vibrations which are long and slow. (3) High velocities of transit may be obtained by the observation of this component of motion. It is possibly an explanation of the preliminary tremors of an earthquake and the sound phenomenon. (4) The amplitude and period of vertical waves as observed at the same or different stations have been measured.

VIII. *Velocity.*—(1) The velocity of transit decreases as a disturbance radiates. (2) Near to an origin the velocity of transit varies with the intensity of the initial disturbance. (3) The rate at which the normal motion outraces the transverse motion is not constant. (4) As the amplitude and period of the normal motion approach in value to those of the transverse motion, so do the velocities of transit of these motions approach each other. (5) That the ratio of the speed of normal and transverse motions is not constant is shown from a table of these velocities calculated for different rocks from their moduli of elasticity.

IX. *Miscellaneous.*—(1) At the time of an earth-disturbance, currents are produced in telegraph lines. (2) The exceedingly rapid decrease in the intensity of a disturbance in the immediate neighbourhood of the epicentrum has been illustrated by a diagram. (3) For the duration of a disturbance due to a given impulse in different kinds of ground, reference must be made to the detailed descriptions of the first four sets of experiments.

Experiments on a Building to resist Earthquake Motion.—In the Report of last year I described a house which rested at its foundations upon cast-iron balls. These balls were 10-inch shell. The records obtained from an instrument placed inside this house showed that, although it was subjected to considerable movement at the time of an earthquake, all *sudden* motion had been destroyed. Although the balls did very much to mitigate earthquake motion, wind and other causes produced movements of a far more serious nature than the earthquake. To give greater steadiness to the house, 8-inch balls were tried, and then 1-inch balls. Finally the house was rested at each of its piers upon a handful of cast-iron shot, each ¼-inch in diameter. By this means the building has been rendered astatic, and, in consequence of the great increase in rolling friction, sufficiently stable to resist all effects like those of wind. The shot rest between flat iron plates. That the house had peculiar foundations would not be noticed unless specially pointed out. From these experiments it seems evident that it is possible to build light one-storied structures of wood or iron in which, relatively to other houses, but little movement will be felt.

Observations in a Pit 10 *feet deep.*—The instrument placed in this pit is similar to all the other instruments, and is installed in a similar position. Comparing the maximum amplitudes, maximum velocities, and maximum accelerations obtained in the pit with those obtained at about thirty feet distance, they are for one particular earthquake respectively in the ratios of 1 : 43, 1 : 52, and 1 : 82. In most earthquakes the extent of motion has been too small to admit of measurement, and that there had been any movement could only be detected by holding the plate on which the record was written up to the light and glancing along it lengthways. This investigation tends to confirm the view which I have previously put forward, that an earthquake at a short distance from its epicentrum is practically a surface disturbance, principally consisting of horizontal movements. The vertical motion is small, and is best seen in the preliminary tremors either of an actual earthquake or of a dynamite explosion. From a practical point of view these results must be of the greatest importance to those who have to erect heavy structures in earthquake districts.

Buildings in Earthquake Countries.—As during the last few years so much destruction both to life and property has taken place in various parts of Europe, it seems that an epitome of the results of observations and experiments carried on in Japan relative to construction in seismic districts might not only be interesting, but possibly it might also be of practical value. When erecting a building it appears that we ought first to reduce as far as possible the quantity of motion which ordinary buildings receive; and, second, to construct a building so that it will resist that portion of the momentum which we are unable to keep out. To reduce the momentum which usually reaches a building the following may be done:—

(1) Institute a seismic survey of the district or area in which it is intended to build, and select a site where experiment shows that the motion is relatively small. (2) For heavy buildings adopt deep foundations (perhaps with lateral freedom), or at least let the building be founded on the hardest and most solid ground. It is perhaps because the tops of the hills in Tokio are harder than the plains that they have relatively the least motion. A building only *partially* isolated may be exceedingly dangerous from the fact that motion entering in the unprotected side will make the excavations (cuttings, valleys, &c.) upon the opposite side into free surfaces which will swing forward through a range greater than they would have swung had the excavations

not existed. (3) For light buildings, especially if erected on soft ground, where the range of motion is always great, if the structure rests on layers of fine cast-iron shot, it cannot possibly receive the same momentum as a building attached to the moving ground. To resist the effects of momentum which cannot be cut off a building: (1) Bear in mind the fact that it is chiefly stresses and strains which are applied horizontally to a building which have to be encountered. A vertical line of openings like doors or windows in a building constitute a vertical line of weakness to horizontally-applied forces. (2) Avoid coupling together two portions of a building which have different vibrational periods, or which from their position are not likely to synchronise in their motion. If such parts of a building must of necessity be joined, let them be so joined that the connecting link will force them to vibrate as a whole, and yet resist fracture. Brick chimneys in contact with the framing of a wooden roof are apt to be shorn off at the point where they pass through the roof. Light archways connecting heavy piers will be cracked at the crown. To obviate destruction due to these causes a system of construction similar to that to be seen in several of the buildings of San Francisco, Tokio, and Yokohama may be adopted. This essentially consists of tieing the building together at each floor with iron and steel tie-rods crossing each other from back to front and from side to side. (3) Keep the centre of inertia of a building or its parts as low as possible. Heavy tops to chimneys, heavy copings, and balustrades on walls and towers, heavy roofs and the like are all of serious danger to the portion of the structure by which they are supported. When the lower part of a building is moved, the upper part by its inertia tending to remain behind often results in serious fractures. All the chimneys in Tokio and Yokohama which have fallen in consequence of their ornamental heads have been replaced by shorter and thicker chimneys without the usual coping. The roof of a portion of the Engineering College rests loosely on its walls, and has therefore a certain freedom. In Manila many heavy roofs have been replaced by roofs of sheet iron. Walls may be lightened in their upper parts by the use of hollow bricks. Such vertical motion as may exist is also partly obviated by light superstructures. Vertically-placed iron tie-rods give additional security. If these and other rules which are the result of experiment and observation could be adopted in earthquake countries, it is certain that the loss of life and property might be greatly diminished.

Earth Tremors and Earth Pulsations.—Notwithstanding the untrustworthiness of level observations, they nevertheless have given results of interest. (1) The bubbles from time to time move back and forth without apparent reason. Considerable changes have sometimes been observed before an earthquake (2) The greatest movement of the bubble of a level takes place during the colder part of the year, which is the season of earthquakes, and also the season when the barometric gradient between Siberia and the Pacific is the steepest. (3) The bubble of a level continues to move long after the sensible motion of an earthquake has ceased, enabling us to study the slow movements which bring an earthquake to a close. (4) When the barometer is very low, as, for instance, during a typhoon, the bubble of a level may be distinctly seen to pulsate back and forth through a range of about ·5 mm. In September of last year, in conjunction with Mr. W. Wilson, C.E., and Mr. Mano, of the Imperial College of Engineering, I carried an instrument to the summit of Fujiyama, which is about 12,365 feet in height, where I succeeded after many failures in recording automatically earth tremors and earth pulsations. But we were unable to remain for more than five days.

The results of interest connected with these observations are:—(1) That the movements on the top of the mountain were much greater than those which I usually observe in Tokio. (2) The tremors, or slight swing-like movements of the instrument, did not necessarily accompany the wind. (3) That during the heavy south and south-east gales the direction of displacement of the pointer was towards the south-east, which is the same result as would be obtained if the bed-plate of the instrument were raised on the south-east side, or if the mountain had tipped over to the north-west. My colleague, Mr. T. Alexander, treating Fuji as a conical solid made of brick, with a wind-load of 50 lbs. on the square foot, found the slope and deflection of a point 100 feet below the apex of the cone. This calculated slope was two or three times greater than the greatest deflection which I measured. As it is difficult to imagine that a mountain could suffer deflection by a wind pressure, I will not insist upon the fact that deflection actually occurred. It is certainly curious that the results of calculation and observation should point in the same direction.

Report of the Committee on Electrical Standards, consisting of Prof. G. C. Foster, Sir W. Thomson, Prof. Ayrton, Prof. J. Perry, Prof. W. G. Adams, Lord Rayleigh, Prof. O. J. Lodge, Dr. John Hopkinson, Dr. A. Muirhead, Mr. Preece, Mr. H. Taylor, Prof. Everett, Prof. Schuster, Dr. J. A. Fleming, Prof. G. F. Fitzgerald, Mr. R. T. Glazebrook, Prof. Chrystal, Mr. H. Tomlinson, and Prof. Barnett, with Mr. Glazebrook as Secretary.—The Committee reported that the Secretary has had constructed a series of coils to serve as standards in terms of the legal ohm. These standards, in accordance with the resolution of the Committee, were constructed on the supposition that the value of the legal ohm is 1·0112 B.A. units. The comparisons were made by the methods given in the reports for 1885 and 1884, and the values found were—

No.		Resistance		Temperature
100	...	·999515	...	14·1
101	...	·998845	...	14·1
102	...	10·00415	...	16·7
103	...	10·00352	...	16·75
104	...	100·0304	...	16·05
105	...	100·0436	...	16·05
106	...	1000·694	...	17·4
107	...	1000·677	...	17·45
108	...	10006·8	...	17·35
109	...	10006·8	...	17·35

These standards have also been compared with mercury-tube resistances constructed by Mr. Benoit, of Paris, and a difference of ·00049 legal ohm was found. The legal ohm standards, as constructed by the Committee, exceed by this amount those constructed in Paris. Six coils have been compared with the standards during the year, and the values are given. The Committee hope that arrangements may be made for issuing standards of electromotive force, and for constructing and issuing standards of capacity. In conclusion, they ask to be reappointed, with the addition of the names of Prof. J. J. Thomson and Mr. W. N. Straw, with a renewal of the unexpended grant of 50*l*.

Report on Electrical Theories, by Prof. J. J. Thomson.—This report deals exclusively with those theories which only profess to give mathematical expressions for the forces due to a distribution of currents. Those theories which profess to give mechanical explanation of these forces are not considered. There was not sufficient time to consider both classes of theories, and it is evident that the mathematical theory must be settled before we can get a satisfactory mechanical one. As to the general result of the inquiry, we may say that all that has been proved is that it is absolutely necessary to take into account the currents in the dielectric; and that the action of these, as well as other currents, must be given by some form of the potential theory—that is, the theory propounded by F. E. Neumann and generalised by Von Helmholtz. But nothing definite is known as to what we should take as the measure of these electric currents, and which of the many forms of the potential theory is the right one. We hardly require experimental proof that alteration in the polarisation of the dielectric, at any rate if the dielectric be other than the ether, produce effects analogous to those produced by an ordinary current flowing through a conductor. For the polarisation of a dielectric by an electromotive force produces a change in the structure of the dielectric. This is shown by the alteration in volume experienced by glass and other bodies when placed in the electric field, and also by the breaking down of the dielectric when the strength of the field is great enough. Now, if we move a magnet we shall, since we produce an electromotive force in its neighbourhood, produce a change in the structure of the dielectric around it because we alter its state of polarisation. It follows, then, from the principle of action and reaction, that if we alter the state of polarisation of the dielectric we shall alter the state of motion of the magnet. So that an alteration in the polarisation of the dielectric produces a magnetic force. We can show in a similar way that an alteration in the polarisation must produce all the effects produced by an ordinary conduction current. We know nothing, however, about the magnitude of the current which is equivalent to a change in the state of polarisation. It seems natural to suppose that the intensity of the current is proportional to the rate of change of the electromotive force. Let us suppose that it equals η (rate of change of the electromotive force). The quantity η has never been experimentally determined, but two hypotheses have been made as to its value by Maxwell and Helmholtz. According to Maxwell $\eta = \kappa/4\pi$, where κ is the specific inductive capacity, and, according to Helmholtz, η is also a function of κ. There is very little experimental evidence for either of these theories. For Maxwell's theory, perhaps the best evidence is that, if we assume the electro-magnetic theory of light, the refractive index should, if $\eta = \kappa/4\pi$, equal the square root of a specific inductive capacity, which is very approximately the case for a good many substances. Maxwell's assumption has the great advantage of getting rid of all discontinuity in the currents; and, when this is the case, all forms of the potential theory lead to the same result. So that, if we could prove Maxwell's theory experimentally, it would be a complete theory of electro-dynamic action. If it should turn out, however, that Maxwell's theory is not true, then we should have to go on further and determine which of the several forms of the potential theory is the true one; as, if the currents are not closed, the different forms of the theory lead to different results. It would seem that the most important thing to be done in electro-dynamic theory is to determine whether $\eta = \kappa/4\pi$ or not, and the author has des_ribed two ways in which this may be done. If Maxwell's theory should prove not to be true, we must go on to determine the value of η for all dielectrics, and which of the forms of the potential theory is the true one.

Report on Standards of White Light.—Various experiments have been made by the Committee. The members have come to the conclusion that the standard candle as defined by Acts of Parliament is not in any sense a standard. The spermaceti used is not a definite chemical substance, and is mixed with other substances. Also the constitution of the wick is not properly defined. The Committee have considered the relative merits of different proposed standards, and have come to the conclusion that for *commer.ial* purposes the pentane standard of Mr. Vernon Harcourt is the best. Although the Committee wish their opinion on this point to be known to the Board of Trade and the public, they do not recommend the adoption of any particular standard until further experiments on radiation have been made. Several experiments are enumerated which they propose to make. They ask reappointment, with a grant of 50*l.* towards the proposed researches.

Report of the Committee on Meteoric Dust.—Experiments have been made at the Scottish Marine Station by means of an apparatus in which the wind blows through gratings of fine platinum wire. The moisture deposited is collected and examined for suspended particles. Funnels have also been placed at different localities for catching rain. The presence of carbonaceous matter is most marked. In smaller quantities occur quartz, felspar, mica, tourmaline, garnet, glassy particles resembling Krakatoa dust or pumice, and small round magnetic particles about 1-500th of an inch in diameter. They resemble similar larger particles got from deep-sea deposits at the greatest distance from continental land. None are of cosmic origin. Usually they have a small nucleus in the interior, but are frequently hollow. Further observations are to be made at various stations all over the world.

Report of the Committee on Meteorological Observations on Ben Nevis.—The chief additional observations made during the year were with regard to rainfall and wind. The amount of water substance deposited, in whatever form, has been collected by specially-designed gauges and measured every hour since June 24, 1884. In the end of October the anemometers designed by Praf. Chrystal were added to the instruments. But during seven months—November, 1884, to May, 1885—no anemometer could indicate results, with the exception of thirty days. This is owing to the deposition of ice-crystals. The greatest speed indicated during three days was on the night of April 24. The mean speed for 12 hours was 74 miles per hour, the speed for one particular hour being 81 miles per hour. The highest temperature reached, 60°·1 F., occurred at 2 p.m., August 9; and the lowest, 11°·1 F., at midnight, February 16. The coldest week—average temperature, 16°·2 F.—was the one ending on February 21. The changes of temperature, particularly in winter, were caused, not by direct solar influence, but by the passage of cyclones or anticyclones over the observatory. Indeed in the stormy months of winter this may be taken to be accurately the case. In summer the afternoon minimum of atmospheric pressure was 0·007 inches above the mean for the whole day, but in winter it was below the mean. During twelve months there were 464 hours of sunshine, being about 11 per cent. of the total possible amount. Heavy rainfalls frequently occur. The longest for one hour was on December 10, 1884. The largest daily fall occurred then also, being 4·264 inches. On an average, a fall of at least one inch occurred one day in seven.

