THURSDAY, APRIL 2, 1885

THE METEOROLOGY OF THE ATLANTIC

Deutsche Seewarte. Segelhandbuch für den Atlantischen Ozean. Mit einem Atlas von 36 Karten. Herausgegeben von der Direktion. Mit zahlreichen in den Text gedruckten Holzschnitten und neun Steindruck-Tafeln. (Hamburg, 1885.)

THE Atlas of the Atlantic which was published by the "Deutsche Seewarte" in 1882, has at length, after a term of three years, been joined by the text, which was intended, in the first instance, to have accompanied it, and of which it was described as an appendix. But though separated in their publication by this wide interval, in spirit and in sense, at least, the two are indissolubly linked together, and either one without the other is but an imperfect and mutilated fragment. Of their excellence, now that they are united, it is unnecessary to speak. When Dr. Köppen, with his able coadjutors, writes, and Dr. Neumayer edits such a work as this physical and meteorological survey of the Atlantic Basin it would be waste of words to say more than that the result of their co-operation must at once take rank as a standard book of reference on this subject. More especially valuable is it in those sections which are descriptive of ascertained facts, and are based to a very great extent on recent, frequently on original observations. The detail of these occupies the largest proportion of the space, leaving but little room for theorising or doubtful matter, and absolutely none for the repetition of those many myths and false statements which have been so often presented to us by successive writers, one blindly copying from another, that we had almost begun—like the poor Hindoo with the mangy cur—to believe in their truth. It is scarcely credible, but is nevertheless a fact, that in this large volume, of nearly 600 closely-printed pages in royal 8vo, there is not a word about ships bound to the West Indies throwing cargoes of horses overboard in the horse-latitudes, which are, however, mentioned as "Rossbreiten"; and the reader will look in vain for the time-honoured allegation that the winter storms on our own coasts are extensions of the West India hurricanes.

The name "Belt of Calm"—"Stillengürtel"—is unfortunately preserved; though the particular "Belt" which has been asserted to exist near the equator is ruthlessly spoken of as "der sogenannte Stillengürtel; and the description of those near the tropics gives no countenance to the pestilential doctrine which the name embodies, but is to this effect:—"Two great whirls occupy the tropical and temperate regions of the Atlantic Ccean; each of these has in the centre a maximum air pressure, around which, in accordance with Buys-Ballot's law, the wind circles, in the direction of the daily motion of the sun in the respective hemisphere. The equatorial sides of these whirls are formed of the trade winds, which thus become more polar on the east side of the ocean, whilst on the west side their direction is due east and so passes to equatorial." "In summer the transition between the west wind of the North Atlantic and the trade takes place, on the coast of Portugal and Morocco, through N.W., N., and N.E., and in the opposite sense on the coast of North America, through S.E., S., and S.W. In winter, on the other hand, the region of high pressure partakes more of the nature of a belt extending from one continent to the other, and the transition is effected in a less regular manner, sometimes with calms, and sometimes with one or more stormy veerings of the wind right round the compass" (pp. 87, 91). All this has, of course, been well known to meteorologists for several years, though it has seldom before been clearly and concisely stated in a practical work of this nature. It seems therefore the greater pity that the name "Belt of Calm" should have been allowed to remain; and it would almost seem that its baneful influence has led the authors to write:—"On the South American coast, from 1°–3° N. latitude, calms and rains prevail almost the whole year through" (p. 65): a statement which does not fully agree either with the wind charts of the atlas, or with the direction in our English "South American Pilot"; according to which the variable winds, calms, and rains last only from the end of April to the beginning of July. The exaggeration is in all probability due to a dim recollection of obsolete maps and a theory that ought to be obsolete, but which from time to time revives in the most unexpected places. To some similar source is perhaps to be assigned the statement that "land and sea breezes are to be found along the whole west coast of Africa from Morocco to the Congo," which is only partially true: on the northern part of this coast, land and sea breezes are, practically speaking, unknown; though from the Senegal southwards they are regular enough.

It is impossible not to regret that statements like this should have been loosely hazarded; for though they are not of much practical importance either way, they tend to raise an unjust suspicion that fanciful theory has been sometimes permitted to dictate the statement of the facts, instead of exact and careful observation. It would have been safer and therefore better to have omitted theorising altogether; for, however tempting it may be, no one knows better than the learned and distinguished editor of this volume that there is as yet scarcely a single point in theoretical meteorology which can be said to be fixed with absolute certainty, or which can be fully and satisfactorily explained. The question of air pressure is one of these. In the theory of meteorology no problem is perhaps so interesting and so important: but in the practical application of rules to which the barometer is a guide, the cause of the variations of the barometer is of no importance whatever. The authors of this book are agreed in the opinion that the pressure of the air at any place depends solely on the weight of the superimposed column of air, and that this weight is dependent on temperature. A great many meteorologists hold this opinion; but many, on the other hand, do not; and, as has been said, there is room to doubt. Temperature alone does not seem to offer any explanation of the barometric maxima near the tropics, or of the barometric minimum near Iceland; still less does it offer any explanation of what Maury first called "The Barometric Anomaly at the foot of the Andes"—the high pressure which has been observed, amidst sweltering heat and extreme humidity, in the valley of the Amazon.

But this is irrelevant to the main purpose of the "Segelhandbuch," and does not at all detract from its great value as a practical guide. As such, it takes what is, in some respects, a new departure: it rejects the familiar notion that as storms are mere derangements of the system of winds, they deserve, in a systematic study, nothing more than an incidental notice; and it puts prominently forward the idea that, on the contrary, they ought to be studied in very full detail; because, as it argues, the derangements are rather exaggerations than alterations of the system, and are thus capable of serving as a microscope for the student's clearer instruction. It is an idea which has been well and fully worked out; and with a care and industry which supply the reader with an exhaustless mine of illustration and example.

J. K. L.

MUIR'S "PRINCIPLES OF CHEMISTRY"

Principles of Chemistry. By M. M. Pattison Muir, (Cambridge University Press, 1884.)

DURING the last two decades chemistry has made, possibly, its greatest strides, and has unquestionably drawn to itself a greater following of students in this country than in any previous period. One result of that has been a multiplication of text-books such as perhaps no other science can show. This is only as it should be in the case of a living and progressing science like chemistry. But if one musters the style of text-book produced during this period it becomes painfully doubtful whether they as a whole have kept abreast of the mental capacity which should have been, and undoubtedly has, developed during this period.

Chemistry is certainly a practical science, and that in a very full acceptation of the term; but at the same time it has a history as a practical and especially as a theoretical or mental study second to none, and the unsatisfactory part of the majority of the text-books of modern date is that this growth and development, and the invaluable effect of this as a mental training, have been almost completely ignored.

As mathematical men have been heard to say when going through a course of chemical drudgery, "there seems to be nothing but a lot of isolated facts to learn up." And one cannot be surprised at the remark. The text-books may be roughly divided into two sorts—those of a dictionary character and those intended as an introductory or elementary teacher; the former fulfil their intention, which can scarcely be said of the latter, in which the points of principal theoretical interest are "atomicity" and "atomic and molecular combination," and various ways of writing "formulæ."

It is much to be feared that the teaching of the past few years in this country in chemistry has assumed such an intensely "practical" form that philosophical chemistry has been left very much out in the cold. The numerous examinations in which practical work is required has raised up, unfortunately, an army of "test tubers" and crammers whose theoretical knowledge is of the slenderest. Without in the least wishing to underrate the value of practical work, it does certainly appear, looking only at the chemical literature of the past few years, that theoretical chemistry has to a great extent receded from view in favour of practical, and that of a not very thorough kind.