Report of the Committee on Solution, Secretary Dr. W. W. J. Nicol.—The subjects discussed in this Report are:—(1) Molecular volumes, (2) saturation, (3) supersaturation, (4) vapour pressures, and (5) expansion of salt solutions. (1) The results of a series of experiments show the molecular volume of a salt in dilute solution to be a quantity composed of two constants: one for the metal and the other for the salt radical; hence the same volume change is produced by replacement of one metal or salt radical by another metal or salt radical. *Wa'er of crystallisation* is not to be distinguished from the solvent water, but the *water of constitution* possesses a volume different from that of the rest of the water—results showing the existence in solution of the anhydrous salt in contradistinction to the view that a hydrate, definite or indefinite, is formed in solution. (2) Saturation is reached when the further addition of salt would produce diminution of the mean molecular volume of the molecules already present. (3) The so-called supersaturated solutions are simply saturated or non-saturated solutions of the anhydrous salts, the only truly supersaturated solutions being those which result from the fact that, when a hot solution is cooled, a finite time is required for the excess of salt to crystallise out.

The Report of the Committee appointed to investigate by means of Photography the Ultra-violet Spark Spectra emitted by Metallic Elements and their Combinations under Varying Conditions, drawn up by Prof. Hartley, F.R.S., was presented by him to the Section; in it an account is given of the results of the investigation of the changes in the character of the spectra of the metals produced by variation in the strengths of the solutions of their salts—*e.g.* chlorides, nitrates, or sulphates. The study of a very considerable number of the photographs of such spectra shows the strength of the solution to have a marked effect on their character, the more dilute the solution the smaller the number of lines; further, that under the same spark conditions, similar solutions of the same strength emit the same spectrum. Solutions containing 1 per cent., 1-10th, 1-100th, and 1-1000th of the metal were used; solutions of the latter strength seldom gave a spectrum of more than three or four lines, and with solutions containing less than 1-10th per cent. the diminution in the number of lines is usually very marked. The spectrum reaction may be utilised for the quantitative analysis of minerals, and yields results more reliable than those obtained by ordinary methods. The reaction is extremely delicate, and in the case of magnesium one part of the metal in 10,000 millions of solution can be detected by the appearance of two characteristic lines.

Third Report of the Committee, consisting of Profs. Williamson, Dewar, Frankland, Crum Brown, Odling, and Armstrong, Drs. Hugo Müller, F. R. Japp, and H. Forster Morley, and Messrs. A. G. Vernon Harcourt, C. E. Groves, J. Millar Thomson, H. B. Dixon (Secretary) and V. H. Veley, reappointed for the purpose of drawing up a Statement of the Varieties of Chemical Names which have come into use, for Indicating the Causes which have led to their Adoption, and for Considering what can be done to bring about some Convergence of the Views on Chemical Nomenclature obtaining among English and Foreign Chemists.—An account of the authorship of some of the various systems of nomenclature which have been devised for the purpose of distinguishing between compounds formed by the union of the same elements in different proportions has been given in the "Historical Notes" prefixed to the Second Report of this Committee. Among these systems the use of the termination *ous* and *ic*, to denote respectively lower or higher degrees of saturation of one element or group with another element or group, is perhaps that which has met with the widest acceptance. This system further directs that when electro-negative groups, the names of which end in *ous* and *ic*, unite with electro-positive groups to form salts, these terminations are to be changed into *ite* and *ate* respectively. It would be ill-advised to attempt on etymological grounds to change a system so firmly established as that involved in the present use of the prefixes *hypo* and *hyper*. No ambiguity can arise from the use of terms about the meaning of which every one is agreed, and their mere etymological accuracy is, in view of this all-important consideration, of secondary importance. As a metal rarely—if ever—forms more than two salifiable oxides, the *ous* and *ic* terminations generally suffice for purposes of distinction so far as the salts of metals are concerned. The practice of further employing these terminations in the case of acid-forming oxides does not lead to confusion, since these oxides are distinguished by the name *anhydride* (or *acid*). Thus we have

CrO	Cr_2O_3	CrO_3
Chromous oxide.	Chromic oxide.	Chromic anhydride. (Chromic acid.)

Indifferent oxides have frequently been classified and named by regarding them as compounds of salifiable, with acid-forming oxides, Cr_2O_4 being termed *chromic chromate*. For stages lower than *ous*, the prefixes *hypo* and *sub* are employed. Custom appears to have restricted *hypo* chiefly to acids and to acid-forming oxides, *sub* to salifiable and to indifferent oxides. With regard to the termination *ous*, the minor question arises, how far this termination ought to be written in the forms *ious* and *eous*. The answer is: as seldom as possible. "Cupreous" has generally given way to "cuprous"; no one writes "chromious" (although the name of the metal is "chromium"); and there is no reason why such names as "ruthenious" and "iridious" should not equally be shorn of their superfluous penultimate syllable. A further question, concerning which considerable difference of opinion has prevailed, is whether any *ous* or *ic* terminations ought to be employed in the names of salts of which only one class is known—thus *magnesic sulphate* instead of *magnesium sulphate*. There is something to be said here for both systems; and, as the diversity of practice does not lead to confusion, and consequently does but little harm (beyond in each case offending the ears of those accustomed to the opposite system), the question need not be regarded as a vital one. In the case of carbon compounds, however, there is a distinct advantage in affixing *ic* to the names of the positive radicals in ethereal salts. A neglect of this precaution leads to ambiguity—at all events in the *spoken* name. Thus, though there is no ambiguity in the name *ethyl phenylacetate* when written, yet the ear cannot distinguish between it and *ethylphenyl acetate*. This ambiguity is obviated by the use of the termination *ic*—thus, *ethylic phenylacetate* and *ethylphenylic acetate*. In the use of the terminations *ous* and *ic* to distinguish different series of *acids and acid-forming oxides*, with the exception of one or two isolated cases, almost perfect unanimity has prevailed. To sum up, the *ous* and *ic* terminations when employed for purposes of distinction in cases where two series of oxides, acids, salts, &c., are known, have been almost free from ambiguity, and for this reason deserve to be retained. On the other hand, in cases where only one series is known, those chemists who have employed one or other of these terminations have occasionally differed as to which ought to be used: the difficulty may be solved, as it has been done by some chemists, by avoiding the use of any termination in such cases. In complex cases where the above modes of naming prove inadequate, recourse may be had to numeral designations. These appear especially admissible in cases where an oxide occurs which is intermediate between the *ous* and the *ic* stage, and at the same time cannot be classed as a compound of oxides already classified and named. In applying numeral designations it is most important to select only such as are free from hypothesis and which afford correct information. In this respect chemists appear not to have been sufficiently careful of late years. As an example, *arsenious oxide* may be quoted; this compound is frequently termed "arsenic trioxide," the formula being written As_2O_3, and it is tacitly assumed that the molecule contains three oxygen atoms. There are three objections to this name:—(1) That, assuming the formula on which it is based to be correct, it affords no information as to the number of *arsenic* atoms associated with the *three* oxygen atoms; (2) that it involves the assumption that arsenious oxide does not vary in molecular weight, whatever its physical state; and (3) that the formula of *gaseous* arsenious oxide is As_4O_6. In employing numeral designations to indicate molecular composition in cases where this is established, it is therefore important to express the number of atoms of each constituent element, as *dicarbon hexachloride*, C_2Cl_6. But in the case of solid and liquid bodies of whichthe molecular weight is unknown, or which may vary with temperature, the name should merely indicate the relative proportions in which the constituents are associated; or, more explicitly, the name should indicate the proportion of the radical associated with what may be termed the characteristic element of the compound. No difficulty occurs in the case of the chloride, or analogous compound, of the monad elements generally, these being termed mono-, di-, tri-, tetra-, penta-, or hexa-chloride, &c., according as combination is in the proportion of 1, 2, 3, 4, 5, or 6 atoms of chlorine to 1 atom of the characteristic element. The application of this system would involve the use of the names tin dichloride and iron trichloride (not sesqui-chloride) for stannous and ferric chlorides respectively, names which accurately express the relative proportions of metal and of chlorine in these compounds without any hypothesis as to their molecular composition, which in the case of the former compound, at all events, certainly depends on temperature. It will, however, involve a slight departure from the existing practice when applied to oxides, sulphides, and other compounds of polyad elements; thus oxides of the type $(R_2)''O$ would be termed *hemi*-oxides, since they consist of the characteristic element and oxygen in the proportion of *one* atom of the former to *half* an atom of the latter. Oxides of the type $(R_2)^{vi}O_3$ would be termed *sesqui*-oxides, since the characteristic element and oxygen are present in the proportion of *one* of the former to *one and a half* of the latter. Oxides of the type R_2O_5 would be termed *sesterti*-oxides, as they contain oxygen and the characteristic element in the proportion of *two and a half* atoms of the former to *one* of the latter. Oxides of the types RO, RO_2, RO_3, and RO_4, would be termed respectively *mono-*, *di-*, *tri-*, and *tetr*-troxides.

The remainder of the report treats of the various systems which have been proposed for the naming of acid, basic, and double salts.

Report of the Committee appointed for the purpose of inquiring in to the Rate of Erosion of the Sea-Coasts of England and Wales, and the Influence of the Artificial Abstraction of Shingle or Material in that Action (C. E. De Rance and W. Topley, Secretaries).—The Committee has, during the past year, received several Returns relating to the south and east coasts of England. Most of those relating to the coast south of the Thames are printed. The thanks of the Committee are especially due to Major-Gen. Sir A. Clarke, who has instructed the officers of the Royal Engineers stationed around the coast to supply the Committee with such information as they may possess or be able to obtain. Further returns are expected from the same department and from other official sources; the Committee therefore think it best to defer any general Report until more complete information is obtained. The Memorandum drawn up by Mr. J. B. Redman so fully sets forth the work of the Committee, and the importance of the inquiry referred to it, that this is now printed. The Memorandum by Mr. G. Dowker, on East Kent, gives a sufficiently complete account of the changes of the coast in this district; changes which are of especial historical importance and interest. Mr. Whitaker has drawn up a list of works relating to the coast-changes of England and Wales, which will be of great service to the Committee and to those who may assist in the work. The Committee would again ask for the assistance of any who, by long residence or other means, have special knowledge of changes on any part of the English and Welsh coast. Printed forms of questions can be obtained from the secretaries or from any member of the Committee.

Third Report of the Committee, consisting of Sir J. Hooker, Dr. Günther, Mr. Howard Saunders, and Mr. Sclater (Secretary), appointed for the purpose of exploring Kilima-njaro and the adjoining mountains of Equatorial Africa.—In their last report, presented at Montreal, the Committee stated the arrangements that they had made with Mr. H. H. Johnston for undertaking an expedition to Kilima-njaro, and gave extracts from Mr. Johnston's letters showing the progress of his expedition up to May, 1884. Mr. Johnston gave an account of his expedition to the Royal Geographical Society at their meeting on January 26, 1885, in which he states that in consequence of the desertion of two natives whom he had taken out with him from Zanzibar as collectors, the collections were not so large as the Committee could have wished. Capt. Shelley prepared a report on the birds collected by Mr. Johnston, and Mr. F. D. Godman on the butterflies of his collection, after which the first sets in both these collections were handed over to the British Museum, as were also all the other zoological collections, with a request to the director that reports might be prepared for publication on such portions of them as seemed to be of sufficient interest. Reports on the zoological collections made by Mr. H. H.

Johnston have already been published in the *Proceedings* of the Zoological Society for this year. The botanical collections were handed over to the Royal Herbarium at Kew, where they were arranged, named, and a set sent to the British Museum. The report upon them is ready, and will be presented to the Linnean Society for publication. Prof. Bonney has kindly undertaken to report on the rock and mineral specimens collected by Mr. Johnston, and his report is presented herewith, and will be read in the Geological Section. Mr. H. H. Johnston has in preparation a volume containing a narrative of his expedition and a summary of the results arrived at, which will shortly be ready for issue. The sum of 25*l.* granted to the Committee at the Montreal meeting has been returned to the treasurer.

Report of the Committee, consisting of Dr. E. B. Tylor, Dr. G. M. Dawson, Gen. Sir J. H. Lefroy, Dr. Daniel Wilson, Mr. Horatio Hale, Mr. R. G. Haliburton, and Mr. George W. Bloxam (Secretary), appointed for the purpose of investigating and publishing Reports on the Physical Characters, Languages, Industrial and Social Condition of the North-Western Tribes of the Dominion of Canada.—The Committee have been in active correspondence with missionaries and others stationed among the Indians, but the unsettled state of the country during the past year has made it impossible to do more than collect materials for a preliminary report; the Committee, therefore, ask that they may be reappointed with a continuance of the grant.

Report on the Blackfoot Tribes. Drawn up by Mr. Horatio Hale.—The tribes composing the Blackfoot Confederacy, as it is commonly styled, have been until recently less known than any others. A correspondence was opened with two able and zealous missionaries residing among these Indians. The Rev. Albert Lacombe, widely and favourably known as Father Lacombe, Roman Catholic Missionary among the Siksika, or proper Blackfeet Indians, and the Rev. John McLean, Missionary of the Canadian Methodist Church to the Blood and Piegan (or Kena and Piekanè) tribes. Father Lacombe has been many years a missionary in the Canadian North-West, and has a very extensive knowledge of the tribes of that region. His elaborate work, the "Grammar and Dictionary of the Cree Language" ranks among the best contributions to American philology. Mr. McLean has been engaged in his missionary duties for five years, has prepared a grammar of the Blackfoot language, and is at present occupied in translating the Scriptures into that tongue. The unfortunate troubles of the past season have for a time interrupted the correspondence, and the principal portion of the report on these Indians will therefore have to be deferred for another year. Some other sources of information, however, have been examined, particularly the valuable official reports and maps of the Canadian and United States Indian Departments.

Fifty years ago the Blackfoot Confederacy held among the western tribes much the same position of superiority which was held two centuries ago by the Iroquois Confederacy among the Indians east of the Mississippi. The nucleus, or main body is still composed of three tribes, speaking the proper Blackfoot language: the Siksika, or Blackfeet proper; the Kena, or Blood Indians; and the Piekanè, or Piegans (pronounced Peegans), a name sometimes corrupted to "Pagan" Indians. To these are to be added the Sarcees from the north, and the Atsinas from the south. The Sarcees are an offshoot of the great Athabascan stock, which is spread over the north of British America, through Oregon and California into Northern Mexico. The Atsinas, who have been variously known as Fall Indians, Rapid Indians, and Gros Ventres, speak a dialect similar to that of the Arapohoes, who now reside in the "Indian Territory" of the United States. It is a peculiarly harsh and difficult language, and is said to be spoken only by those two tribes. None of the Atsinas are now found on Canadian territory, and no recent information has been obtained concerning them, except from the map which accompanies the United States Indian Report for 1884, and on which their name appears on the American Blackfoot Reservation. The five tribes were reckoned, fifty years ago, to comprise not less than 30,000 souls, the terror of all the western Indians on both sides of the Rocky Mountains. It was not uncommon for thirty or forty war parties to be out at once against the Salish (or Flatheads) of Oregon, the Upsarokas (or Crows) of the Missouri Plains, the Shoshonees of the far south, and the Crees of the north and east. The country which the Blackfoot tribes claimed properly as their own comprised the valleys and plains along the eastern slope of the Rocky Mountains, between the Missouri and the Saskatchewan, the favourite resort of the buffalo, whose vast herds afforded the Indians their principal means of subsistence. In the year 1836 a terrible visitation of the small-pox swept off two-thirds of the people, and five years later they were supposed to count not more than 1,500 tents, or about 10,000 souls. Their enemies were then recovering their spirits, and retaliating upon the weakened tribes the ravages which they had formerly committed.