In the present book Mr. Muir has made up for the lacking in our text-books, and has certainly rendered a real service to the English student who aspires to be something more than a mere test-tuber and writer of graphic formulæ.

As the author informs us, the book is intended for students who already have some elementary acquaintance with the science, and is meant to give "a fairly complete account of the present state of knowledge regarding the principles and general laws of chemistry." And in this the author has certainly succeeded; for it may with certainty be said that we have not a more comprehensive work of the kind in the language. For although it does not pretend to the rank of a Kopp, still it quite fills the place in English chemical literature that Lothar Meyer's "Modernen Chemie" does in the German, which latter work, the author tells us, he has made "free use of."

The subject-matter of the book is necessarily extensive, and has been divided into two main parts—Chemical Statics and Chemical Kinetics. The historical method of treatment adopted cannot fail to be appreciated by the real student who aspires to be something more than a mere recipient of dry facts.

The chapter on Atomic and Molecular Systems and on the Application of Physical Methods to Questions of Chemical Statics, as well as that on Affinity, are condensations from all the most recent works on the subjects, and are, as a rule, clear and concise. The references to originals, &c., &c., are numerous, and the mechanical errors throughout the work are surprisingly few.

The book should be very useful to students training for teachers, and who may not have the advantage of reference to original literature on the numerous subjects treated of.

OUR BOOK SHELF

Eine Weltreise. Plaudereien aus einer Zweijährigen Erdumsegelung von Dr. Hans Meyer. (Leipzig: Verlag des Bibliographischen Instituts, 1885.)

THIS handsome volume is something more than the work of a "globe-trotter," even of a very amusing "globe-trotter." Dr. Meyer sailed down the Danube to Constantinople, thence to Athens, Syria (where he visited Smyrna, Beyrout, Damascus, and Jerusalem), Egypt, and by the Red Sea to Bombay. He then travelled through Northern India to Calcutta, and from Madras through Southern India to Ceylon. The journey in the Far East included Singapore, a considerable portion of Java, the Philippines, Hong Kong, Shanghai, and Japan. Thence he reached the United States, through a large part of which he travelled, Mexico, Cuba, and so back to Europe. The journey was more extensive than the usual modern journey around the globe; Java appears to have been thoroughly visited, but the only place in which the work displays any mark of originality is in the Philippines. The scenes and experiences by the way are described with much liveliness, but soon after his arrival in Manila he made a journey into the northern mountainous regions of Luzon, for the purpose of studying the Igorrotos and other tribes having their habitat there. The story of the journey, which occupied about three months, is full of interest, and the ethnology of these tribes is discussed in a special appendix. Prof. Blumentritt, the Austrian scholar, who has devoted many years to the study of the archipelago, especially to the vast Spanish literature of the seventeenth and eighteenth centuries relating to it, comes to the following conclusions on its ethnography. The authoctonous population of the Philippines, the Negritos, were driven back by two Malay invasions, and are now to be found only in isolated remnants scattered throughout the islands of the archipelago. By the first invasion the Negritos were forced from the coast into the interior, where they remained undisturbed until the second Malay irruption. This drove the first Malay invaders in their turn from the coast, and the descendants of the new comers still occupy the ports and harbours to this day. The Negritos were either destroyed by wars with the first Malays, or completely absorbed by marriage with them, that now no tribes of them are to be found. The Malays of the first invasion came from Borneo, and are found to-day in the mountain districts of Luzon, under various tribal names, such as the Tingianes, Igorrotos, Guinanes, Apayos, Abacas, Calnigas, Gaddanes, &c. ; while the second invaders, now known as Tagals, Pampangos, Visayas, Ilocanes, Cagayanes, &c., inhabit the coast regions, where they were found by the Spaniards in the third quarter of the sixteenth century. Naturally the various tribes were unable to prevent being influenced by each other, as well as from without, and to this we must attribute similarities in many respects, and especially in religion, which mark the Malays of the whole archipelago. Allowance too has to be made for the influence of the Chinese, perhaps also of the Japanese, on the tribes living on the coast long prior to the Spanish invasion. The inhabitants of the coast, the Malays of the second invasion, for the most part profess Christianity now, and are well known, but the pagans of the interior, the Borneo Malays, who, according to Prof. Blumentritt's theory, formed the first invasion, have never been thoroughly investigated, and this circumstance led Dr. Meyer to spend three months among the Igorrotos. The appendix in which he records his observations is very full. It discusses the name and extent of the Igorrotos, their territory, and its climate, their build, mode of dressing the hair, and tattooing (which is far more elaborate than that of even the Japanese grooms, and is probably the most complicated in the world), their dress, ornaments, weapons, villages, huts, agriculture, and cattle-breeding, food, and drink, domestic utensils, art, tools ; customs at birth, and marriage, and death ; their priests and religion ; head-hunting, war customs, festivals, language, modes of reckoning time and numbers, and their myths and sagas. Finally comes Dr. Virchow's account of an Igorroto skull, and a brief vocabulary. It is this portion of the work which renders it one of scientific interest, and prevents it from being a mere amusing account of the modern grand tour. The numerous illustrations which it contains of the tattooing ornaments, utensils, and the like, add greatly to its value. The Igorrotos are among the disappearing peoples of the earth. They leave the impression of having once possessed a higher culture ; their manufactures now are far below those of even half a century ago, and Dr. Meyer thinks that, like every primitive race brought into direct contact with European civilisation, nothing can save them from ultimate extinction.

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.*]

Molecular Dynamics

I THINK there must be some mistake in Prof. Forbes' report of Sir Wm. Thomson's remarks as quoted in NATURE of last week (p. 461) upon the rate of wave-propagation on Maxwell's electro-magnetic theory of light. From the end of the last quotation one would suppose that Sir Wm. Thomson intended to convey that the rate of wave-propagation that Maxwell's theory asserted to be the same as that of light, was the rate of propagation of a variation of a current in a conducting wire. Now Sir Wm. Thomson cannot, I am sure, have intended to convey any such mistaken notion. Maxwell carefully guards against any such mistake by pointing out that conduction of electricity is of the nature of diffusion, and not of a wave-propagation, and so has no definite velocity. What Maxwell has calculated is the rate of propagation of disturbances in *non-conductors*, and not in conductors. It is the rate at which the disturbances, produced in the way considered by Sir Wm. Thomson in the preceding part of this quotation, would be propagated by transverse vibrations. Of course, as Sir Wm. Thomson asserts, something analogous to a longitudinal vibration may co-exist with these, but Maxwell's theory shows that a medium which would transmit only transverse vibrations would explain electric and magnetic phenomena.

GEO. FRAS. FITZGERALD

40, Trinity College, Dublin, March 23

[The passage quoted by Mr. Forbes is correctly reported. A more full explanation of this subject will be found in Nichol's "Cyclopædia," second edition, 1860, article, "Electricity, velocity of;" reprinted in vol. ii., art. lxxxi., of my collected mathematical and physical papers.—W. T.]

Civilisation and Eyesight

HAVING read with much interest the recent correspondence in NATURE on this subject, I am forwarding the results of some observations which I recently made to determine the degree of acuteness of vision possessed by the natives of the islands of Bougainville Straits, in the Solomon Group.