In 1855 the United States Government humanely interfered to bring about a complete cessation of hostilities between the Blackfoot tribes and the other Indians, and framed a treaty for them, accompanying the act by a large distribution of presents. Dr. F. V. Hayden, in his account of the Indian Tribes of the Missouri Valley, states: "From my own experience among them, and from information derived from intelligent men who have spent the greater portion of their lives with them, I am convinced that they are among the most peaceable and honourable Indians in the West; and in an intellectual and moral point of view they take the highest rank among the wild tribes of the plains." This favourable opinion of Dr. Hayden is entirely in accordance with the testimony of the Indian agents and other officials of the Canadian North-West. At the present time, while constantly harassed on their reserves by the incursions of thievish Crees and other Indians, they forbear to retaliate, and honourably abide by the terms of their treaty, which binds them to leave the redress of such grievances to the Dominion authorities. Since the general peace the numbers of the Blackfeet have apparently qeen on the increase. Dr. Hayden reports the three proper Blackfeet tribes as numbering in 1855 about 7000 souls. The present population of the three Canadian Reserves is computed at about 6000, divided as follows: Blackfeet proper, 2400; Bloods, 2800; Piegans, 800. On the American Reservation there are stated to be about 2300, mostly Piegans. This would make the total population of the three tribes exceed 8000 souls. The adopted tribe, the Sarcees, have greatly diminished in numbers through the ravages of the small-pox. This tribe, now numbering less than 500 souls, have their Reserve near Calgary. They are reputed to be less cleanly and moral than the proper Blackfeet tribes. In this respect their habits and character correspond with those of other Athabascan tribes. During the past five years, as is well known, a great change has taken place in the condition of the north-western tribes through the extermination of the buffalo. The Blackfeet have been the greatest sufferers from this cause. The buffalo were their main dependence. Suddenly, almost without warning, they found themselves stripped of nearly every necessary of life. The change was one of the greatest that could well befall a community. The Governments both of the United States and of Canada came to the rescue; but in the former country the urgency of the case was not at first fully understood, and much suffering ensued. The agent on the Blackfoot Reservation in Montana (Major Allen) states in his official report that when he entered upon his duties in April 1884 he found the Indians in a deplorable condition. The supplies of food which had been sent for them had proved insufficient, and before these could be renewed many died from actual starvation. Some stripped the bark from the saplings which grew along their creeks, and ate the inner portion to stifle their sense of hunger. On the Canadian side, fortunately, the emergency was better understood. Col. McLeod, an able and vigilant officer, was in charge of the Mounted Police at that time, and through his forethought the necessary preparations were made. In 1879 and 1880 the buffalo disappeared from that region. Arrangements were at once made for settling the Indians on Reserves, and for supplying them with food and clothing, and teaching them to erect wooden houses and cultivate their lands. Daily rations of meat and flour were served out to them. Ploughs, cattle, and horses were furnished to them. Farm instructors were placed among them. The Indians displayed a remarkable readiness to adapt themselves to the new conditions. According to the reports of all the agents, they have evinced a quickness to learn and a persevering industry which place them decidedly in advance of the other Indian tribes of that region. In 1882 more than 500,000 lbs. of potatoes were raised by the three Blackfoot tribes, besides considerable quantities of oats, barley, and turnips. The Piegans had sold 1000 dollars' worth of potatoes, and had a large supply on hand. "The manner in which the Indians have worked," writes the agent, "is really astonishing, as is the interest they have taken, and are taking, in farming." Axes and other tools were distributed among them, and were put to good use. In November, 1882, log-houses had "gone up thick and fast on the Reserves, and were most creditable to the builders." In many cases the logs were hewn, and in nearly all the houses fireplaces were built. In the same year another official found comfortable dwellings, well-cultivated gardens, and good supplies of potatoes in root-houses. Most of the families had cooking stoves, for which they had sometimes paid as much as 50 dollars. He "saw many signs of civilisation, such as cups and saucers, knives and forks, coal-oil lamps, and tables; and several of the women were baking excellent bread and performing other cooking operations." Three years before these Indians were wild nomads, who lived in skin tents, hunted the buffalo, and had probably never seen a plough or an axe.

The Blackfeet have been known to the whites for about a century, and during that period have dwelt in or near their present abode. There is evidence, however, that they once lived further east than at present. The explorer Mackenzie, in 1789, found them holding the south branch of the Saskatchewan, from its source to its junction with the north branch. He speaks of four tribes—the Picaneaux, Blood, and Blackfeet, and the Fall Indians (Atsinas), which latter tribe then numbered about 700 warriors. Of the three former tribes he says: "They are a distinct people, speak a language of their own, and, I have reason to think, are travelling north-west, as well as the others just mentioned (the Atsinas); nor have I heard of any Indians with whose language that which they speak has any affinity. Mr. McLean's inquiries confirm this opinion of the westward movement of these Indians in comparatively recent times. "The former home of these people," he writes, "was in the Red River country, where, from the nature of the soil which blackened their mocassins, they were called Blackfeet." This, it should be stated, is the exact meaning of *Siksika*, from *siksinam*, black, and *ka*, the root of *oqkatsh*, foot. The meaning of the other tribal names, *Kena* and Piekanè, is unknown. This westward movement has probably been due to the pressure of the Crees, who, according to their own tradition, originally dwelt far east of the Red River, in Labrador and about Hudson's Bay. They have gradually advanced westward, pushing the prior occupants before them by the sheer force of numbers. This will explain the deadly hostility which has always existed between the Crees and the Blackfeet. M. Lacombe, however, expresses a doubt as to their former sojourn in the Red River region: "They affirm, on the contrary, that they came from the south-west, across the mountains—that is from the direction of Oregon and Washington Territory. There were" (he adds) "bloody contests between the Blackfeet and the Nez-percés, as Bancroft relates, for the right of hunting on the eastern slope of the Rocky Mountains." Mr. McLean, who mentions the former residence of the Blackfeet in the Red River country as an undoubted fact, also says: "It is supposed that the great ancestor of the Blackfeet came across the mountains." Here are two distinct and apparently conflicting traditions, each having good authority and evidence in its favour. One of the best tests of the truth of tradition is to be found in language. Mackenzie, well acquainted with the Crees and Ojibways, who speak dialects of the great Algonkin stock, recognised no connection between their speech and that of the Blackfeet. Another traveller (Umfreville), whose book was published in 1791, gave a list of forty-four words of the Blackfoot language. Albert Gallatin, whose "Synopsis of the Indian Tribes" appeared in 1836, examined this list of Umfreville, and pronounced it sufficient to show that the language of the Blackfeet was "different from any other known to us." A few years later, having received from an Indian trader a more extended vocabulary, he corrected his former statement, and showed that there was a clear affinity between the Blackfoot speech and the language of the Algonkin family. More recently the French missionaries made the same discovery. M. Lacombe writes to me: "The Blackfoot language, although far from, belongs to the same family as, the Algic, Ojibway, Santeux, Maskegon, and Cree. We discovered this analogy by studying the grammatical rules of these languages." Thus some of the ablest and most experienced of North American linguists have at first supposed the Blackfoot language to be distinct from all others, and have only discovered its connection with the Algonkin family by careful study. M. Lacombe has been good enough to send me a pretty extensive vocabulary of Blackfoot words, compared with the corresponding words in the Cree and Ojibway languages. He has added many paradigms of grammatical forms in the Blackfoot, compared with similar forms in the Cree and Ojibway tongues. The Blackfoot language is thus shown to be, in its grammar, purely Algonkin. The resemblance is complete in the minutest forms. But when we turn to the vocabulary, by which the first judgment of a language is necessarily formed, the origin of the early error becomes apparent. Many of the most common words are totally different from the corresponding words in the Algonkin languages. Others, found on careful examination radically the same as the corresponding Algonkin terms, are yet so changed and distorted that the resemblance is not at first apparent. Of this variation and distortion the numerals afford a good example. Other words in ordinary use show the total unlikeness in some cases and the distorted resemblance in others. The possessive pronoun "my" is expressed by the same prefix *ni* (or *n'*) in all three languages. Pursuing this trace we compare the personal pronouns, and find a close resemblance, the difference being mainly in the terminations. In the possessive prefixes the resemblance is still more notable. Thus in the Blackfoot language *n'otas* means "my horse, or dog" (the same word, oddly enough, applying in this form to both animals); and in Cree *n't'em* has the same meaning. These words are thus varied with the possessive pronouns and in the two numbers:—

	Blackfoot	Cree
My horse (or dog)	n'otas	n't'em
thy ,, ,,	k'otas	kit'em
his ,, ,,	otas	otema
our ,, ,,	n'otasinan	n't'eminan
your ,, ,,	k'otasinan	kitemiwaw
their ,, ,,	otasiwaw	otemiwawa
my horses (or dogs)	n'otasiks	n't'emak
thy ,, ,,	k'otasiks	kit'emak
his ,, ,,	otasiks	otema
our ,, ,,	notasinaniks	n't'eminanak
your ,, ,,	kotasiwaweks	kitemiwawok
their ,, ,,	otasiwaweks	otemiwawa

It will be seen that the close resemblance in grammar is as striking as the wide difference in the vocabulary. These facts admit of but one explanation. They are the precise phenomena to which we are accustomed in the case of mixed languages. In such languages—our English speech is a notable example—we expect the grammar to be derived entirely from one source, while the words will be drawn from two or more. Furthermore, wherever we find a mixed language we infer a conquest of one people by another. In the present instance we may well suppose that when the Blackfoot tribes were forced westward from the Red River country to the foot of the Rocky Mountains they did not find their new abode uninhabited. It is probable enough that the people whom they found in possession had come through the passes from the country west of those mountains. If these people were overcome by the Blackfeet, and their women taken as wives by the conquerors, two results would be likely to follow. In the first place, the language would become a mixed speech, in grammar purely Algonkin, but in the vocabulary largely recruited from the speech of the conquered tribe. A change in the character of the amalgamated people would also take place. The result of this change might be better inferred if we knew the characteristics of both the constituent races. But it may be said that a frequent, if not a general, result of such a mixture of races is the production of a people of superior intelligence and force of character. The circumstances thus suggested may account, not only for the peculiarities of the language and character of the Blackfeet tribes, but also for the different traditions which are found among them in regard to their origin and former abode. It would be very desirable to trace that portion of the Blackfoot vocabulary which is not of Algonkin origin to its source in the language of some other linguistic stock. The religion of these tribes (applying this term to their combined mythology and worship) resembles their language. It is in the main Algonkin, but includes some beliefs and ceremonies derived from some other source. "The primitive creation," writes M. Lacombe, "is attributed to a superior divinity, whom they call the Creator (*Apistotokin*). This divinity, however, is in some manner identified with the sun (*Natōs*). The earth itself is believed to be a divinity of some kind, for, in their invocations, if they call the sun 'our father' (*Kinnon*), they call the earth 'our mother' (*Kikristonnon*). It seems also that the moon is considered to be one and the same divinity with the sun. At any rate, in the invocations it is designated by the same name, *Natōs*. Yet it is often said to be the 'old woman,' the consort of the sun. The whole of this is confused enough in the minds of the Indians to render them unable to give, when questioned, exact explanations. As to the secondary creation, the Indian account runs: At a certain time all the earth was covered with water. The 'Old Man' (*Napiw*) was in a canoe, and he thought of causing the earth to come up from the abyss. He used the aid of four animals. The musk-rat dived, and remained so long under water that when he came to the surface he was fainting, but brought a little particle of earth between the toes of his paw. This particle the 'Old Man' blew into the size of the whole earth. It took him four days to complete his work. The 'Old Man' worked two days more to make the first woman, for after the first day's work he had not succeeded in making anything graceful." This Napiw, or "Old Man," adds Father Lacombe, "appears again in many other traditions and legendary accounts, in which he is associated with the various kinds of animals, speaking to them, making use of them, and especially cheating them, and playing every kind of trick. According to the account of the Indians, the "Old Man" came from the south-west, across the mountains; and after a prolonged sojourn in these countries he went toward the north-east, where he disappeared, and nobody has heard of him since. Those who have read Schoolcraft's "Algic Researches," Mr. Leland's "Algonquin Legends," and, above all, Dr. Brinton's "Myths of the New World," will recognise in Napiw the most genuine and characteristic of all the Algonkin divinities. In every tribe of this widespread family, from Nova Scotia to Virginia, and from the Delaware to the Rocky Mountains, he reappears under various names—Manabosho, Michabo, Wetuks, Glooskap, Wisaketjack, Napiw—but everywhere with the same traits and the same history. While these beliefs are all purely Algonkin, the chief religious ceremony of the Blackfoot tribes is certainly of foreign origin. This is the famous "sun-dance." That this ceremony is not properly Algonkin is clearly shown by the fact that among the tribes of that stock, with the sole exception of the Blackfoot and a few of the western Crees, it is unknown. Neither the Ojibways of the lakes nor any of the numerous tribes east of the Mississippi had in their worship a trace of this extraordinary rite. The form of government among the Blackfeet, as among the Algonkin tribes generally, is exceedingly simple, offering a striking contrast to the elaborately complicated systems common among the nations of the Iroquois stock. Each tribe has a head-chief, and each band of which the tribe is composed has its subordinate chief; but the authority of these chiefs is little more than nominal. The office is not hereditary, the bravest or richest are commonly chosen; but in what manner the election is made is not stated. The term "confederacy" commonly applied to the union of the Blackfoot tribes is somewhat misleading. There is no regular league or constitution binding them together. "The tribes are separate," writes Mr. McLean, "and the bonds of union are the unity of religious belief, social customs, and language. They united against a common enemy, but I have never heard of their fighting against each other." Father Lacombe's account is similar. "The Blackfeet," he writes, "have no league or confederation, properly so-called, with councils and periodical reunions. They consider themselves as forming one family, whose three branches or bands are descended from three brothers. This bond of kinship is sufficient to preserve a good understanding among them." They can hardly be said to have a general name for the whole community, though they sometimes speak of themselves as *Sawketakix*, or "men of the plains," and occasionally as *Netsepoyè*, or "people who speak one language."

SECTION A.—MATHEMATICS AND PHYSICS

Discussion on the Kinetic Theory of Gases.—A most valuable and interesting discussion took place in this section on the kinetic theory. As at present applied the theory gives a much larger ratio for the specific heats of a gas than experiment allows. And the more complex a gaseous molecule becomes, the greater, according to theory, must be the ratio of its intrinsic to its translational energy. The object of the discussion was to determine whether the theoretical conclusions were legitimate, or the experimental facts incorrectly observed. It would seem that the theoretical conclusions are not correct, because they are founded upon inadmissible assumptions; and also that the facts require more thorough investigation.

Prof. Crum Brown opened the discussion upon lines already indicated in our present volume, p. 352. The ratio of the specific heat of mercury vapour at constant pressure to that at constant volume is 5/3. This gives, on the dynamical theory, only three degrees of freedom to the molecules: which must be the three translational freedoms. To prevent rotation, the molecules may be regarded as perfectly smooth, rigid, and spherical. But then the radiation cannot be accounted for. Similarly in diatomic gas the ratio is 7/5—giving three translational and two rotational freedoms; but again, not accounting for vibration of the atoms, either on the one hand, as parts of the molecules, or, on the other hand, in themselves.

Boltzmann's theorem asserts that the energy of a molecule is equally distributed amongst the different degrees of freedom. So if, in addition to the six degrees of freedom of a rigid body in space, the molecules have twenty or thirty others, it would seem that the dynamical theory must be abandoned, as there would not be sufficient energy for translational motion. The suggestion that radiation is caused not by vibration of the particles, but by disturbance of the ether due to the motion of the molecule through it, is scarcely admissible.

Difficulties again arise from the theoretical conclusion that energy of each kind is distributed among the molecules according to some form of the law of probability. For them, in a mixture of gases, we should always have some molecules in a condition favourable for combination. Also there should be no such sharp temperature and pressure limits for combination as exist—*e.g.* in the case of phosphorus and oxygen. Hydrogen and oxygen can be kept very long at a temperature near that of combination, without any chemical action occurring.

Prof. G. D. Liveing, in a paper on kinetic theory, said that the first doctrine leading to difficulties arises from assumptions, and is not a necessary part of the theory. The final distribution is the result not only of circumstances which vary, but of laws of force which are determinate. So there will be a tendency finally to limitation of the distribution of the energy in the different degrees of freedom. The dissipation of energy is the result of such laws limiting the reversibility of transmutations. Boltzmann's result will *not* follow if we consider other laws in addition to the conservation of energy. Indeed, the probability for it would be *nil*. Boltzmann also does not distinguish different kinds of motion—such as those of liquefaction, vaporisation, and dissociation. Those of translation and vibration even are often classed together. Yet the former three take place only after a certain accumulation of energy in the system; and the same may be true of the different vibrational degrees of freedom.

The constancy of the specific heats of some gases for large ranges of temperature indicates a constant *proportional* distribution of energy among the different degrees of freedom. But the proportion need not be that of equality. It is quite possible that mercury vapour at those temperatures at which its specific heat has been measured has no sensible vibrational energy. Experiments upon the emissivity of the more perfect gases show that they have, at ordinary temperatures, much less vibrational than translational energy; so that they may have only one, or, at most, two modes of vibration. The theoretical relation between the number of degrees of freedom in gases and their specific heats possibly requires revision. Still, it only limits the number of degrees sensibly exercised at the temperatures at which the specific heats were measured.

As regards the distribution of energy amongst the molecules, it is almost impossible to evade the conclusion that great differences of motion will exist, even although no particular law of distribution be assumed. Still, it is quite possible that there may be laws regulating the actions in encounters which prevent the excessive accumulation of any one kind of motion. Again, some molecules at 100° may have the average translational motion of molecules at 600°, but not that of vibration. So that very few molecules may have, at the same time, excess of motion of both kinds. Further, since this excess of energy is acquired at the expense of neighbouring molecules, the probability of there being at the same place two atoms of hydrogen and one of oxygen, in a mixture of these gases, in the average condition of those at the higher temperature, is infinitesimal. And yet again degrees of freedom exercised at the higher temperature alone may never be exercised by any molecule at the lower temperature on the average.

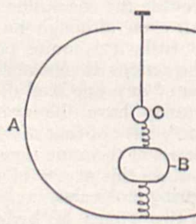
Differences of pressure in the two masses of the same gas at the same temperature are on the dynamical theory only differences of average free paths, so that it is difficult to imagine how any of the molecules in the more compressed gas can be said to be in the state, as to pressure, of the average molecules in the less dense gas. The free path of a molecule of the denser gas may at any instant be the same as the average free path of the molecules of the less dense gas; but its *average* free path will not be the same as theirs, and it is this that determines the pressure. In a system consisting of phosphorus and oxygen the possibility of chemical combination implies the possibility of an atom of phosphorus acquiring the same motion of translation, both as to speed and direction, as several atoms of oxygen, and of their jointly taking up the vibrational motions proper to an oxide of phosphorus at the temperature of the system, and that the transformations of energy involved in all this should be attended on the whole with a degradation. Since a diminution of the pressure of a gas means a degradation of its energy, this may facilitate combination when the mere fact of the molecules having instantaneous free paths of greater or less length would not suffice to produce such a result.

Sir W. Thomson remarked that Boltzmann's theorem was true in one particular case, but a proof of this case could be arrived at without the aid of the theorem, so that this does not prove the truth of the theorem. On the other hand, he had never seen any reason for believing in it at all. If we take an absolutely elastic globe and cause it to rebound between two parallel absolutely smooth and hard planes in a region where gravity does not act, it will go on moving between the two. But he does not believe that this will continue for ever. The translational energy of the ball will get transformed into energy of higher and higher modes of vibration, so that at last the ball will come to rest, as it will be impossible for this energy to be retransformed into translational energy.

Prof. J. J. Thomson said that he thought the reason that the ratio of the specific heats of a gas, as found by experiment, did not agree with the value given by Boltzmann's theorem, was because Boltzmann's theorem was not true.

Boltzmann, in his theorem about the distribution of energy in a gas the molecules of which consisted of dynamical systems with n degrees of freedom, assumed that there were no limits to the velocity which any co-ordinates could have, and therefore that the limiting velocity which any co-ordinate could have was independent of the velocity of any of the others. Now it was easy to see that in some cases there must be limits to the velocities, for, take the case of a molecule consisting of two atoms attracting each other with a force varying inversely as the square of the distance between them, then, if the relative velocity exceeded a certain value, the atoms would describe hyperbolas about their common centre of gravity, and the distance between them would increase indefinitely—in other words, the molecule would break up. Again, if we considered the case of a series of balls connected together by springs and fastened to a system which vibrated much more quickly than the natural period of vibration of the balls, then, if all the impacts fell on this system, the dynamics of the case, as investigated by Stokes and Sir William Thomson, showed that any disturbance would not be equally distributed among the balls, but that the energy in the balls would diminish in geometrical progression as we went away from the system at the end. It seemed, to say the least, rash in a case of this kind to assume that the velocity of any of the balls far away from the system was independent of those preceding it.

He had devised a molecule which it was easy to see would not obey Boltzmann's theorem. A was an envelope to the



bottom of which a feeble spring was fixed, the other end of which was attached to a heavy weight, B. To this weight a strong spring was attached, to the other end of which a light weight, C, was fixed. A rod of small mass was fastened to C, of such a length that it only extended beyond the envelope when the springs were stretched. This system would have two periods of vibration—a quick one corresponding to the upper sphere, and a slow one corresponding to the lower one. Then if all the molecules were stated, so that the amplitude of the quick vibration of C was much greater than the slow one, it was easy to see that the mean energy of the upper sphere would be greater than the mean energy of the lower ones, while, according to Boltzmann's theorem, these two quantities ought to be the same.

It might be mentioned that any co-ordinate which only entered the expression for the energy through its differential coefficient could be eliminated from the expression occurring in Boltzmann's theorem and the method applied to the remaining co-ordinates, so that, even if Boltzmann's method was unobjectionable the result need not apply to co-ordinates of this kind.

With regard to the second of the difficulties mentioned by Prof. Crum Brown, he thought that the point raised presented no difficulty if we took Williamson and Clausius's view of chemical combination. According to this view it was necessary to consider the number of molecules dissociated as well as the condition of the molecules; and though, if we took two gases at any temperature, it was true that there were a finite number of their molecules whose energy did not differ much from the mean energy of the molecules at the temperature at which these combined, yet it did not follow that a finite proportion of these were dissociated, and if there were not we could not expect them to combine. If the collision between two molecules in nearly the same condition was more efficacious in splitting up the molecules into atoms than a collision between molecules in widely different conditions, then we should not expect a finite proportion of the molecules in any state widely different from the mean to be dissociated.

Prof. W. M. Hicks said that one of the greatest objections to Boltzmann's theorem appeared to him to be the difficulty in believing that the mean energy of any vibration whatever of an atom was susceptible of unlimited increase, and referred to the case of a vortex ring inside a rigid spherical shell, where such energy could not be made to exceed a particular limit. As a matter of fact it was not proved that Boltzmann's theorem must correspond to the actual state, but only that an arrangement given by his theorem, if a possible one, was a permanent one. He stated that if the momenta could not exceed definite limits, Watson's proof could easily be modified to show that the energy was not distributed equally amongst the degrees of freedom. On the other hand, it was not permissible to assume all momenta consistent with the equation of energy as existent. As an example, the case of a system of mutually attracting spheres might be taken. Here the equation would admit of the infinite velocities due to infinitely near approach of the centres, which would in the actual case be prevented by the finite size of the spheres. Further, any particular system might possess other integrals of the equations of motion, which would introduce further limitations.

Prof. Osborne Reynolds remarked that the kinetic theory is only supposed to be true in as far as the assumptions on which it was based represented the actual circumstances. In these assumptions no account whatever was taken of any resistance to which the molecules in their motions might be subjected, other than that which arose from the mutual encounters. Whereas it was perfectly well known and certain that there must be such resistances connected with the radiation of heat—these resistances, applying only to motions of certain character, *i.e.* to the vibratory motions, whatever these may be. Neglecting these resistances, the kinetic theory points to the conclusion that the mean energy in each one of these vibratory motions would be the same as in each one of the translatory motions. In the same way, neglecting resistance, a pendulum continuously struck at varying intervals with a hammer of a given weight and moving at a given speed would possess the same mean energy whether the intervals were to be measured by years or seconds. But experience at once showed that with friction, the shorter the interval between the blows and the smaller the friction, the greater would be the mean energy of the pendulum. So, taking resistance into account, it would follow from the kinetic theory that the mean energy in the so-called degrees of freedom would be greatest in those in which the diffusion of energy was greatest and the resistance least, while it would be least in those in which the rate of communication was least and the resistance greatest. Hence, in any gas, the mean energies of translation, in which there is most rapid communication and no appreciable resistance, will be much greater than the mean energies of vibration to which there is all the resistance consequent on the radiation, and in all probability but little communication.

The same answer applies to difficulties raised as to the distribution of motion. The assumed distributions leave out of consideration all resistances, and resistance, however slight, would cut off the extreme velocities.

Mr. H. B. Dixon said that, by a series of observations made on a mixture of oxygen and hydrogen at intervals of 1000 hours, he had obtained evidence of combination at temperatures below that of dissociation.

Constant Gravitational Instruments. — Sir W. Thomson showed and explained constant gravitational instruments for measuring electric currents and potentials. In one instrument for measuring currents he employs the principle that a mass of soft iron of dimensions and shape not differing too much from a sphere, experiences, in a field of magnetic force, a pull from a place of weaker to a place of stronger force. The variation of the field is produced by variation in the dimensions of the conductor through which the current passes. In an instrument for measuring high potentials he used one pair of opposite quadrants placed vertically. The quadrants are connected to one pole of the instrument whose potential is required, and the needle, the lower end of which can be weighted, is joined to the other pole.

On the Dilatancy of Media composed of Rigid Particles in Contact, by Prof. Osborne Reynolds.—In the account which Prof. Reynolds gave of his paper, he did not submit a complete dynamical theory, but discussed a very fundamental property of granular masses. To this property he gives the name of *dilatancy*. It is exhibited in any arrangement of particles where change of bulk is dependent upon change of shape. In the case of fluid matter, as we know it, change of shape and volume are independent. In solids they are sometimes not separable. With granular masses the result is different—change of shape *always* produces change of volume. And further, in every case, if change of volume is prevented any change of form is impossible.

If we suppose the component granules to be spherical, no granule can change its position without disturbing the adjacent ones —for the granules are all supposed to be perfectly rigid, and to be absolutely in contact—and the internal particles are fixed if the external ones are. In illustration Prof. Reynolds showed a model of connected spherical bodies arranged in crystalline form. This model showed the arrangement of the particles corresponding to (say) the condition of least possible density of the whole mass (about one-half the density of the separate spheres). The shape could then be altered to that which corresponds to maximum density—the change taking place by sliding of the particles one upon another. Between the extreme states there are intermediate stages of equilibrium corresponding to maximum-minimum positions, where alteration in one direction produces decrease of density, and in the other increase of density.

In a complete treatment of the problem, friction must be closely considered; but in the experiment shown it is not of consequence, the result being independent. The above statements will be true of any continuous mass of granules if we hold the boundaries.

This principle of the dilatancy of such granular media explains many phenomena of common occurrence. For example, take a sack of corn; if set on end, it remains perfectly flexible, but if placed on its side it becomes hard, and its shape will not alter. Now take an indiarubber sack, fill it with corn—it remains perfectly flexible in all positions. The reason for this difference of behaviour is that in the former case the boundary of the granular mass is inextensible, while in the latter it allows increase of internal volume. So if it be possible with an extensible envelope, to impose a maximum volume upon the contents, effects similar to those obtained with the inextensible boundary may be expected: and this can be done. If we place some shot (No. 6 was used in the experiment) in a thin indiarubber bag, and add a certain amount of water, we obtain the result wished. For if the amount of water added be such that the spaces between the granules when in close arrangement are all filled by it, while with a wide arrangement the amount is not enough, a point will be reached in passing from the first to the second arrangement such that any further change of shape, and consequently of volume, would produce a vacuum. When this stage is reached the whole mass becomes perfectly hard. Prof. Reynolds illustrated this in a very beautiful manner by means of a ball of shot to which a glass tube open at the end was fitted. With a close arrangement of the shot, the water, which was coloured, stood high in the tube; but when pressure was applied to the bag, the level was lowered. This was shown also by the lecturer with a ball containing sand instead of shot. The water level sank till the whole was at maximum density, and, still more pressure being applied, the level again rose, the maximum having been passed. In these experiments about 6 per cent. of the water was free at the top of the ball with the close arrangement of granules. When another ball containing 20 per cent. of free water was used, the hard condition could only be approximated to by pressure, and then passed. So long as the maximum is not passed in this case the ball springs back to its original state when the pressure is released. But if the maximum be passed, it will not spring back. If some of the water be now let out, the maximum cannot be passed, except by shaking, and, if the flattened ball be then turned on edge, it will bear a pressure of a hundredweight without change of shape.

When the dilatant material, such as shot or sand, is bounded by smooth surfaces, the layer of grains adjacent to the surface is in a condition differing from that of the grains within the mass. This layer can slide between the one succeeding it and the surface, so that its displacement will cause much less dilatation than would be caused by the sliding of a layer within the mass. Hence, if two parts of the mass are connected by such a surface, certain conditions of strain may be accommodated by a streaming motion of the grains next the surface. Thus, if into a glass funnel partially filled with shot and held in a vertical position more shot be forced from below, the particles will flow up all around the sides—not rising in the centre as might have been thought.

As the foot presses upon the sand, when the falling tide leaves it firm, that portion of it immediately surrounding the foot becomes momentarily dry. When this happens the sand is filled, completely up to its surface, with water raised by capillary attraction. The pressure of the foot causes dilatation of the sand, and so more water is required. This has to be obtained either by depressing its level against the attraction or by drawing it through the interstices of the surrounding sand. As this latter requires time, for the moment the capillary forces are overcome, and the surface of the water is lowered below that of the sand, leaving it dry until a sufficient supply has been obtained from below, when it again becomes wet. On raising the foot we generally see that the sand under and around it becomes wet for a little time. This is because the sand contracts when the distorting forces are removed, and the excess of water escapes at the surface.

In referring to the results which might be expected to follow from a recognition of the property of dilatancy the author said that it places a hitherto unknown mechanical contrivance at the command of those who would explain the fundamental arrangement of the universe, and one which seems to promise great things besides possessing the inherent advantage of great simplicity. He then proceeded to explain, in a general way, how bodies in such a medium would—in virtue of the dilation caused in the medium—attract each other at a distance, with a force depending on the distance, which might well correspond with the force of gravitation. Further, owing to the existence of a region close to the body in which the density varies several times from maximum to minimum, the mutual force might undergo a change from attraction to repulsion, and this more than once as the bodies approach—a condition which seems to account for cohesion and observed molecular force far better than any previous hypothesis.

The transmission of distortional waves becomes possible if the medium be composed of small grains with large grains interspersed. The separation of two such sets of grains leads to phenomena closely resembling the phenomena of statical electricity. The susceptibility of such a medium for a state in which the two sets of grains are in conditions of opposite distortions may explain electrodynamic and magnetic phenomena, while the observed conducting power of a continuous surface for the grains of a simple dilatant medium closely resembles the conduction of electricity.

In remarking upon Prof. Reynolds's paper Sir W. Thomson pointed out an interesting question. Take a cube of spheres in the condition of maximum volume, and let every sphere touching the boundary be glued to it to prevent slipping. Other states are possible in the interior, but can we pass *continuously* to another condition, the boundary being held firm? Prof. Reynolds replied that he believed that he had got the result that it could not be done if we have a continuous medium. As other problems for solution, Sir W. Thomson suggested the theory of the hour-glass—what fixes the constant time for the sand running? and why does a substance sink deeper in a quicksand than in a viscous fluid of the same density?