I examined the powers of vision of twenty-two individuals who were in all cases either young adults or of an age not much beyond thirty. For this purpose I employed the square test-dots which are used in examining the sight of recruits for the British army, and I obtained the following results :—Two natives could distinguish the dots clearly at 70 feet, one at 67 feet, two at 65 feet, three at 62 feet, four at 60 feet, two at 55 feet, three at 52 feet, four at 50 feet, and one at 35 feet. The conclusion at which I arrived was that 60 feet represented the average distance at which a native could count the dots—a distance rather greater than that at which they should be placed to test the normal powers of vision, viz. 57 feet.

Of these twenty-two natives I came upon only one whose vision seemed at all defective. In this instance—that of a man about thirty years old—the nature of the cause was sufficiently indicated by the prominence of the eyes and the nipping of the lids, especially when the sight was strained by trying to count the test-dots at a distance. The limit of distance at which this man could count the test-dots was 35 feet. The question which presented itself to my mind in this case was, whether a white man who could count the dots at the same distance—viz. 35 feet—would exhibit to the same degree the external signs of myopia. I might put this query into other words, and ask whether, considering the far-seeing powers of these natives, the peculiar external signs of myopia would not appear with a less degree of this defect than with the white man.

Natives of these islands are very quick at perceiving distant objects, such as ships at sea. I was often much impressed by their facility in picking out pigeons and opossums, which were almost concealed in the dense foliage of the trees some 60 or 70 feet overhead. My attention was not attracted by the unusual size of the pupils ; the eyes, however, have a soft, fawn-like appearance with but little expression. In conclusion, I may refer to the circumstance that the interiors of their houses are always kept dark, the door being usually the only aperture admitting light. The object is, I belive, to exclude flies and other insects from their dwellings. Coming in from the direct sunlight, I have often had to wait a minute or two before my eyes became accustomed to the change ; but the natives do not experience this inconvenience. Some hours of the day they commonly spend in their houses, while at night they use no artificial light except the fitful glare of a wood fire. It would seem probable that the influence of the opposite conditions, presented by the bright sunlight and the darkness of their dwellings, would be found in the increased rapidity of the contraction and dilatation of the pupil with the enlargement, perhaps, of the retinal receiving area. It is, however, a noteworthy circumstance that these natives are able to pass from the bright tropical glare outside their dwellings to the dark interiors, and *vice versâ*, without showing the temporary derangement of vision which the white man experiences whilst the iris is adapting itself to the new condition. H. B. GUPPY

17, Wood Lane, Falmouth, March 30

Mr. Lowne on the Morphology of Insects' Eyes

IN reference to the discussion between Dr. Sydney Hickson and Mr. Benjamin Lowne, I beg to state that I have been favoured by both of those gentlemen with opportunities of carefully studying their preparations, and I feel it to be my duty to state that in my judgment Mr. Lowne's preparations do not justify the conclusions which he has based on them, and are, in fact, not made with that skill and knowledge of modern histological method which is necessary in order that trustworthy conclusions may be obtained. On the other hand, Dr. Hickson's preparations are thoroughly satisfactory as examples of histological manipulation. Dr. Hickson supports the accepted view as to the termination of the optic nerve-fibres in the nerve-end cells of the retinulæ. Mr. Lowne denies this connection. I have no doubt that such a connection cannot be readily observed in Mr. Lowne's preparations. At the same time I have no doubt whatever that this is because the preparations are badly made. Mr. Lowne's preparations fail to show many other simple features in the structure of the insect's eye, which are readily seen in preparations made by the application of methods now recognised and approved, but not made use of by Mr. Lowne.

I am sorry to see the resources of the Linnean Society employed in publishing a memoir the conclusions of which, although startling in their novelty, are undeniably based upon the mistaken interpretation of defective preparations.

I think it is important that the Fellows of the Linnean Society should know whether the memoir now published is the same which was read a year or two ago at the Royal Society, and whether the Council of the Royal Society took any steps to ascertain the value of Mr. Lowne's preparations, or came to any decision as to the fitness of Mr. Lowne's paper for publication.

March 14 E. RAY LANKESTER

On the Terminology of the Mathematical Theory of Elasticity

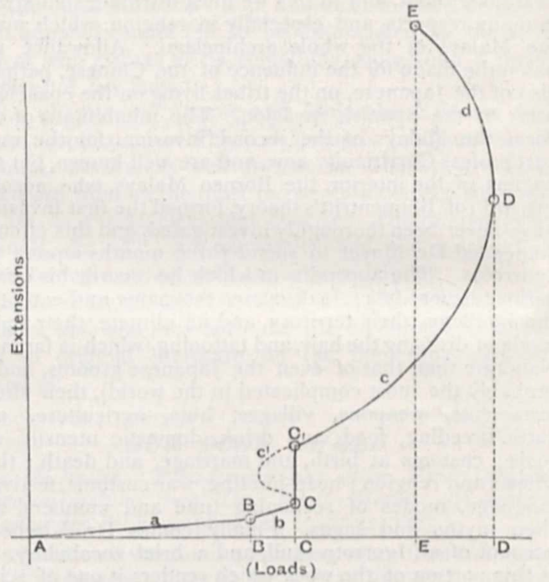
ENGINEERS quite as much as "elasticians" have reason to want some such terminology as that sought by Prof. Pearson (NATURE, vol. xxxi. p. 456), and have equal reason to be indebted to him for undertaking the work which he has at present in hand, which seems already to have given results of practical value as great as their scientific interest.

As I have for some years made a study of the physical side of the problems mentioned by him, I should be glad to make some suggestions as to terminology as contributions to the discussion of the subject in your columns. I will confine what I have to say to what may be called ductile materials (such as wrought iron, ordinary steel, copper, &c), because in these only the whole phenomena are visible. The behaviour of such material in tension is illustrated by the accompanying figure, in which stresses are measured along the horizontal, and strains along the vertical axis.

It is extremely rare to obtain a piece of raw material already in a *state of ease*. *Wire*, of course, is highly strained by its process of manufacture, but that even ordinary bar and plate is also slightly strained, is shown in the manner mentioned by Prof. Pearson. Such initial strains as become visible as *set* by the first stretching up to any load (within limit of elasticity) disappear after one or two applications of that load. The material is then in a state of ease up to that load, but higher loads (still within the limit), on their first application, generally produce more set—the state of ease thus extending only to the stress employed to produce it. The *sets* are, along with the elastic strain, proportional to the stress, their effect being simply to lower the modulus of elasticity. Probably the process of *annealing* will bring the material into a state of ease for all loads at which such a state is possible. I propose to examine this matter further by aid, if possible, of the apparatus described by Prof. D. E. Hughes in the Inst. M. Eng. *Proc.*, 1883, p. 73. In the figure, *a* represents this *condition of perfect elasticity* (maximum state of ease being presupposed) and B, the superior limit of this condition, is the mathematical *limit of perfect elasticity*.

After B comes a stage *b*, within which the set is *not* proportional to the stress, although it still remains small; the total extension, therefore, increases faster than the stress. Occasionally this stage does not occur at all, and both its higher and lower limits seem—more than any other points in the life of the material—to be susceptible of change depending on manipulation. Accidental shock will shorten the stage considerably; very gradual loading extends it somewhat. For these and other reasons I therefore suggest that this stage be called the *condition of instability*, or of *unstable equilibrium*.