On Calculating the Surface-Tensions of Liquids by means of Cylindrical Drops or Bubbles, by Prof. Pirie.—There are two methods by which the surface-tension of liquids are calculated. One involves the measurement of the height to which the liquid rises in a cylindrical tube of known diameter. The other involves the measurement of the height of a certain point of a drop of the liquid above a flat surface upon which it is placed. This point is the point of contact of the tangent plane when it becomes vertical. The former method is objectionable, because the results might be vitiated by the presence of a very small quantity of grease in the tube, or by electrification, &c. The latter, too, is not in a satisfactory state. Gay Lussac's results were in no degree different from those obtained by the ordinary method. Quincke's measurements are good, but his mathematics are misleading. To obviate the mathematical difficulties the author makes use of long drops—that is, drops obtained by placing portions of the liquid upon a concave cylindrical surface. The advantage is that the differential equation used in the calculation is immediately integrable. In remarking upon this paper Prof. Stokes said that Worthington has shown, by extending Quincke's result, that the theory agrees with experiment.

On the Surface-Tension of Water which contains a Gas dissolved in it, by Prof. Pirie.—This question is important, for no liquid is usually free from gas in solution. Prof. Pirie finds that the surface-tension is unaltered so long as the specific gravity of the water is unaffected by the dissolved gas. It is strongest in the pure liquid.

On the Thermodynamic efficiency of Thermopiles, by Lord Rayleigh.—The question has often arisen whether or not the dynamo may be replaced by an arrangement of thermopiles. There is a great difficulty due to the conduction of heat. Let t and t_0 be the temperature of the hot and cold junctions; e the electromotive force of one pair per degree Centigrade, and E the total E.M.F., hence we have

$$ne(t-t_0)=E.$$

From this equation the author obtains by means of Joule's law the expression

$$\frac{n^2e^2(t-t_0)^2}{4R_0}$$

for the useful work done externally. And again, if r_1, r_2, σ_1, σ_2, represent the specific electric resistance and the cross-sectional area of the metal bars, while l is their length,

$$R_0=nl\left(\frac{r_1}{\sigma_1}+\frac{r_2}{\sigma_2}\right).$$

To obtain the efficiency the above work must be compared with that done by the apparatus regarded as a perfect heat engine working between the same temperature. The ratio is

$$\frac{4J}{te^2}\left(\frac{r_1}{\sigma_1}+\frac{r_2}{\sigma_2}\right)\left(\frac{\sigma_1}{r'_1}+\frac{\sigma_2}{r'_2}\right).$$

where v'_1, v'_2 are the specific thermal resistances. The efficiency therefore is independent of $(t-t_0)$, of n, and of l; and also of the *absolute* values of σ_1, σ_2, r_1, r'_1, r_2, and r'_2.

Putting in numerical values for a thermopile of iron and German silver, Lord Rayleigh got 300 as the value of the above ratio. Since e^2 is involved, this number may be somewhat reduced; but high values of e are usually associated with high internal resistance. There is therefore no possibility of the thermopile becoming a useful generator of electricity on a large scale.

On Molecular Distances in Galvanic Polarisation, by Mr. J. Larmor.—Mr. Larmor's method involves the electro-chemical equivalent of the liquid used, and so differs from the two methods previously adopted. He has obtained extremely accordant results.

Cooling of Wires in Air and Vacuum, by Mr. J. T. Bottomley.—Mr. Bottomley finds that the medium has a most marked cooling effect. An electric current passed through a wire, when surrounded by air at atmospheric pressure, heated it only to 80° C. But when the air-pressure was $\frac{1}{19(10)^6}$ of an atmosphere, the wire became red hot. The temperature did not alter much until the pressure became 1-100th of an atmosphere.

An Account of Levelling Operations of the Great Trigonometrical Survey of India, by Major A. W. Baird.—This paper opened with an account of the methods formerly used in the determinations of relative height by the survey. The errors affecting these methods and the means adopted for their elimination were then pointed out. Various lines of level carried out to connect tidal stations lying north and south indicated a difference of sea-level at the stations. This difference cannot be due to false levelling of the instruments produced in consequence of the illumination of the spirit-level by the sun, for the same end of the line was not always brought out highest, and along one line no difference of level was perceptible. The discrepancy in one case amounted to three feet along the line from Bombay to Madras. The two weakest parts of this line were re-levelled, giving the same results as before. Consequently it would appear that the error is caused by local attractions influencing the instruments in greater degree than the more distant ocean.

On the Rainfall of the British Islands, by Mr. A. Buchan.—Mr. Buchan pointed out that the greatest differences in local climates arise from differences in the rainfall. For example: the mean temperatures of Skye and the Moray Firth coasts for any month are not much different, but the rainfall in Skye is about four times that at the Moray Firth. The former is one of the latest and poorest grain-producing districts in Scotland, and the latter is just the reverse. The inquiry was based on observations of rainfall made at 1080 stations in England and Wales, 547 in Scotland, and 213 in Ireland. They extend from the year 1860 to the year 1883. The regions of heaviest rainfall, giving an average of 80 inches or upwards annually, were four: Skye and a large portion of the mainland to the south-east as far as Luss, on Loch Lomond; the greater part of the Lake District; a long strip, including the more mountainous part of North Wales; and the mountainous district in the south-east of Wales. The West Highlands is the most extensive region of heavy rainfall in the British Islands. Its mountainous coast-line faces the rain-bringing winds of the Atlantic, and the air, being cooled in its passage up the lochs and valleys, the moisture is precipitated. At Glencoe, in this district, the heaviest rainfall in Scotland occurred—128·5 inches. The smallest rainfall was in a large portion of the south-east of England. The average rainfall for the last half of the period from 1860 to 1883 was comparatively high, chiefly in the eastern districts.

On a Remarkable Occurrence during the Thunderstorm of August 6, 1885, by Mr. W. H. Preece.—A house at St. Cuthbert's, ten miles from Wolverhampton, is connected with that town by telephone, and is also lighted by electricity. The dining-room was lighted by a single lamp in multiple arc with some others. The telephone wire was connected to the lightning-conductor as an earth. When the storm occurred, the dining-room lamp flashed up and went out, while a loud report was heard. The lightning-rod made bad earth, and it is believed that it had been struck, and that part of the discharge had entered the telephone circuit and then sparked across to the electric-light circuit. It did not seem to have divided, but to have passed entirely along the one branch, including the dining-room light, the platinum wire of which was volatilised and deposited on the interior of the glass, forming a good mirror.

Meteorology of Ben Nevis, by Mr. A. Buchan.—Mr. Buchan remarked that Ben Nevis possesses great advantages as a meteorological station because of its great height and its summit being only about four miles horizontally distant from a sea-level station. Also it is in the track of the Atlantic storms, which exercise so great an effect on the weather of Europe, especially in autumn and winter. The observations made on the mountain are for the purpose of determining more fully the great movements of the atmosphere and the dependence of the weather upon them. Mr. Buchan called attention to the great importance of abnormal values in the thermometric and hygrometric observations especially. The recurring periods of warmth characteristic of Ben Nevis do not occur at lower stations. The *föhn* peculiar to Switzerland occurs on Ben Nevis, and is always associated with heavy rainfall in the neighbourhood. When a cyclone prevailed at the foot of the mountain there is an anticyclone at the top, and *vice versâ*.

On some of the Laws which Regulate the Sequence of Mean Temperature and Rainfall in the Climate of London, by Dr.

Courteney Fox.—The laws enunciated in this paper are deduced empirically from observations extending over the last seventy years. Even as detached laws they are of great value; but their importance is more evident when we consider that, as the author remarks, it is from such material that the future science of meteorology must be built up by cautious induction. Given that a certain month of season is in certain condition as regards temperature or rainfall, Dr. Fox seeks to determine what may be predicted of the succeeding period as regards these qualities. He finds that, if a spring or a summer be very cold, the succeeding season will be cold; and warm autumns succeed very warm summers. The fact of a very dry August being followed by a wet September is unique. The following table shows other results obtained.

Characteristics.	Month.	Month following.
Very cold	Jan, April, June, July, Aug., Sept., Dec.	Cold
Very warm	Jan.	Dry
	June, July, Aug.,	Warm
Very dry	June, July,	Warm
Very wet	Jan., March. April,	Warm
	May, July	Cold

In addition the author records what follows when a given month has marked temperature and moisture characteristics simultaneously.

Characteristics	Month	Month following
Warm and wet	Nov., Dec.,	Wet
	Jan.,	Warm
Warm and dry	June, July,	Warm
	Aug.,	Wet
Cold and wet	July, Aug.,	Cold
Cold and dry	Dec.,	Cold
	Nov.	Dry

A very cold and very wet summer is succeeded usually by a cold autumn.

Domestic Electric Lighting, by W. H. Preece, F.R.S. Electrician G.P.O.—After referring to the full details of the lighting installation of his house in Wimbledon, given to the section at the meeting at Montreal, Mr. Preece referred generally to the experiences he had gained during the past twelve months. The secondary batteries upon which he had mainly relied exceeded his expectations in the services they rendered. They returned 70 per cent. of the energy put into them without any apparent diminution whatever in their E.M.F. They showed no signs of deterioration and gave no trouble whatever. He used his gas engine for charging only two days a week. He had experienced no fault with the wiring of his house. He had used only the very best materials, and had attended personally to the insulation of the system. It was periodically tested and found to be good. He referred in severe terms to the cheap and nasty wire which was so frequently and ignorantly used, and feared that the prejudice against the electric light would increase when failures from this cause arose. None but the very best materials should be used, and the joints should be seen to by experts. He had devoted considerable attention to the problem of distributing light, and had succeeded so far that while his rooms were beautifully illuminated the eye was not irritated by regarding a bright source of light. The lamp he used was a 50 volt 10 candle power glow lamp, and it was, as a rule, so fixed that the eye never saw it. He had arrived at the use of these lamps after careful consideration and many trials of other lamps. They secured greater safety in the leads, and involved less capital in batteries through the use of low E.M.F. He ran his lamp at an E.M.F. about 2 per cent. less than the normal E.M.F. He did this to secure long life to his lamps. The breakage had been very small. The E.M.F. and current which will give a lamp a normal life of 1,000 hours and a certain candle power should be determined by every maker. The sixth power of the current will give the candle power and the twenty-fifth power the life with any other current. The great advantage of batteries is that the proper current once determined can never be exceeded, and thus efficiency is ensured. If lamps are run too low there is a waste of power, if too high there is a waste of lamps. We are now gradually acquiring a thorough knowledge of the number of Watts which should be expended in each lamp to secure the maximum economic efficiency. He had introduced into the charging lead and into the discharging lead a Ferranti meter, so that he was able to record exactly the quantity of electricity passed through the batteries and that passed through the lamps. This beautiful meter is based on Ampere's laws which determine the attraction and repulsion of currents. A small phosphor-bronze vane is immersed in a bath of mercury, through which the current flows radially, fixed in a magnetic field. The mercury rotates and carries with it the vane. The rate of rotation varies directly with the strength of current and the number of rotations are recorded by a counter, which can be read off directly. So far he was perfectly satisfied with its performance. As regards expense, excepting the first cost, he did not find much addition to his expenditure for illumination. His electric light was costing him about 50*l*. a year for gas, wages, oil, and lamps. It was the cheapest luxury he indulged in. The great advantages were the comfort and cheerfulness it engendered, and as cheerfulness was the main element of health he thought that the electric light would prove a serious rival to the doctor. There was no one who valued health and comfort who should neglect to apply the electric light to his home, when it was brought, as it has been by the success of the secondary batteries, within his means. It was said that he, as an expert, could make things go which would fail in ordinary hands; but he mentioned several cases where coachmen, butlers, gardeners, and grooms had been found perfectly competent and intelligent enough to attend to everything.

Discussion on Standards of White Light.—This discussion was not so well sustained as the discussion on the kinetic theory. All the speakers agreed with the adoption of the pentane standard for commercial purposes. For scientific purposes a definition in terms of energy was deemed necessary. The eye cannot be used as an accurate instrument. On this point Prof. Stokes referred to the fact that if two equal areas differently coloured seem to have equally intense illumination, we have only to alter the size of the common area to destroy the apparent equality of intensity.

On Photometry with the Pentane Standard, by Mr. A. Vernon Harcourt.—Mr. Harcourt described the construction of the pentane standard light, and the method of using it for photometric purposes. In the course of his remarks he referred to the meaning of the expression "white light." Any so-called standard of white light is more nearly a standard of yellow light. He had never got a satisfactory definition of the expression, but supposed it to be such light as we have in ordinary daylight.

The Constitution of the Luminiferous Ether on the Vortex Atom Theory, by Prof. W. M. Hicks.—The simple incompressible fluid necessary on the vortex atom theory is quite incapable of transmitting vibrations similar to those of light. The author has therefore considered the possibility of transmitting waves through a medium which consists of this fluid modified so as to contain small vortex rings closely packed together. The rings are supposed to be composed of the same material as the rest of the fluid, to be very small compared with the wave-length, and to be at distances from one another also small compared with the wave-length. Their motion of translation is also taken to be so comparatively slow, that very many waves can pass over any one before it has much changed its position. Such a medium would probably act as a fluid for large motions. The vibration in the wave front may be (1) swinging, such as a ring oscillating on a diameter; (2) transversal vibration of the ring; (3) vibrations perpendicular to the plane of the rings; (4) apertural vibrations. Of these (3) seems to be impossible. If r be the radius of the rings, l the distances of their planes, w their cyclic constant, and v the velocity of translation, the author found

$$\text{For (1)} \ldots\ldots v \propto \frac{w}{l}\left(\frac{r}{l}\right)^4,$$

$$\text{For (2)} \ldots\ldots v \propto \frac{w}{l}\left(\frac{r}{l}\right)^2,$$

whilst for (4) in case of rings arranged parallel to a wave-front—

$$v \propto \frac{wr^2l^2}{(l^2+4r^2)^{\frac{5}{2}}}$$

On a Photometer made with Translucent Prisms, by Mr. J. Joly.—In this photometer each side of the prism is illuminated by one of the lights to be compared, the edge being turned to the observer. The great advantage here is that the two illuminated parts are placed in sharp juxtaposition.

On a Point in the Theory of Double Refraction, by R. T. Glazebrook.—The author suggested that the theory of double refraction given by Lord Rayleigh, in which the ether is supposed to have an effective density different in different directions, might be modified so as to agree with Fresnel's theory, if it be not necessary to assume that the ether offers an infinite resistance to compression, but only that, as compared with its rigidity, its compressibility is very great, and further that in a crystal the light vibrations are normal to the ray, not to the wave normal, as was pointed out by Boussinesq and referred to by Ketteler in some of his papers.

On a New and Simple Form of Calorimeter, by Prof. W. F. Barrett.—The bulb of a thermometer is made in the shape of a double cup. In this cup is placed the substance whose specific heat (say) is to be determined. The stem of the thermometer is horizontal, and rests on a fulcrum so that the weight of the substance may be determined by using the apparatus as a balance. Special precautions are taken in determining the temperature of the substance when placed in the cup, and to prevent evaporation, &c. The specific heat is then given by the ordinary equation,

$$WS(T - \theta) = C(\theta - t),$$

the constant C being determined by experiment once for all.

Section B—Chemistry

On the Non-Existence of Gaseous Nitrogen Trioxide, by Prof. Ramsay.—After pointing out the inconclusive character of Lunge's argument in support of the existence of gaseous nitrogen trioxide, inasmuch as the use of any reagent may either decompose the gas or react with the products of its dissociation—viz. NO and $N_2O_4(NO_2)$, as though they consisted of N_2O_3 itself, the author shows the only criterion of the existence of this gas to be its vapour density. He finds that NO_2 may be mixed with NO without effecting any change in volume, and therefore no combination, or only a very slow combination, can take place between these gases. The vapour density of the first portion of the gas obtained by distilling liquid N_2O_3 is found to be 22·35, a result which accords fairly well with what the density should be, supposing it to be a mixture of N_2O_4, NO_2, and NO, having the empirical composition N_2O_3. Supposing the gas weighed to contain no N_2O_4, an assumption not warranted by facts, and consist of NO and NO_2, then, in order to make the specific gravity 22·35, 17·63 per cent. of N_2O_3 must be added to the mixture. These facts the author considers as deciding the point against the existence of gaseous nitrogen trioxide.

Observations on some Actions of a Grove's Gas Battery, by Prof. Ramsay.—The action of an ordinary Grove's gas battery can be explained by supposing that, at the point of contact between the platinum, hydrogen, and liquid, a decomposition of the water molecule takes place, its oxygen uniting with the hydrogen gas to form water, whilst the hydrogen is liberated from molecule to molecule until the free gas arrives at the point of contact of the platinum, the oxygen, and liquid; here it unites with the oxygen gas, forming water. If the liquid in the battery be coloured with indigo sulphuric acid, the author finds the indigo in contact with the hydrogen to undergo no changes, whereas that in contact with the oxygen is discoloured, a change probably due to the oxidation of the indigo to isatine. Hydrogen, therefore, in uniting with oxygen, does not bleach indigo. Now if, in the ordinary gas battery, the acid be replaced by a saturated solution of sodium chloride and hydrogen, and chlorine be substituted for hydrogen and oxygen, the indigo is found to be bleached on both sides, the bleaching taking place from above downwards, and taking place at once on admitting the chlorine, but some time is required before the reduction by the hydrogen is evident. These experiments show that when hydrogen unites with chlorine it is in a more active state than when it unites with oxygen. To explain this difference the author suggests that, when a molecule of hydrogen unites with a molecule of chlorine, atomic hydrogen exists for a moment, and this, in presence of indigo, reduces it to indigo-white. In the case of hydrogen and oxygen the union of two molecules of the former with one molecule of the latter may be effected without the hydrogen assuming the atomic condition, whereas the oxygen must assume the atomic or nascent condition, to which the bleaching of the indigo may be ascribed; or it may be that ozone or hydrogen peroxide are formed. These phenomena may, therefore, be regarded as chemical evidence corroborative of the following method of expressing the union of these gases with one another:—

$$H_2 + Cl_2 = HCl + HCl. \qquad 2H_2 + O_2 = H_2O + H_2O.$$

On the Spontaneous Polymerisation of Volatile Hydrocarbons at the Ordinary Atmospheric Temperatures, by Sir H. E. Roscoe, LL.D., F.R.S.—The attention of the author was drawn by Mr. Staveley, of West Bromwich, to a camphor-like solid, formed from the more volatile liquid hydrocarbons, produced by decomposing crude phenol at a red heat. The change from the liquid to the solid state was, at first, supposed to be due to the influence of the oxygen of the air, but investigation has shown the solid to be a hydrocarbon having the formula $C_{10}H_{12}$, and the change to be one of polymerisation. This solid hydrocarbon undergoes a further polymeric change when heated in a sealed tube at 180°. The author finds also that the first runnings of ordinary coal tar, which distil below 30°, are, on keeping in sealed tubes, converted spontaneously into this solid hydrocarbon $C_{10}H_{12}$.

On some New Vanadium Compounds, by J. T. Brierley.—The compounds described form a series of well-defined crystalline salts of purple or dark green colour, possessing a metallic lustre, which contain both the oxides V_2O_4 and V_2O_5, and may be regarded as vanadate-vanadites. These salts are formed by adding a caustic alkali to the dark green liquid formed by adding hypovanadic sulphate to a solution of an alkaline metavanadate. The composition of the sodium, potassium, and ammonium salts are represented by the following formula:— $2V_2O_4 . V_2O_5 . 2Na_2O + 13H_2O$., $2V_2O_4 . V_2O_5 2K_2O + 6H_2O$, and $4V_2O_4 . 2V_2O_5 . (NH_4)_2O + 14H_2O$.

The Essential Food of Plants, by T. Jamieson, F.C.S., F.I.C.—Whilst no doubt exists as to the essential character of the elements of carbon, hydrogen, oxygen, and nitrogen as constituents of the food of plants, the evidence in support of the elements phosphorus, potassium, magnesium, calcium, sulphur, iron, and chlorine to be regarded in this light cannot be considered conclusive. A little consideration shows the two elements, iron and chlorine, have but little claim to be considered as essential to the food of plants, and the experiments, of which an account was given in this paper, were made by the author with the view of vindicating the right of the five remaining elements to be so considered. These investigations were conducted at an experimental station in Sussex and also at one in Aberdeenshire, the nature of the soil in both cases being specially favourable. The method adopted consisted in observing the effects on plants grown in similar soil and under similar conditions, when supplied with manures, containing all these elements and comparing the results with those obtained when one or other of these elements was withheld. These experiments seem to provide proof that sulphur must be discarded from the list of essentials, while some doubt is thrown on even lime and magnesia. At the same time striking confirmation is afforded of the essential characters of both phosphorus and potassium.

A Plea for the Empiric Naming of Organic Compounds, by Prof. Odling, M.A., F.R.S.—Verbal translations of the structural formulæ assigned to organic compounds possess certain advantages as names for the several compounds. Thus, they are applicable to all organic compounds of which the structural formulæ are made out; they are the only sort of names applicable to complex isomeric compounds; and their use cannot be dispensed with wholly in the case of even less complex compounds. Notwithstanding these advantages, structural names constitute unsuitable names for general use, more especially as applied to fundamental hydrocarbons, alcohols, and acids. They are objectionable for this use by reason of their length, complexity, and want of ready indicativeness; by the circumstance of their being based on conceptions of chemical constitution of a kind pointed out by experience as eminently liable to change; and by the further circumstance of their representing a one-sided and, so far, an untruthful notion of the bodies designated. Structural names, expressing other than a distorted view of the constitution of all but a few of the most simple of organic bodies, are impracticable by reason of their length and complexity. Hence, to avoid the distortion inseparable from the use of any single structural name for an organic body, the only expedient is the assignment to each body, in proportion to its complexity, of an indefinite number of structural names, a proceeding almost tantamount to not assigning it any particular name at all. Although from their number and complexity, organic bodies can only be designated by names which do in some measure describe and characterise them, the primary purpose of a name is undoubtedly to designate, and not to describe. Accordingly, with a view to the prompt mental association of object with name, brief empiric names, based on the origin and properties of bodies, are, wherever practicable, to be preferred to structural names. As regards isomeric bodies, they may to a large extent be advantageously distinguished from one another by means of significant letters or syllables prefixed to the name common to the different isomers. But the suggested use of the particular letters α, β, γ, each in a special sense; also a general resort to the particles hydro-, oxi-, and hydroxi- as name-components; and, more especially, the innovation of substituting the word "hydroxide" for the long-established word "hydrate" are practices open to grave objection.

The Periodic Law, as illustrated by certain Physical Properties of Organic Compounds, by Prof. Thos. Carnelley, D.Sc.—In this paper the author shows that the physical properties of the normal halogen and alkyl compounds of the hydrocarbon radicals exhibit numerous relationships, which, with one exception, are similar to those which he has shown to exist between the normal halogen or the alkyl compounds of the elements. It appears that the physical properties of the following four classes of compounds obey the same rules:—(1) The halogen compounds of the elements—*i.e.* of elements with elements. (2) The alkyl compounds of the elements. (3) The halogen compounds of the hydrocarbon radicals. (4) The alkyl compounds of the hydrocarbon radicals—*i.e.* of hydrocarbon radicals with hydrocarbon radicals. The relationships referred to have been tested in no less than 6117 cases, 5 per cent. only of which are exceptions.

Suggestions as to the Cause of the Periodic Law, and the Nature of the Chemical Elements, by Prof. Thos. Carnelley, D.Sc.—The truth of the periodic law of the chemical elements is now generally allowed by most chemists. Nevertheless, but little has been done towards attaining a reasonable explanation of the law. The object of this paper, therefore, is to offer a few suggestions on this subject. Granting the truth of the periodic law, we cannot help theorising as to its cause, and thence by a natural step as to the nature of the elements themselves. Even long before the discovery of the law many chemists had pointed out certain numerical relationships existing between the atomic weights of bodies belonging to a given group, and had hence supposed that the elements belonging to the several natural groups were not primary, but were made up of two or more simpler elements. These conclusions, however, were more or less fragmentary, and referred only to particular groups of elements. In the light of the periodic law the author has made a general extension of the fragmentary conclusions of Dumas, and has brought that law into juxtaposition with an extended generalisation of the analogy of the elements with the hydrocarbon radicals. His conclusions are based on the relationships which he has observed to obtain between certain physical properties and the atomic weights of the elements, and those of their compounds (see previous paper). A careful consideration of the points submitted leads almost irresistibly to the conclusion that the elements are analogous to the hydrocarbon radicals in both form and function. This is a conclusion which, if true, would further lead us to infer that the elements are not elements in the strict sense of the term, but are built up of (at least) two primary elements, A (= carbon at. wt. 12), and B (ether at. wt. −2), which by their combination produce a series of compounds (viz. our present elements), which are analogous to the hydrocarbon radicals. If the above theory of the constitution of the elements be true, the periodic law would follow as a matter of course, and we should therefore be able to represent the elements by some such general formula as $A_n B_{2n+(2-x)}$, analogous to that for the hydrocarbon radicals, $C_n H_{2n+(2-x)}$, in which n = the series, and x the group to which the element or hydrocarbon radical belongs.[1] Assuming the truth of the theory here advanced, it is interesting to observe, that whereas the hydrocarbons are compounds of carbon and hydrogen, the chemical elements would be compounds of carbon with ether, the two sets of bodies being generated in an exactly analogous manner from their respective elements. There would hence be three primitive elements—viz., carbon, hydrogen, and ether. Finally, it may be stated that this theory would remove the chief objections which have been urged against the periodic law, whilst the existence of elements of identical atomic weights and isomeric with one another would be possible. May not Ni and Co, Ru and Rh, Os and Ir, and some of the rare earth metals be isomers in this sense?

[1] Cf. Abney's researches on the infra-red absorption spectra of carbon compounds (*Proc.* Roy. Soc., 31, 416), also the article on the Decomposition of Didymium by Welsbach in NATURE, vol. xxvii. p. 435.

The Value of the Refraction Goniometer in Chemical Work, by Dr. J. H. Gladstone, F.R.S.—The principal points illustrated and enforced in this communication were (1) that the index of refraction and length of spectrum are important physical properties of any substance; (2) the specific refraction and specific dispersion may be serviceable: (*a*) in determining the purity of a substance, (*b*) in the analysis of such a mixture as ethyl and methyl alcohols, (*c*) as a guide in the investigation of organic compounds, (*d*) as arbiter between rival views as to the constitution and structure of particular chemical compounds.

Refraction of Fluorine, by G. Gladstone.—From a comparison of the observations on fluorspar, cryolite, and several artificial fluorine compounds, the author shows the refraction equivalent of fluorine to range from 0·3 to 0·8, the mean of the whole series of determination being 0·6. Thus, taking the highest estimate, the specific refraction of this element is scarcely equal to half that of any other substance.

Note on the Conditions of the Development and of the Activity of Chlorophyll, by Prof. Gilbert, LL.D., F.R.S.—An account of some experiments made in conjunction with Dr. W. J. Russell, which show a close connection to exist between the formation of chlorophyll and the amount of nitrogen assimilated by plants; the amount of carbon assimilated is not, however, in proportion to the chlorophyll formed, unless a sufficiency of mineral substances, required by the plants, is available. In cases where both nitrogenous and mineral manures were applied a lower proportion of nitrogen assimilated and chlorophyll formed over a given area was observed, which is no doubt due to the greater assimilation of carbon and consequent greater formation of non-nitrogenous substances, although the amounts of nitrogen assimilated and chlorophyll formed were as great, if not greater.

On the Action of Sodium Alcoholates on Fumaric and Maleic Ethers, by Prof. Pardie, Ph.D., B.Sc.—By the action of *sodium methylate* on *ethylic fumarate*, *methylic methoxysuccinate* is formed, from which *methoxysuccinic acid* can be obtained, a crystalline solid melting at 101°–103°; this same acid is obtained from the products of the reaction of sodium methylate on *ethylic maleate* or *hydric methylic maleate*. Similarly an *ethoxysuccinic acid* is obtained by the action of sodium ethylate on *ethylic fumarate*, also by its action on *hydric ethylic maleate*. Thus fumaric and maleic acids yield alkyloxy-succinic acids, which are identical with one another, or, if not identical, resemble one another so closely that their isomerism must be of the same character as that of substances which differ from one another only in their optical and crystallographic characters.

On Sulphine Salts derived from Ethylene Sulphide, by Orme Masson, M.A., D.Sc. (Edin.).—Ethylene sulphide, when heated at 160°, is converted into diethylene sulphide $S(C_2H_4)_2S$, an ethereal solution of which, when mixed with methyl iodide, unites with the latter to form *diethylene sulphide methyl sulphine iodide* $S(C_2H_4)_2S.CH_3I$, which is a crystalline compound soluble in water, but insoluble in alcohol or ether. From this compound a series of the *sulphine* salts have been prepared, which resemble the salts of trimethyl sulphine in their behaviour when heated, but differing from these compounds in the ease with which they are decomposed by caustic alkalis with the formation of *diethylene sulphide methyl sulphine hydroxide* $(C_2H_4)_2S_2CH_3OH$. The compounds obtained by Dehn (*Annalen*, Supp. iv. 83) by heating together ethyl sulphide, ethylene bromide, and water together in sealed tubes, and styled "sulphinic salts" by him, were, in all probability, dimethylene sulphine-methyl-sulphine derivatives.

On an apparently new Hydrocarbon from Distilled Japanese Petroleum, by Dr. Divers and T. Nakamura.—A description of a yellow solid hydrocarbon found amongst the final products of the distillation of the petroleum from the wells at Sagara. The hydrocarbon melts at 280°-285°, and has a composition expressed by the formula $(C_4H_3)_n$.

The Composition of Water by Volume, by Dr. A. Scott, M.A., D.Sc.—After pointing out the desirability of renewed determinations of the exact proportions in which hydrogen and oxygen combine with one another, inasmuch as neither of these gases obey Boyle's law exactly, the author gave a description of the apparatus he had employed in making such determinations, which allowed the use of considerable volumes of these gases. The results obtained show the ratio not to be exactly that of 1 vol. of oxygen to 2 vols. of hydrogen; but the proportions are 1 : 1·994 or 1 : 1·9935; or, if the impurity be supposed to exist in the oxygen alone, then the ratio is 1 : 1·996. The gases were examined as to their purity, the results indicating the presence of ·2 c.c. to ·3 c.c. of foreign gas in the 450 c.c. used.

In a communication entitled *On Solutions of Ozone and the Chemical Action of Liquid Oxygen*, Prof. Dewar gave a description of the apparatus and method employed by him in the liquefaction of such gases as oxygen, &c., and after discussing the conditions required for the successful conversion into the liquid state of the so-called permanent gases, he gave an account of some experiments made with liquid oxygen. At $-130°$ liquid oxygen loses the active characters possessed by this element in the gaseous state; it is without action on phosphorus, sodium, potassium, solid sulphuretted hydrogen, and solid hydriodic acid. Other substances appear to undergo similar changes at very low temperatures; thus liquid ethylene and solid bromine may be brought in contact without any action taking place, whereas gaseous ethylene and liquid bromine unite directly at the ordinary temperatures. Hautefeuille and Chapuis by subjecting a mixture of carbonic anhydride and ozone to great pressure obtained a blue liquid, the colour of which is due to the ozone. If ozonised air be passed into carbon disulphide at $-100°$, the liquid assumes a blue colour, which disappears if the temperature be allowed to rise, and at a certain point a decomposition, resulting in the production of sulphur, takes place. The best solvent for ozone is a mixture of silicon tetrafluoride and Russian petroleum. These solutions of ozone are without action on metallic mercury or silver. Prof. Dewar, in remarking on the liquefaction of nitric oxide, stated that a comparison of its curve of liquefaction with that of methane shows the pressure to increase more rapidly with the temperature in the case of nitric oxide than in other gases, a fact which would appear to indicate, that at low temperatures the molecule of nitric oxide is of greater complexity, and probably exists as N_2O_2. An account was given of some of Cailletet's experiments on the electrical conductivity at low temperatures, which seemed to indicate that as the limit $-220°$ was approached ordinary electrical conductors become almost perfect conductors.