This condition terminates at C, in what I have called a "breaking-down" in the paper referred to by Prof. Pearson, in which paper I believe the phenomenon was described for the first time. This point is the one called by engineers the limit of elasticity, because it is the only one markedly visible without special apparatus. (The extension at B, on a length of 10 inches, may be about 0·01 inch; at C 0·03 inch and at C_1, same stress, it increases to 0·20, 0·25, and even occasionally 0·4 inch.) If "breaking-down point" be too crude a name, I would suggest *limit of stability*. It should be noted that the stress at this



point does not remain constant, but in reality appears to diminish as the extension goes on, as shown at *c'* (this dotted curve not drawn to scale), a matter on which I am at present experimenting. I should add that, during the application of load at this point, extension appears to be occurring at different parts of the length *successively*, and not at all parts simultaneously, as during conditions *a* and *c*.

In the next stage, C to D, the whole strains consist of a very small elastic portion (apparently closely following the modulus), and a very large set, increasing much faster than the stress. The test bar remains at each load practically constant in its cross-section at all points of its length, and rises in temperature instead of (as in condition *a*) cooling. I would suggest for this stage the name *condition of uniform flow*, the physical applicability of which will be obvious to any one who has seen ductile metal in this condition.

At some point, D, a maximum load is reached, and at *about* the same point (generally, I think, a little earlier, but the difference is small, and not very easy to get at with certainty) the metal begins to flow *locally*, a part becoming much more reduced in cross-section than the rest, and eventually fracture occurs at this place under a less load than D, but with a greater extension, as at E. This final stage, *d*, might be called *condition of local flow*. The loads D and E (as Prof. Pearson suggests) would be *maximum* and *terminal* loads respectively). (Their difference was first pointed out, I think, by Mr. Daniel Adamson's experiments, *Journal* I. and S. Inst., 1878). The maximum *intensity* of stress occurs always, I think, at E, the cross-section of the bar being proportionately more reduced than the load.

ALEX. B. W. KENNEDY

University College, March 23

The Colours of Arctic Animals

THE white colour of Arctic mammals and birds has hitherto been generally ascribed by evolutionists to protective resemblance, the adaptation to a snow-covered country being attributed to the preservation of individuals which by assimilating to their environment in colour, either escaped detection by their foes, or, on the other hand, were by this means enabled to secure their prey more advantageously. Although a certain weight may, in the case of some species, be fairly given to these organic factors, it always appeared to me that this explanation was not in itself sufficient, in face of the consideration that many of the species so coloured could hardly be said to require such protection on account of persecution, or to derive any obvious advantage therefrom for predatory purposes. A more satisfactory explanation seemed to be that the mode of coloration in question had, at any rate in the first instance, been brought about by natural selection through physical rather than through organic agencies. It is well known that white, as the worst absorber, is also the worst radiator of all forms of radiant energy, so that warm-blooded creatures thus clad would be better enabled to withstand the severity of an Arctic climate—the loss of heat by radiation might, in fact, be expected to be less rapid than if the hairs or feathers were of a darker colour.[1] According to a paper recently published by Lord Walsingham,[2] it seems that this view was entertained as far back as 1846 by Craven,[3] the only addition to the theory required by modern evolution being that we must regard the white covering as having been acquired by the ordinary Darwinian process of the survival of the fittest, *i.e.* by the climatic selection of those individuals best fitted to withstand the extremely low temperatures of their habitat.

It is perfectly familiar to zoologists that most animals occasionally give rise to white varieties, so that the basic variations necessary for the establishment of the required modification in the colour of the hair and feathers would not have been wanting during the gradual approach of the Glacial Epoch. It may be conjectured whether white may not have been the prevailing colour among all warm-blooded animals during this period, with the exception, perhaps, of those species in which the severity of the climate may have been met by an equally effective thickening of the fur. Certain species which, like the stoat and ptarmigan, become white during winter, may, from this point of view, be regarded as reverting seasonally to the mode of coloration which in their ancestors was normal during the Glacial Epoch, the reversion being in these cases brought about by the same influences which formerly fixed white as the most advantageous form of covering. In accordance with this view, it is sometimes asserted that the stoat does not commonly turn white during winter in the south of England, excepting in very severe seasons.[4] Further observations on this point are much needed.

In striking contrast to the white covering of Arctic and Alpine mammals and birds, it has been found that there is a quite opposite tendency for the insects to become darker and more suffused, this melanism being especially noticeable among many of the Lepidoptera. Although numerous speculations as to the cause of this phenomenon have from time to time been advanced, it is in the paper by Lord Walsingham above referred to that what appears to be a true cause has for the first time been suggested. The author has, in fact, most ingeniously extended the very argument which had been adduced to account for the white colour of the mammals and birds to explain the quite opposite melanism of the insects. According to the present view the the melanic tendency of northern Lepidoptera must be ascribed to the natural selection of the darker forms owing to the advantage which these would possess in being able to absorb more of the solar radiation than their lighter congeners. The same action must be regarded as here bringing about opposite effects: in the case of warm-blooded animals the loss of heat by radiation is retarded by the white covering, whilst in insects, which develop but little heat by respiration, it is of the utmost importance to utilise as much as possible of the solar energy. This will be seen to be all the more necessary when it is considered that, under Arctic conditions, the solar rays have but little power, and that the pairing of the insects has to be effected with great rapidity. In order to test these views experimentally, the author exposed numerous species of Lepidoptera of various colours to the sun's rays on a surface of snow, and observed the rate at which the insects sank beneath the surface. As might have been anticipated, the darker insects, like *Tanagra chærophyllata*, sank more rapidly than white moths like *Acidalia immutata*, which made but little impression on the snow.

The questions raised by these suggestions and observations certainly appear to be well worthy of consideration when discussing the subject of animal coloration. Thus the explanation of the melanism of Arctic insects now advanced may perhaps, when more fully elaborated, throw further light upon the theory of seasonal dimorphism first proposed by Weismann.[1] If, in accordance with the views of this author, we regard the present winter forms of these seasonally dimorphic Lepidoptera as the ancestral Glacial types, it becomes clear why in such white species as *Pieris napi*, the parent Glacial form *Bryoniæ* should be the darker. In the case of *Araschnia levana* the theory does not at first sight apply, inasmuch as the winter form is lighter than the summer generation (*Prorsa*); here, however, both forms are coloured, and there would be but little difference in their relative heat-absorbing powers. The same remark may apply in the case of our own seasonally dimorphic species of *Selenia* and *Ephyra*.

R. MELDOLA

[1] *Trans. Essex Field Club*, vol. i. *Proc.*, March 20, 1880, p. vi.

[2] "On some probable causes of a tendency to melanic variation in Lepidoptera of high latitudes;" the Annual Presidential Address to the Yorkshire Naturalists' Union, Doncaster, March 3, 1885.

[3] "Recreations in Shooting," p. 101.

[4] R. M. Christy in *Trans. Essex Field Club*, vol. i. p. 67.

[1] I may take the present opportunity of pointing out to those who possess the English edition of the "Studies in the Theory of Descent" that an error inadvertently occurs in the numbering of the figures in Plate I. Figs. 2, 3, 4, and 5 should have been numbered respectively 3, 5, 2, and 4. I am indebted to Mr. E. B. Poulton for kindly calling my attention to this transposition.

An Error in Ganot's "Physics"

IN your issue of February 19 (p. 361), E. Douglas Archibald calls attention to a typical error in Ganot's "Physics," 10th edition, p. 325, and assumed that it had run through the ten editions. If he had taken the pains to look back to previous editions the formula would have appeared right, viz.:—

$$P = \frac{0\cdot31\, V(H - \frac{3}{8}FE)}{(1 + \alpha t)\, 760}.$$

In going over the text of earlier issues of the book some minor errors are discoverable, but do not detract materially from the value of the same to the careful student

FRANK E EMERY,
1st Asst. Sci. Dept.