On the use of Sodium or other Soluble Aluminates for Softening and Purifying Hard and Impure Water, and Deodorising and Precipitating Sewage, Waste Water from Factories, &c., by F. Maxwell Lyte, F.C.S., F.I.C.—The advantages attending the use of sodium or other soluble aluminates for the above purposes are dependent upon their easy decomposition with the production of a precipitate of hydrated alumina, which removes organic matter, and further by their use the temporary hardness may be completely destroyed, and the permanent hardness reduced.

Some New Crystallised Combinations of Copper, Zinc, and Iron Sulphates, by J. Spiller, F.C.S.—The author gave an account of the preparation of a large series of double sulphates of copper and iron, zinc and iron, and copper and zinc.

In a communication on *Barium Sulphate as a Cementing Material for Sandstone* Prof. Clowes pointed out that, although Bischof mentioned instances of foreign sandstones in which the material cementing the sand grains together was barium sulphate, it appeared that up to the present time no such sandstone had been met with in the United Kingdom. Having learned that opinions differed regarding the calcareous nature of certain new red sandstone beds in the neighbourhood of Nottingham, he undertook to examine the chemical composition of these sandstones, and procured specimens of the sandstone from different levels. On being analysed, the sandstone was found to contain barium sulphate in varying proportions, at present being determined, while some of the lower beds also contained calcium carbonate. In some of the sandstone beds the barium sulphate was very unequally distributed, forming a network or a series of small masses more or less spherical in shape. In such sandstone the sand grains between the sulphate streaks and patches were quite loose, the result being that the weathered surface presented a honeycombed appearance. To explain the presence of the barium sulphate he suggested that it might have been deposited along with the sand; but if such had been the case it had certainly undergone a physical change, as it now existed in a firm, compact, and crystalline condition. It would, therefore, appear that it had been either deposited from aqueous solution or that it had been rendered crystalline by a slow percolation of a solvent liquid through the sedimentary deposit, or owed its origin to the action of water containing calcium sulphate passing through sandstone cemented originally with barium carbonate.

NOTES

BOTANISTS will learn with very great regret of the death of Mr. Edmond Boissier, the learned and indefatigable author of the "Flora Orientalis," and many other important works on Systematic Botany. We have received no particulars, but we imagine his death must have been somewhat sudden, for the event was quite unexpected by his friends in this country. As recently as the month of August Prof. Oliver heard from him, the communication relating to the Supplements to the "Flora Orientalis," on which the deceased botanist has been for some time engaged, and in which he wished to incorporate the botanical results of Dr. Aitchison's latest investigations in Afghanistan. Boissier's career as a botanist may be said to have commenced with his travels in Spain in 1837, when he collected the materials published in his "Voyage Botanique dans l'Espagne," a richly illustrated work which appeared at intervals from 1839 to 1845. He subsequently travelled and botanically explored various parts of South-eastern Europe and Asia Minor. Independently of his larger works he published, separately, diagnoses of the exceedingly large number of undescribed species he found from within the limits of his "Flora Orientalis," the first volume of which appeared in 1867, and the last in 1881. This work alone is sufficient to place the author in the first rank of a school of distinguished systematists, now alas fast disappearing without leaving a corresponding rising generation to take up the work where they have left it. Like the late Mr. Bentham, M. Boissier was in a position to give his undivided attention to the science he had chosen, and like him he laboured unceasingly; and it is to be hoped that the supplement to the "Flora Orientalis" is in a sufficiently forward state for publication. Among other things the vast genus *Euphorbia* furnished materials for several valuable works, including a monograph of all the species, and a folio volume containing figures of 120 species. Mr. Edmond Boissier was a Foreign Member of the Linnean Society, having been elected in 1860; and from his constant readiness to give others the benefit of his extensive knowledge, he enjoyed the esteem and admiration of a wide circle of botanists.

THE death is announced, at the age of seventy-eight years, of Mr. John Muirhead, one of the very few survivors of the early days of telegraphy, and closely connected with its practical development. Mr. Muirhead, in conjunction with Mr. Latimer Clark and Mr. W. M. Warden, of Birmingham, founded the house now known as Latimer Clark, Muirhead, and Co., more than a quarter of a century ago. It was from this manufactory that Mr. Muirhead introduced the form of battery which bears his name, a form so eminently portable and practical that it has become the model for most of the existing batteries, while continuing itself to be largely employed.

A *Times* telegram dated Philadelphia, September 27, states that the President of the United States has asked Prof. Alexander Agassiz to accept the post of Superintendent of the Coast Survey.

A REMARKABLE memoir on the development of the sternum in birds, prepared by Miss Beatrice Lindsay, of Girton College, and communicated to the Zoological Society of London by Dr. H. Gadow at their meeting on June 16 last, will appear in the forthcoming number of the Society's *Proceedings*. Miss Lindsay, after close investigation of the embryonic condition of different stages in five types of bird-structure (the ostrich, guillemot, gull, domestic fowl, and gannet), has come to the conclusion that the keel of carinate birds is a special outgrowth of the true sternum peculiar to birds, and is not homologous with the episternum or interclavicle of reptiles, as has been held by Götte and others. There are no traces whatever in the embryonic stages of the ostrich, according to Miss Lindsay's observations, of the existence of any rudiments of the clavicles or keel. It follows that the view held by some morphologists that the ostrich may be a degraded descendant of some carinate form can no longer be supported.

THE Edinburgh International Industrial Exhibition will be opened on May 4 next.

A CORRESPONDENT of the *Times* in a recent article on the new Electorate, describes the fishermen at Staiths, a village on the Yorkshire coast, lying between Whitby and Saltburn. The people, he says, are imbued with all manner of quaint superstitions. They have a firm belief in witchcraft, the witch being wholly unconscious of his or her power of evil. Until recently—and it is said that the custom is still secretly maintained by some of the older inhabitants—it was customary, when a smack or coble had had a protracted run of ill-fortune, for the wives of the crew and owners of the boat to assemble at midnight, and, in deep silence, to slay a pigeon, whose heart they extracted, stuck full of pins, and burned over a charcoal fire. While this operation was in process the unconscious witch would come to the door, dragged thither unwittingly by the irresistible potency of the charm, and the conspirators would then make her some propitiatory present. Again, it is of frequent occurrence that, after having caught nothing for many nights, the fishermen keep the first fish that comes into the boat and burn it on their return home as a sacrifice to the Fates. All four-footed animals are considered by the Staiths folk as unlucky, but the pig is the most ill-omened of quadrupeds. If when the men are putting their nets into the boats the name of pig is by accident mentioned, they will always desist from their task and turn to some other occupation, hoping thus to avert the evil omen, and in many cases will renounce the day's expedition altogether. The sight of a drowned dog or kitten, too, as he goes towards his coble will always keep a Staiths fisherman at home; and, what is still more curious, if as he walks to his boat, his lines on his head or a bundle of nets on his shoulder, he chances to meet face to face with a woman, be she even his own wife or daughter, he considers himself doomed to ill-luck. Thus, when a woman sees a man approaching her under these circumstances she at once turns her back on him. If a fisher sends his son to fetch his big sea boots, the bearer must be careful to carry them under his arm. Should he by inadvertence place them on his shoulder his father will inevitably refuse to put out to sea that day. An egg is deemed so unlucky that the fishermen will not even use the word, but call it a roundabout; and, fearless as are the fishers in their daily struggling with the dangers of the sea, yet so fearful are they of nameless spirits and bogies that the writer was assured he could not find in the whole fishing colony of Staiths a volunteer who for a couple of sovereigns would walk by night to the neighbouring village, a couple of miles distant.

WE have received the report of Miss Pogson, the meteorological reporter to the Government of Madras, for the year 1884-85. It contains remarks on the various stations scattered over the Presidency, together with the usual tables. Part of the observer's work is to train learners, who afterwards take charge of the local stations. One of these, it is interesting to notice, is on the Laccadives, which islands are inaccessible during a great part of the year. The assistants in most cases are native officials.

ALL the legal steps have been taken by the French Government for entering into possession of the late M. Giffard's fortune, which is to be devoted to the good of science. The fortune is valued at 200,000*l.*, after paying about 100,000*l.* in legacies to friends, family, or scientific societies. The decree is ready and will shortly appear in the *Journal Officiel*. Several projects have been proposed already for utilising this large sum of money, but it is very likely nothing will be done before taking the advice of the French Academy of Sciences.

ON September 12, just after sunset, a remarkable mirage was seen at Valla, in the province of Sudermania, Sweden. It appeared first as a great cloud-bank, stretching from south-west to north, which gradually separated, each cloud having the appearance of a monitor. In the course of five minutes one had changed to a great whale blowing a column of water into the air, and the other to a crocodile. From time to time the clouds took the appearance of various animals, and finally that of a small wood. Subsequently they changed to a pavilion, where people were dancing, the players being also clearly visible. Once again the spectacle changed, now into a lovely wooded island with buildings and parks. At about nine o'clock the clouds had disappeared, leaving the sky perfectly clear. The air was calm at the time of the display, the temperature being 6° C.

THE aquarium at the Inventions Exhibition has lately been entirely restocked, the latest arrivals being a fine selection of bass weighing 10 lbs., some large specimens of Crustaceans, and an assortment of flat-fish of all descriptions. There is also on view a diversified collection of foreign freshwater fish presented by the General Import Company.

CAPT. VIPAN's aquarium of foreign fishes at Stibbington Hall, Wansford, is a most valuable one, and includes unique and rare specimens of fish from all parts of the world, which are retained with the utmost care, the temperature of the water being regulated to suit the natural necessities of the various fish. This aquarium is considered to be one of the most unique in the United Kingdom, and increases in value annually on account of periodical additions to the collection.

THE taxidermist who has had charge of the work upon the body of "Jumbo," who was recently crushed between two trains, states that the elephant's stomach contained many English coins—gold as well as silver and bronze. His tusks had by the collision with the train been driven nearly through the skull. According to later accounts as to the accident, Jumbo at the last moment faced and charged the locomotive. The elephant's skin was found to be an inch and a half thick, and it weighed 1537 lbs. The skeleton weighs 2400 lbs., and the total weight of the body was over 6 tons.

MESSRS. SWAN SONNENSCHEIN AND CO. announce, for the season 1885-6, the following publications:—"A Treatise on Animal Biology," by Prof. Adam Sedgwick, Fellow and Lect. of Trin. Coll., Camb. (illustrated); "Practical Botany," by Prof. Hillhouse, of Mason Coll., Birm., based upon the work of Prof. Strasburger (largely illustrated); a translation of Profs. Nægeli and Schwendener's work, "The Microscope in Theory and Practice," with several hundred woodcuts; an "Alpine Flora," a pocket handbook for botanists and travellers, by Mr. A. W. Bennett, B.Sc., M.A.; an illustrated "Handbook of Mosses," by Mr. J. E. Bagnall; a "Star Atlas," by the Rev. T. H. Espin; further parts of Mr. Howard Hinton's "Scientific Romances"; an entirely new and partly re-written edition of Prof. Prantl and Vines's "Text-Book of Botany"; "From Paris to Pekin over Siberian Snows," an account of the Asiatic wanderings of M. Meignan, by Mr. William Conn; "The Wanderings of Plants and Animals," an adaptation from the German work of Prof. Victor Hehn, by Mr. James Stallybrass, tracing (chiefly by means of etymology) the history and the migration of European plants and animals to their home in Asia.

MESSRS. CROSBY LOCKWOOD AND CO. make the following announcements for the approaching publishing season:—"Electro-Deposition," by Alexander Watt, author of "Electro-Metallurgy"; "The Prospector's Handbook, a Guide for the Prospector and Traveller in Search of Metal-bearing or other valuable Minerals," by J. W. Anderson, M.A., F.R.G.S.; "The Engineman's Companion, a Practical Educator for Enginemen, Boiler Attendants, and Mechanics," by Michael Reynolds; "The Combined Number and Weight Calculator," by Wm. Chadwick, Public Accountant; "Our Temperaments, their Study and their Teaching, a Popular Outline," with illustrations, by F.R.C.S.E.; "The Artist's Tables of Pigments," by H. C. Standage; "Land and Marine Surveying," by W. Davis Haskoll (entirely new edition); "The Metal Turner's Handbook, a Practical Manual for Workers at the Foot Lathe," by Paul N. Hasluck (second edition, revised), being the first volume of a new series of "Handbooks on Handicrafts."

THE "Sun" Knife-cleaner has some points which deserve notice. It is supported on a light cast-iron standard, the upper portion of which is bored out and faced to make the bearing where alone perfect fit is required. A cast-iron spindle is fitted into this bearing, and supports upon a flattened face two spring disks made of cast steel finely tempered, dished in the centre and having rays upon them like the spokes of a wheel, which turn slightly outwards at their ends, so as to form a tapered space adapted to the wedge form of the length of the knife. These springs are so mounted upon the spindle that the rays of the one are opposite to the space, between the rays of the other. The spindle is terminated by a screw upon which a thumb nut is fixed to hold the handle in position and keep the working parts together. By means of this screw the springs can be pressed more or less closely together as required. Leather rings are riveted to the inner faces of the springs, and form the surfaces upon which the knives are cleaned and polished; the rivets are in the dished portion of the springs and so out of the way of the knife-blade; the polishing powder is supplied through a hole in the face of the front spring. The knife whilst being cleaned is supported below a wrought-iron piece cast into the standard and passed in and out of the machine. The difficulty in cleaning a knife is due to its double wedge form. A knife is a long wedge from the tip to the shoulder, and a short wedge from the edge to the back, and it is evident that the pressure brought to bear upon it must be of an elastic character, so as not to grind the knife away. As regards the length of the knife this is effected by the outward taper of the rays of the springs. The two leather rings between which the blade is passed in and out being pressed against the blade of the knife by the rays of the springs as described, it is evident that there is an elastic pressure upon it; the spring on the one side diminishes in its bearing pressure, as that on the other side increases, and hence an equable pressure is applied to all parts of the blade, as is proved by the excellent polish produced. A small portion of powder being supplied through the hole in the front spring, the knife is placed with its edge downwards below the wrought-iron support and passed slowly in and out of the machine between the leather disks with the left hand, whilst the right hand is employed in turning the handle of the machine in the direction of the hands of a clock. In this way from one inch to two inches in depth of the surface of each leather (depending upon the size of the machine) presses elastically upon the blade. This being the greatest frictional resistance at any moment between the blade and the polishing surfaces, the labour of cleaning is reduced to a minimum, while the knife can be polished to the shoulder owing to the leathers being bevelled. Special tools have been designed for cutting and bending the wrought-iron supports in one operation, for cutting and bevelling the leathers, and riveting and fitting them to the springs. These machines are supplied in four sizes.

IN contrast to the weather in Southern Norway during May and June (NATURE, vol. xxxii. p. 354) the weather of July was warmer and more normal, the mean temperature of the month—viz. 17·1° C. being 0·5° above the normal, 16·6°. This is chiefly due to the southern winds prevalling in the first part of the month. On July 21, however, the weather changed, northern and north-western winds prevailing, with clear and dry air, and in consequence of the great radiation, the temperature fell several times very low during the second part of the month. The minimum temperature—viz. 6·4° C.—was registered at Christiania on the night of the 22nd., and the highest—viz. 29° C.—on the 6th. The rainfall was 40 per cent. below the normal. With the exception of the coast towards the Naze, the month has been cold throughout the land on the whole, the most unfavourable parts being the west coast, where the temperature was 1° C. below the normal mean. In the mountains and in East Finmarken it sank several times below 0°. The rainfall in the southern and eastern parts was below the average, but in th northern and north-western parts it was above it. The greatest rainfall was registered in Finmarken, where, in Alten, for instance, it was 142 per cent. above the average.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mrs. Paterson; a Humboldt's Lagothrix (*Lagothrix humboldti*) from the Upper Amazons, presented by Mr. F. J. Hammond; two Macaque Monkeys (*Macacus cynomolgus*) from India, presented respectively by Mr. F. Debenham and Miss Lucy McArthur; two West Indian Agoutis (*Dasyprocta cristata*), seven Crab-eating Opossums (*Didelphys cancrivora*), two Rough Terrapins (*Clemmys punctularia*), two Brazilian Tortoises (*Testudo tabulata*), two Teguexin Lizards (*Teius teguexin*), two Tuberculated Iguanas (*Iguana tuberculata*), nine Giant Toads (*Bufo aqua*) from Trinidad, presented by Mr. F. J. Guy; two Palm Squirrels (*Sciurus palmarum*) from India, presented by Mr. A. Bellamy; a Great Kangaroo (*Macropus giganteus* ♂), a Rufous Rat Kangaroo (*Hypsiprymnus rufescens*) from New South Wales, a Roan Kangaroo (*Macropus erubescens* ♀) from South Australia, presented by Mr. C. Czarnikow, F.Z.S.; a Common Crossbill (*Loxia curvirostra*), British, presented by Mr. H. S. Eyre; a Green Lizard (*Lacerta viridis*) from Jersey, presented by Mr. G. V. Colliver; a Guinea Baboon (*Cynocephalus sphinx*) from West Africa, two Bonnet Monkeys (*Macacus sinicus*) from India, two Ælian's Wart Hogs (*Phacochœrus africanus* ♂ ♂) from Africa, deposited; a Garnett's Galago (*Galago garnetti*) from East Africa, a Harnessed Antelope (*Tragelaphus scriptus* ♀), an Elate Hornbill (*Ceratogymna elata*) from West Africa, a Puff Adder (*Vipera arietans*) from South Africa, a Lacertine Snake (*Cœlopeltis lacertina*), European, an Aldrovandi's Lizard (*Plestiodon auratus*) from North-West Africa, purchased; a Leopard (*Felis pardus*), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *OCTOBER* 4–10

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on October 4

Sun rises, 6h. 8m.; souths, 11h. 48m. 37·5s.; sets, 17h. 29m.; decl. on meridian, 4° 31′ S.: Sidereal Time at Sunset, 18h. 29m.

Moon (New on October 8) rises, 1h. 10m.; souths, 8h. 31m.; sets, 15h. 41m.; decl. on meridian, 12° 2′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	5 10	11 18	17 26	0 43 N.
Venus	9 55	14 17	18 39	19 4 S.
Mars	0 15	8 0	15 45	18 47 N.
Jupiter	4 13	10 38	17 3	4 12 N.
Saturn	21 35*	5 43	13 51	22 18 N.

* Indicates that the rising is that of the preceding day.

Oct.	h.	
6	17	Jupiter in conjunction with and 1° 25′ north of the Moon.
7	20	Mercury in conjunction with and 0° 29′ north of the Moon.

HEREDITY

AT the February meeting of the Swedish Anthropological Society Prof. Wittrock read a paper on the hereditability of colour of the eyes. The speaker had been requested by Prof. Alphonse De Candolle, of Geneva, to make observations on this point, which, together with those made in Switzerland, North Germany, and Belgium, had formed the material for M. De Candolle's paper, "Hérédité de la couleur des yeux dans l'espèce humaine" (*Archives des Sciences Physiques et Naturelles*, 3e période, t. xii., Genève, 1884). From the same the remarkable fact was derived that brown eyes were more common in men than women; of the individuals examined 41·6 per cent. of men and 44·2 per cent. of women had brown eyes. Further, in families where the parents had the same colour of eyes 80 per cent. of the children of parents with brown eyes had brown eyes, whilst of children of parents with blue eyes 93·6 per cent. of them had eyes of that colour. The unconformity was no doubt due to atavisme or the hereditary influence of ancestors. Of the children of parents of whom the father had brown and the mother blue eyes 53·3 per cent. had brown, whilst where the reverse was the case 55·9 per cent. had blue eyes. As the percentage of brown-eyed children of parents with bi-coloured eyes was highest, it seemed as if brown eyes were always on the increase to the detriment of blue ones. It appeared also from these researches that women with brown eyes have better prospects of marrying than those with blue. 52 per cent. of the married women had brown eyes, and only 48 per cent. of them blue—a circumstance which is the more remarkable as the number of women with brown eyes in Italian Switzerland is only 44 per cent. Another remarkable discovery was that the average number of children of parents with eyes similar in colour was 2·7, whilst that of those with different colour was 3·18, which was an additional proof of the fact that children of parents with similar organisation were as a rule of weak constitution. Comparing the colour of the eyes of the children where the parents were bi-coloured, with those of each of the latter, it was discovered that the eyes of the father were inherited by 48·8 per cent. of the children, and those of the mother by 51·2 per cent., which, divided between sons and daughters, showed that 47 per cent. of the former and 49·5 per cent. of the latter inherited the eyes of the father, whereas 53 per cent. of the sons and 50·5 per cent. of the daughters inherited those of the mother. Since Prof. Candolle had published his paper, he (the speaker) had continued his researches in Sweden, and from the material he had collected he had discovered results differing from Prof. Candolle's. Of the individuals reported to him 29·6 per cent. of the men and 30·7 per cent. of the women had brown eyes, so that even in that country the latter were more numerous than the former, but this was no doubt due to the circumstance that he had been most anxious to obtain particulars from bi-coloured parents. In accordance with Candolle's results, 75·6 per cent. of children of parents both with brown eyes inherited this colour, whilst of those with blue eyes 97 per cent. inherited that colour. It was but natural that this should be the case in Sweden, where blue eyes predominated. As regards the bi-coloured parents the case was different in Sweden too. If the father had brown and the mother blue, 59·9 per cent. of the children had brown eyes, whilst where the reverse was the case 53 per cent. of them had brown ones. These figures were the reverse of Candolle's. But of *all* bi-coloured parents 56 per cent. of the children had brown eyes, *i.e.* that in Sweden too the latter are on the increase. He could not say what *rôle* the colour of the eyes played in the selection of a wife in Sweden, as he had no statistics of the distribution of brown eyes in general, but there was a tendency similar to that stated above, as, of the parents embraced by these researches, the majority of wives had brown eyes. With reference to the number of children in Sweden of con-coloured and bi-coloured parents, that of the former was 4·49 and that of the latter 4·03, whilst 52·6 per cent. of the children inherited the eyes of the father and 47·4 per cent. those of the mother; of the sons 51·8 per cent. inherited the eyes of the father, and 48·2 per cent. those of the mother, which figures as regards the daughters were respectively 53·5 and 46·5 per cent. This shows that in Sweden the eyes are not predominantly inherited from the mother alone, and that the offspring of equally-constituted parents should not be weaker. The speaker stated in conclusion that he is continuing his researches. He excludes children under ten years of age from the same, and classifies blue-grey or grey eyes as blue.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

PROF. W. GRYLLS ADAMS, F.R.S., will deliver a Course of Lectures at King's College, London, on Heat and Light, during the Academical Year 1885-6. A Course of Practical Work in Electrical Testing and Measurement, with especial reference to Electrical Engineering, will be carried on under his direction in the Wheatstone Laboratory. There will also be a Course of Lectures on Mechanics and the Principles of Energy. The Wheatstone Laboratory is open daily from 1 to 4, except on Saturdays. For further particulars apply to Prof. Adams, King's College, London.

THE following appointments have recently been made at the Victoria University, Owens College, Manchester:—To the Professorship of Mathematics: Mr. Horace Lamb, M.A., F.R.S., late Fellow of Trinity College, Cambridge, and Professor of Mathematics in the University of Adelaide. To the Professorship of Anatomy: Mr. Alfred H. Young, M.B., F.R.C.S.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 21.—M. Bouley, President, in the chair.—On the development of cholera in India, by M. Gustave Le Bon. In support of Prof. Peter's view that European differs from Asiatic cholera only in the greater intensity of the causes producing it, the author argues that both forms might break out spontaneously in any country through the volatile germs arising from putrified organic matter. In his former researches he showed that, apart from these germs, there exists a series of volatile alkaloids which, when introduced by respiration, produce almost fulminating effects. These researches throw much light on the accidents attending the exhumation of bodies long buried and on the spread of typhoid or analogous fevers. The facts recently observed by M. Le Bon during a sudden outbreak of cholera at Kombakonum, in the south of India, tend to confirm this hypothesis. In India itself cholera rages almost exclusively amongst the native populations; the English, who reside in large cantonments, where sanitary arrangements are scrupulously attended to, being seldom attacked. That cholera and intermittent fevers are propagated chiefly by bad water is a point on which opinion is unanimous in that country, and the author's personal experience places it beyond all reasonable doubt.—Elements of Brooks's comet, by M. R. Radau. These elements, according to observations made at Cambridge and Paris, are found to be:—

T = 1885, August 10·30457; mean Paris time.

$$\left.\begin{aligned}\pi - \Omega &= 43\ \ 0\ 47\\ \Omega &= 204\ 33\ \ 7\\ i &= 59\ 22\ 30\end{aligned}\right\}\text{Mean equinox of 1885·0.}$$

$$\log q = 9·87694$$

—Note on a new stellar spectroscope, by M. Ch. V. Zenger. This instrument is constructed on a new principle, and chiefly intended to measure simultaneously and accurately the angle of position and the distance of double stars situated very close together.—On the process of fertilisation in the Cephalopods, by M. L. Vialleton.—On the anatomical organisation of the urns in *Cephalotus follicularis*, by MM. Jules Chareyre and Edouard Heckel.

BERLIN

Physiological Society, July 31.—Prof. Fritsch spoke on the functions of the sebaceous glands, raising a protest against the conception, represented quite recently by Herr Unna, that these glands served only to lubricate the hairs, while the globiform glands, commonly called the sudoriparous glands, lubricated the skin and induced the formation of the subcutaneous fat, and that, finally, the perspiration was discharged by the sweat-pores, or, rather, the extreme ends of the straight canals into which the sweat found its way out from intercellular spaces through the stomata. A whole series of anatomical, histological, and physiological grounds were brought forward against this view both by the speaker and, in the course of the discussion on the subject, by Prof. Du Bois-Reymond, Prof. Waldeyer, Dr. Gad, and Dr. Lassar. All known observations and experiments were, on the contrary, they maintained, in favour of the view that the sebaceous glands provided fat for the skin, while the globiform glands had the production of sweat assigned to them.—Dr. Weyl reported on the results of a chemical examination of the cholesterin, the composition of which had not hitherto been ascertained, although this substance had been discovered more than a hundred years ago, and had since been traced in the most varied organs of the animal body and even in plants. The most searching investigation down to the present of cholesterin had been made by Herr Zwenger, who, by treatment with sulphuric acid and nitric acid, had found combinations which he had distinguished and chemically characterised as cholesterylene and cholesterone. By repeating these experiments Dr. Weyl had achieved much purer derivatives of the cholesterin, in particular chloric and bromic combinations, in very pure crystals, which rendered exact elementary analysis possible. This led to the result that the derivatives of cholesterin were found to be hydrocarburets belonging to the great class of the terpenes—that is, they were products of condensation or polymerisations of the simple terpene (C_5H_8). Even though it were not yet possible to state precisely the number of the C_5H_8 which had become polymerised in the several cholesterin derivatives, the speaker yet thought he had sufficient ground for assuming that the composition $(C_5H_8)^5H_2O$ was the one proper to the cholesterin itself. Substances which, both by their reactions and their percentage compositions, were denotable as terpenes, might also be obtained from the choleic acid, a circumstance which pointed to the more intimate relation between cholesterin and choleic acid.—Dr. Biondi communicated the results of an investigation carried out by him in the Institute of Prof. Waldeyer with a view to throwing light on the origin of the spermatozoids in the seminiferous canals—a question on which the views of physiologists were so widely divergent. By appropriate use of appliances for hardening, fixing, and colouring, among which the advantages of Flemming's fluid had to be mentioned with quite special prominence, Dr. Biondi arrived at results which corroborated none of the views formerly put forth, but which explained the earlier observed facts. In accordance with these results it had been endeavoured diagrammatically to distribute the contents of the seminiferous canals into columns, which, proceeding from the wall towards the central cavity, might be grouped into three layers. In the first stage of development, a stage always met with, in particular, in animals not yet ripe, the extreme layer lying on the wall of the canal consisted of round, primitive cells, the second layer, proceeding inwards, of round mother-cells, which were very rich in caryokinetic figures, and the third innermost layer consisted of a larger number of small round daughter cells. In a second stage of development observable in ripe glands the nucleus of the daughter cells were seen converted into spermatozoids, the exterior half of the nucleus becoming the head and the other interior half the middle part and tail of the spermatozoon. The protoplasm of the daughter cells took no part in this transformation, and enveloped the bodies of the spermatozoa, making them cohere into bundles from which the tails of the spermatozoa projected towards the central canal. These masses of protoplasm enveloping the bodies of the spermatozoa altogether resembled the figures described by the earlier observers as "Spermatoblasten." In this stage the above diagrammatically assumed column consisted, from the outside inwards, of the primitive cell, the mother cell, and the bundle of spermatozoa. In the next stage of development the formation of the spermatozoa, arising always in the same manner from the nucleus of the daughter cells, was pushed farther outwards, so that the column now consisted of but one large round cell on the outside and bundles of spermatozoa on the inside. The formation of the seminal corpuscles advanced still further, and at last the whole column, as far as the wall of the canal, consisted of spermatozoa, the bodies of which were agglutinated into bundles by masses of protoplasm, their tails being directed inwards. Primitive cells out of neighbouring columns now intercalated themselves between the wall of the canal and the spermatozoa, pushing the latter towards the middle. By the development of the mother and daughter cells the spermatozoa were quite pressed and discharged into the central canal. The process thus described then began anew. It must, however, be observed that in nature there was no separation into columns and layers such as was here diagrammatically described. It was only for the sake of clear representation that the processes succeeding each other in time were thus exhibited as divided in space. Dr. Biondi had examined this structure of the seminiferous canals, and this development of the spermatozoids in the bull, the swine, the cat, the rabbit, the guinea-pig, the rat, and other mammalia; and in all these cases he had found alike the same results. Prof. Waldeyer testified that Dr. Biondi had attained to these results quite independently and had communicated and demonstrated them to him as early as February of this year. It was only on his advice that Dr. Biondi had further examined a longer series of animals before publishing his results. A few days ago, continued Prof. Waldeyer, he had received a letter from Prof. Grünhagen in Königsberg, in accordance with which he (Prof. Grünhagen) had attained to the same results on spermatogenesis as had Dr. Biondi, to whom, of the two independent discoverers, was due the title of priority.—Dr. Blaschko briefly explained a series of microscopic preparations he exhibited, which served to show that between the epidermis and the cutis there lay no cementing substance; but just as it was long known that in the case of the epidermis cells they had processes grooving themselves digitately into one another, so here, too, the processes of the epidermis and cutis cells were seen to intertwine with one another and form a network, the meshes of which were particularly large in an œdematous skin.—Dr. Lassar demonstrated microscopic preparations of skin which he had excided from a patient suffering under lichen ruber. In the copious protoplasm (the exudation of the inflammation) surrounding the canals of the epidermis there were seen, after colouring with fuchsine and Bismarck-brown, an uncommonly large number of micrococci, distinguishing themselves particularly by their remarkable smallness.

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