Mountainville, Orange Co., New York, March 4

WITH reference to the letter of Mr. Frank E. Emery on mine, calling attention to the typical error in Ganot's "Physics," I beg to say that though in some of the earlier editions the error may not exist, it occurs in the 5th and 10th, both of which are in my possession. The inference is very strong that if it occurs in these two it occurs in the editions *intervening*, and thus in HALF of the editions published. The first five editions are now getting out of date, so it is not of much value to people if the error does not exist in them.

I would also observe that if Mr. Emery takes the pains of reading my letter over again he will notice it was explicitly stated to be for the benefit of the large class of students who are *not careful*.

My purpose was in no way to run down Ganot, but to warn people of a pitfall in it.

E. DOUGLAS ARCHIBALD

Tunbridge Wells, March 23

Exceptional Whiteness in Tropical Man

SINGULARLY enough, being encamped in the same place as that from which the paper on "The Blackness of Tropical Man" was written to NATURE some months ago, the converse, a case of the whiteness of this class of man, presented itself unexpectedly. While entering, to-day, the native village of Jeykondasholapurm, that had sunk to nothing from having been the capital of a native dynasty in the south of India, and situated about lat 11° N. and long. 78° E., the writer observed an apparently white woman sitting on a doorstep by the side of the road, with flaxen-coloured hair, but having in other respects the characteristics of natives attacked by leprosy. Making inquiries from one of the principal native revenue officials at the place, it was ascertained that there was a family living hardly a mile away, of which more than one of the members had been born, and continued, white all their lives. That this did not result from their being lepers, and that none of their neighbours were in the least afraid of them, though opinion was not quite clear as to the whiteness not being disease.

Losing no time, it did not take long to reach the hut in which this family of albinos were to be found. They are of the Hindu blacksmith caste. The father and mother are stated to be of the ordinary blackness of natives of India, but were not seen on this occasion. A son, aged twenty-two, was there working at his trade, with the white colour, features, and light flaxen hair of a European, the only difference being a coarseness of the texture of the skin, and a slightly vacant expression. There was, beside him, an apparently elder brother, quite dark, and a native Hindu in every respect. It was said that albinos had occasionally appeared in the family, one of the uncles, for instance, having been white.

On being questioned as to whether there was any difference between the albinos and ordinary natives, it was at once said that the former could not stand being in the sun, which reddened and inflamed the skin, upon which the remark fell from the writer that it would be worth while to transport such individuals to a cold climate, where they would he exposed to no inconvenience. And so it would, because there can be no doubt that one of these white Hindus, early taken, and educated in a European climate, would from palpable observation of the specimen now described be absolutely indistinguishable as a native of India.

Evidently some cause has interfered with the production of pigment in the cells of the skin, with the effect of rendering the albinos highly sensitive, and more so than a European, to the invisible heat rays of the spectrum, which are so injurious to the constitution in India.

The contrast between the faces of the brothers was peculiarly striking, for there was sufficient resemblance, in the lower part of the face especially, to show there was a distinct relationship—that of the one who was dark wore the ordinary mild composure; but the other, by the mere change of colour, had completely and inadvertently thrown off the Oriental mask; and it would be almost impossible to convey to any one, not seeing it exemplified, how vast a change could be made by so simple an alteration, displaying the way the real individuality of race is lurking in an extraordinary manner beneath a tropical blackness.

India, February 24 A. T. FRASER

Far-sightedness

THOUGH I have already published a note on the subject in a Dutch paper (*Tijdschrift van het Aardrijkskundig Genootschap*, February, 1885), perhaps you will kindly allow the following lines to have a place in NATURE, because those who are occupied in the trigonometrical survey of British India may take an interest in the matter, and be able to give more particulars about it.

In a paper on Mr. Whymper's travels in Greenland, which appeared in *Ausland*, t. xii., 1884, I found in a foot-note the following remark:—"The reader might be astonished on hearing that I [Mr. Whymper] could see a mountain at such a great distance (about 100 English miles); but I may add that the day before I saw two other mountains 40 and 150 English miles distant; with one exception this was the greatest distance at which I have ever been able to make out objects."

Since I have not found any other reports in which it is expressly stated that objects were seen at a greater distance, I presume I may allege my own experience. While occupied with the trigonometrical survey of Western Java I sometimes had an opportunity of seeing objects at a very great distance, though, under the circumstances I was in, I had no time to look for them on purpose.

The greatest distance at which the angular points of triangles of the first order were from each other was about 105 kilometres; no difficulty ever arose from the distance, and no difference was made whether signals or heliostats (square mirrors of about 3 inches side) were observed.

When on Gng Karang (Bantam) I made out Keizerspick (Sumatra) at a distance of more than 110 English miles, though not quite easily, the top just peeping out from the slopes of Sebesic; if there had been a signal on Keizerspick at that time I think I could have observed it.

The greatest distance at which I remember ever to have seen an object was noted during my stay on Gng Tjikoraij (Preanger Regentsch), when I made out Gng Merapi (Java) most distinctly at a distance of about 180 English miles [1] and I suppose that Gng Lawu was also visible (225 English miles distant), but I could not quite distinguish it from the group of mountains of which it is one. It is, of course, from high summits that objects are seen at the greatest distances, and objects which are more elevated at a greater distance than such as are close to the ground.

I think it would be interesting to gather experiences referring to the subject made in different climates and under different circumstances. EMIL METZGER

Stuttgart, March 23

Krakatoa

SUPPOSING that the underground noises heard at Caïman-Brac on Sunday, August 26, 1883, were not only synchronous with, but actually the same as, those caused by the great eruption in the Straits of Sunda, it does not seem to follow that the sound-waves were propagated through the whole diameter of the earth. On the contrary, the question is at once raised, at what depth below the surface did the disturbances occur which found such destructive vent at Krakatoa? And if only the time-record east and west were accurate and satisfactory, there would seem to be some datum supplied for approximately estimating this depth. The centre of disturbance may have receded from and become inaudible at the Caïmans in proportion as, on the 27th, it found final vent at Krakatoa. HENRY CECIL

Bregner, Bournemouth, March 30

The Recent Aurora

THE "Sunk" lightship is in electrical communication with the Essex coast, being connected thereto by a telegraphic cable 8·984 nautical miles in length, laid from Walton-on-the-Naze in an easterly direction. The electrical condition of this cable is ascertained daily at 10 a.m., by means of tests applied at the shore ends. Until the 15th inst. these tests were very regular and satisfactory, but on the morning of that day it was found to be impossible to obtain any satisfactory results, owing to electrical disturbances produced in the cable by some external influence. The electrician on board reported that the weather was very fine and summer-like, sea perfectly smooth, with variable light airs, and he could in no away account for the effects the electrician was observing on shore. Between 9 and 10 p.m. those on board the lightship observed in the northern sky a very brilliant aurora, from which at intervals two very bright columns extended upwards to the zenith, and there apparently joined.

I send you these particulars as they may be worth recording in connection with the aurora seen at Christiania on the same evening, and described by Mr. Sophus Tromholt in his letter to NATURE, published on the 26th inst. (p. 479). There can be no doubt but that the aurora seen at Christiania was identical with that noticed by the men on the lightship off Walton-on-the-Naze, and, although it was not visible until the evening, it was evidently affecting the electrical condition of the earth on the morning of that day, and was the direct cause of the electrical disturbance in the cable. Since that date the tests have been as satisfactory and regular as before. WILLOUGHBY SMITH

March 30

THE COSMOGONIC THEORY OF M. FAYE [2]

M. FAYE has expounded his theoretical views on cosmogony in the several publications named above, and in his book he has also treated of the historical development of cosmogonic theories. We shall in the present article confine our attention to that which is original in his speculation; and we recommend the

[1] In the junction of triangulations of Spain and Algiers the greatest side is about 270 kilometres.

[2] "Comptes Rendus," 1880, vol. xc. pp. 637 and 1246.
"Sur l'Origine du Monde." Pp. 257. (Paris: Gauthier-Villars, 1880.)
"Annuaire pour l'an 1885, Bureau des Longitudes." Pp. 757-804. (Gauthier-Villars.)

reader to refer to the essay in the "Annuaire" of the Bureau des Longitudes, 1885, for this portion of his work. M. Faye's writing is always easy and finished, and this essay has been intended for the general scientific reader. Had the original speculation been condensed for insertion in a purely technical journal it would have occupied but a few pages.

The earlier portion of the essay we may dismiss by saying that it gives a lucid exposition of the state of our knowledge of stellar systems, as derived from the spectroscope and the telescope, interpreted by aid of the principle of conservation of energy. In the following description of M. Faye's theory, we do not follow his words, but we believe that we give a fair interpretation of his meaning.

The best general idea of the line of speculation adopted may be given by saying that it is a theory of evolution from meteorites, instead of from the nebulous matter which gives its name to Laplace's theory.

In its primitive condition the Universe consisted of matter widely scattered in chaotic disorder. Currents were then generated in the midst of this chaos under the influence of mutual gravitation; and in consequence of these intestinal movements rags or shreds of matter became detached, and moved with rapid linear and slow gyratory motion.

It is not claimed that the existence of these currents can be explained, but the spectroscope affords evidence of a sorting process, for some nebulæ consist of a single gaseous element, whilst the stars with continuous spectra consist of a great diversity of elements.

The various modes are sketched in which one of these shreds may proceed to agglomerate and evolve itself, but we shall not follow M. Faye in the application of his theory to the formation of nebulæ, double-stars, and star-clusters.

The solar system is taken to have originated from a shred which aggregated into a spheroidal shape, and consisted, at the epoch when we begin to watch it, largely or principally of separate meteorites. The spheroidal aggregate possessed a considerable amount of rotation (moment of momentum), about an axis approximately identical with the axis of the sun's rotation.

It is at first supposed that the spheroidal aggregate consists of matter pretty nearly equally distributed throughout its volume, and later a nucleus is formed. If r be the distance of any point from the centre, the force is central, and follows the law $a r + \frac{b}{r^2}$, where, in the beginning of the evolutionary process, b is very small, and later a becomes small.

Initially, then, when the force is simply as the distance from the centre, each meteorite moves in an ellipse about the centre, and the periodic time of all of them is the same, whatever their eccentricity of orbit. Those meteorites whose orbits are decidedly eccentric, cross the orbits of many others, and have much less chance of escaping collision than those whose orbits are nearly circular. In consequence of collisions, a central nucleus is soon formed, and then many meteorites with very eccentric orbits begin to strike against it, and to be absorbed into it. As the nucleus increases the a in our formula for the force diminishes, and the b increases; but orbits which are circular still retain that form, notwithstanding the progressive change in the law of force.

At the same time that the nucleus is being formed, a series of flat and nearly circular rings arise around it, those near to the nucleus attaining a definite shape sooner than the remote ones. It is not adequately explained why the matter should be sifted, and should arrange itself in rings at definite intervals around the nucleus; still less is any light thrown on the law of Titius concerning the distances of the planets from the sun. Nor do we see why the rings should first be formed nearest to the nucleus. We must, however, here follow M. Faye and accept these conclusions.

If there be only a small nucleus (b small), each ring revolves with very small relative motion of its parts; whilst if the nucleus be large (a small), each meteorite in a ring revolves after Kepler's laws, and the bodies in the external margin have a slower angular velocity than those in the internal margin. As the nucleus gradually increases there will be a transition from one mode of motion to the other.

Now let us follow the first ring:—Slight differences of angular velocity, mutual attractions between the parts of the ring and collisions gradually cause the aggregation of all the matter in the ring around some centre in its line. When the nucleus is small the ring moved as a rigid whole, and the linear velocity of the outer meteorites was greater than that of the inner ones, therefore when the planetary aggregate is formed it will be found rotating with direct motion about an axis nearly perpendicular to the plane of its orbit.

Whilst the first ring is agglomerating into a planet, a second ring is being formed outside of it, and this in its turn agglomerates; but the tendency to direct rotation is weaker than in the first planet, because the increase of the solar nucleus by absorption of meteorites has prevented so large an excess of linear velocity of the outer meteorites over that of the inner ones as in the first case.

The process continues and the planets are successively formed, until we come to an epoch when the nucleus has increased so far that on agglomeration the tendency to direct rotation vanishes—the constituent ring, in fact, revolved irrotationally.

Still further we come to planets in which the meteorites move nearly according to Kepler's laws, and here the resulting planet has a markedly retrograde rotation. Each planetary agglomeration in its turn forms a miniature solar system, and generates satellites by the same process as that in which the planets were formed.

We have now sketched this theory in its main outlines, and must refer the reader to the original sources for further details.

Neither in the historic part nor in his cosmogonic speculations does M. Faye make reference to the possible effects of tides in the evolution of the solar system, perhaps thinking that a theory founded on that influence is not even worthy of mention. It is, however, a factor which cannot be left out of account. Tidal friction is a *vera causa*, and the possible effects on our evolution have been submitted to a rigorous quantitative examination.[1] As it is the only cosmogonic influence which has hitherto been so treated, the results to which it points are at least as worthy of attention as those of other vaguer influences.

The hypotheses that tidal friction has had free play in the past leads to a remarkable quantitative coordination of the several elements of the earth's rotation, and of the moon's orbital motion, and points to the genesis of the moon close to the present surface of the earth. No phenomenon in the heavens could have been devised more perfectly apt to confirm the truth of the hypothesis than the rapid orbital motion of the inner satellite of Mars. Near to the sun solar tidal friction would be much more powerful than at a distance, and thus the rotation necessary for the manufacture of satellites would be destroyed in the vicinity of the sun; a light is thus thrown on the cause of the observed distribution of satellites in the system.[2]

It has, however, been decisively shown that tidal friction cannot have played the leading part either in the evolution of the whole solar system or of the remoter

[1] We refer to a series of papers by the present writer on this subject in the *Phil. Trans. Roy. Soc.* from 1878 to 1882.

[2] This theoretical effect of tidal friction has not been commented on by any writer. Further numerical details and discussion will be found in *Phil. Trans.*, Part ii., 1881, p. 531.

planetary systems, and whilst the field is thus left open to the nebular hypothesis or other rival theories, it is submitted that tidal friction has a bearing on those theories which cannot be neglected.

A numerical comparison of the distribution of moment of momentum amongst the several planetary sub-systems shows that the terrestrial system differs considerably from all the others, but it would hardly be logical to postulate an absolutely independent mechanism in this case, and it is not very easy to reconcile the genesis of the moon close to the earth with the formation of a ring in the midst of a planetary agglomeration of meteorites. Let us now summarise the advantages and disadvantages of M. Faye's scheme.

The conception of the growth of planetary bodies by the aggregation of meteorites is a good one, and perhaps seems more probable than the hypothesis that the whole solar system was gaseous, and that the influence of hydrostatic pressure was felt throughout. The internal annulation of the meteorites is left unexplained, and this compares very unfavourably with Laplace's system, where the annulation is the very thing explained. The difference of orbital motion of the inner and outer meteorites of a ring, the development of that difference as time progresses, and the consequence of direct and retrograde rotation at different distances from the sun is an excellent idea. But it is necessary to this idea that the inner planets should have been formed the first, and we are met directly by the fact that the single surviving ring, that of Saturn, is nearer to the planet than are the satellites. It is, of course, possible that special causes have preserved this ring, but we should be driven to the startling conclusion that Saturn's ring is the oldest feature of his system.

The actual distribution of satellites in the solar system is at variance with M. Faye's theory, for, according to him, the internal planets were generated from rings whose motion was such as would give greater moment of momentum to the planetary agglomeration than would the external ones. The number of satellites manufactured should be greater the greater the amount of rotation in the primitive agglomeration of meteorites, and thus the nearer planets should be richer in satellites than the remote ones.

The celebrated experiment of Plateau, in which a drop of oil rotating in alcohol and water is made to parody Laplace's solar system, is worthy of attention, and it tells against Faye and in favour of Laplace. It is of course to be admitted that surface-tension does not duly represent gravity.

On the whole, then, we must hold the opinion that there are great difficulties in the acceptance of M. Faye's theory, notwithstanding its excellences. The time does not appear yet ripe for definite judgment on this very complex subject, but science is undoubtedly the gainer by such suggestive theories. Whilst a false statement of fact always proves a serious detriment, the enunciation of false or partially true theories is always the incentive to, or initiation of, the discovery of truth.

G. H. DARWIN

SIR WILLIAM THOMSON ON MOLECULAR DYNAMICS [1]

II.

IN the present article Sir William Thomson's spring and shell molecule will be described and its theory sketched, in so far as this has been investigated with the view of getting over some of the difficulties which surround the wave theory of light. In Helmholtz's memoir on anomalous dispersion, a sketch of such a theory was published. But this new molecule differs from that of Helmholtz in several points, chiefly in the fact that absorption is not accounted for by any viscous action in the molecule dissipating the energy of vibration into low grade heat. Most readers who have ever visited the natural philosophy lecture-room in Glasgow University will recognise a very old friend in this new molecule, where they have seen it vibrating, I suppose, any time since the University occupied its present site. In appearance the molecule has been changed, but its theory as taught to the students there is identical. For a description of this molecule let us refer to page 10 of the lectures:—

"Imagine for a moment that we make a rude mechanical model. Let this be an infinitely rigid spherical shell; let there be another absolutely rigid shell inside of that, and so on, as many as you please. Naturally we might think of something more continuous than that, but I only wish to call attention to a crude mechanical explanation possibly of the effects of dispersion. Suppose we had luminiferous ether outside, and that this hollow space is of very small diameter in comparison with the wave-length. Let zig-zag springs connect the outer rigid boundary with boundary number two. I use a zig-zag, not a spiral, spring which has the helical properties which we are not ready for yet, such properties as sugar and quartz have in disturbing the luminiferous vibrations. Suppose we have shells two and three also connected by a sufficient number of spiral springs, and so on; and let there be a solid inclosed in the centre with spring connections between it and the shell outside of it. If there is only one of these interior shells, you will have one definite period of vibration. Suppose you take away everything except that one interior shell; displace that shell and let it vibrate. The period of its vibration is perfectly definite. If you have an immense number of such shells with moveable molecules inside of them, distributed through some portion of the luminiferous ether, you will put it into a condition in which the velocity of propagation of the wave will be different from what it is in the homogeneous luminiferous ether. You have what is called for, viz. a definite period; and the relation between the period of vibration in the light considered and the period of the free vibration of the shell will be fundamental in respect to the attempt of a mechanism of that kind to represent the phenomena of dispersion.

"If you take away everything except the one shell, you will have almost exactly, I think, the view of Helmholtz's paper—a crude model as it were of what Helmholtz makes his paper on anomalous dispersion. Helmholtz, besides that, supposes a certain degree or coefficient of viscous resistance against the vibration of the inner shell, relatively to the outer one. Helmholtz does not reduce it to a gross mechanical form like this, but merely assumes particles connected with the luminiferous ether and assumes a viscous motion to operate against the motion of the particles."

In the lectures the action of such a molecule when subjected to forced vibrations was illustrated by a model of ingenious construction, which among the irreverent passed by the name of the "wiggler." A steel wire was hung vertically, and five or six lathes 2 feet long and 2 inches wide were attached in a horizontal position to the wire, each one having three pins fixed in it for this purpose. These lathes were loaded at their ends, the weight on each lathe being less than that on the one above it. The lowest lathe was attached to a pendulum arrangement which impressed forced vibrations upon the system, the period being adjustable. The theory of such a system is the same as that of the molecule described above.

But in working out the theory a third type of vibrator was used, the identical one which vibrates in the lecture room at Glasgow. This is a series of weights attached to each other by vertical springs which can be stretched. The highest is the heaviest, and the others are arranged in the order of weight.

[1] Continued from p. 463.

Calling P the lathe with forced vibrations (corresponding to the external massless shell acted on by the ether), and ξ its displacement, m_0, m_1, &c., are the successive masses, x_0, x_1, &c., are their displacements

$$u_2 = -\frac{c_2 x_1}{x_2},$$

and measures the relative displacement of m_1 and m_2. c_1, c_2, &c., are the constants of successive spring connections. $c_2(x_1 - x_2)$ is the force of restitution in virtue of the spring connection between x_1 and x_2. τ is the period of forced vibration.

We thus arrive at the equation

$$\frac{du_i}{d\tau} = -\frac{2}{\tau^2} \cdot \frac{1}{x_i^2} m_i x_i^2 + m_{i+1} x^2_{i+1} + \ldots + m_j x_j^2),$$

and since the right hand member is essentially negative, it follows that all the u's diminish with increase of period. The critical cases occur when the period of forced vibration agrees with the natural period of any of the shells or lathes. When the forced vibration is very rapid, all successive masses move in opposite directions. When the forced period is slower, u_1 becomes zero, and x_1 is infinite—*i.e.* the vibration of the lowest mass is infinite in comparison with the forced vibrator, and so with the other vibrators. When the forced period is slower, u^1 becomes negative, *i.e.* the lowest mass begins to vibrate in the same direction, as the forced vibrator. Successive critical cases occur as the forced period reaches the natural periods of successive vibrators. At the critical period for any one vibrator, all those below it are vibrating in one direction, while the critical one and those above it are executing very large vibrations in opposite directions successively.

These critical periods are admirably adapted for explaining absorption and also anomalous dispersion. In highly absorbing media which cut off a band of light from the spectrum, the refractive index for colours neighbouring to the band is remarkable; thus light of greater wave-length than the band is refracted more, and light of less wave-length than the band is refracted less than in normal substances. Lord Rayleigh considered this to be due to the mutual influence of the vibrating molecule and ether. If the point of support of a pendulum is vibrated in a different period, the period of the pendulum is changed. Lommel seems to have been the first to make dispersion depend upon associated matter.

The influence of a large number of the spring and shell molecules distributed through the ether upon the velocity of light in that medium is examined and shown to depend upon the wave-length or period. Finally at p. 108 we obtain the following formula:—

$$\frac{\tau^2}{\lambda^2} = \frac{1}{l}\left[\rho - c_1\tau^2\left\{1 + \frac{c_1\tau^2}{m_1}\left(\frac{\kappa_1^2 R_1}{\kappa_1^2 - \tau^2} + \frac{\kappa_2^2 R_2}{\kappa_2^2 - \tau^2} + \ldots\right)\right\}\right].$$

ρ and l measure the density and rigidity.

$$R_1 = \frac{\text{Energy of } i\text{th shell}}{\text{Energy of the whole}}.$$

κ_1 = the ith critical period.

"This is the expression for the square of the refractive index, as it is affected by the presence of molecules arranged in that way. It is too late to go into this for interpretation just now, but I will tell you that if you take τ considerably less than κ_1 and very much greater than κ_2 you will get a formula with enough disposable constants to represent the index of refraction by an empirical formula, as it were, which from what we know, and from what Sellmeier and Ketteler have shown, we can accept as ample for representing the refraction index of most transparent substances. We have the means of extruding its powers and introducing the effects of those other terms, so that we have a formula which is more than sufficient to give us a mathematical expression of the refrangibility in the case of any transparent body whose refrangibility is reliable."

In fact the above formula is equivalent to the well-known formula of Cauchy and others, viz.

$$\mu = \mu_0\left(A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4} + \ldots\right)$$

when we are not dealing with critical cases. Examining the formula for $\frac{\tau^2}{\lambda^2}$ or μ^2, we see that as τ approaches κ_1, μ^2 becomes infinite, and for τ a little greater than κ_1, μ^2 is negative, which is impossible, and we can have no assignable velocity for such a period—*i.e.* there is absorption for all values of $\tau > \kappa_1$, which make μ^2 negative. Moreover, owing to the existence of a critical period, κ_1, the refractive index is abnormally increased for values of τ which are just less than κ_1, and it is abnormally diminished just when μ^2 becomes positive. This means that the refrangibility of rays in a highly absorbent medium, in the neighbourhood of the band of absorption, is anomalous in the direction indicated by Kundt in his researches on anomalous dispersion. Here is what we find at p. 150 on critical values of τ and the manner of absorption:—

"We shall try to see something more of the effect of light propagated through a medium of a period exactly equal K_1. I believe each sequence of vibrations will throw in a little energy which will spread out among the different possible motions of the molecule. The combination of the sequences, forming what we call continuous light, is not a continuous phenomenon at all. I believe that the first effect when light begins will be: each sequence of waves of the exact period throws in some energy into the molecule. That goes on until, somewhere or other, the molecule gets uneasy. It takes in an enormous amount of energy before it begins to get particularly uneasy. It then moves about, and begins to collide with its neighbours perhaps, and will therefore give you heat in the gas, if it be a gaseous molecule. It goes on colliding with the other molecules, and in that way imparting its energy to them. The energy will be simply carried away, by convection if you please, or a part of it perhaps. Each molecule set to vibrating in that way becomes a source of light, and so we may explain the radiation of heat from the molecule after it has been got into the molecule by sequences of waves of light. I believe we can so explain the augmented pressure of a gas due to the absorption of heat in it.

"We may consider, however, that the chiefest vibration of the molecule is that in which the nucleus goes in one direction, and the shell in the opposite direction, but with a great amount of energy in the interior vibrations and very little in the shell, so that the shell may go on giving out phosphorescent energy for two or three hours or days, simply vibrating for ever, except in so far as the energy is drawn off and allowed to give motion to other bodies."

A great deal more is said about the influence of critical periods upon anomalous dispersion, but, as the author says, "it is like fiddling when Rome is burning to discuss anomalous dispersion when double refraction is waiting to be explained," so I will pass from this subject.

We have in the lectures some indications of the effect of introducing a gyrostat inside the shell molecule, especially with relation to magnetic rotation of the plane of polarisation. On this subject the author said sadly: "But alas! my results give me another law, not more effect with greater frequency, but less effect with greater frequency, according to the inverse square of the wave-length. I therefore lay it aside for the present, but with perfect faith that the principle of explanation of the thing is there" (p. 244).

But, on returning to this country, a more complete theory of the gyrostatic molecule was worked out, sent to

America, and incorporated in the lectures. In my next and concluding notice I shall touch on the further developments if space permits.[1] GEORGE FORBES

(*To be continued.*)

CITY AND GUILDS OF LONDON INSTITUTE

THE Fifth Annual Report of the Council of this Institute, which was presented last week to the Governors by the Lord Chancellor, gives evidence of marked progress in all departments of the Institute's operations. During the last five years, the advance made in this country in providing technical schools of various grades has been very great, and brings us educationally within a measurable distance of France and Germany. Much praise is certainly due to the City Companies for the very energetic manner in which they have set about giving effect to the important objects they have undertaken. The Technical College at Finsbury and the Central Institution at South Kensington are important additions to the educational establishments of the metropolis. That the Finsbury College has supplied a great want is shown by the rapid increase in the number of students during the two years since it was opened. The number of evening students might have been expected to be large, because in very few places, if in any, do evening students have the same advantages as at Finsbury of obtaining practical instruction in physics and mechanics. But the great success of the College is shown in the increasing number of its day students. In little more than two years the number has increased from 30 to 148; and nearly all these students are in regular attendance throughout the whole day, and go through the complete course of instruction as laid down for them in the programme. Some changes have taken place in the staff of the College in consequence of the opening of the Central Institution. Mr. Philip Magnus has been relieved of the duties of Principal, which he temporarily undertook in addition to his other duties as organising Director of the Institute, and Profs. Ayrton and Armstrong have resigned the Chairs of Physics and Chemistry for similar positions at the Central Institution. The appointment of Dr. Silvanus Thompson as Principal and Professor of Physics at Finsbury promises well for the future of the College, and the Council have been well advised in this selection. The Professorship of Chemistry is still vacant.

The Central Institution, which is to form a kind of technical university, was formally opened in June last, but, as generally happens, the completion of the fittings has occupied more time than was anticipated, and the Institution is consequently not yet in working order. The Prince of Wales, who has shown great interest in the progress of the Institute, issued an appeal to the Lord Mayor and to the Masters of the several Companies for additional funds to defray the cost of the fittings, which brought in over 17,000*l*. It may be expected, therefore, that this Central College will be very completely furnished with all the necessary appliances and apparatus for scientific and technical instruction.

The Council of the Institute refer with satisfaction to several passages in the Report of the Royal Commissioners on Technical Instruction, showing the great need in this country of improved facilities for higher technical teaching. It is a common error, which the building in South Kensington will help to correct, that technical education has reference to artisans only, and that the improvement of the skill of the working man is the great *desideratum* in the commercial interests of the country. But this is not so. The difference between foreign countries and our own in the facilities afforded for the education of artisans is not so marked as in the opportunities for the higher education of masters and managers of works.

But the City Guilds Institute, whilst giving prominence in its scheme to the provision of this higher education at its Central Institution, has done a great work in assisting in the establishment of evening technical schools in all the principal manufacturing centres of the kingdom, by means of its system of technological examinations. The Director's special Report on this part of the Institute's work is full of detailed information as to the increase in the number of candidates and of subjects of examination, and is supplemented by remarks of the examiners on the causes of the failures of the candidates. The percentage of failures is decidedly high; but the Institute very wisely insists upon a high standard of excellence, so that its certificates may be accepted by masters and employers as proof of the efficiency of those who hold them. In many crafts, this would be impossible, if the certificates were awarded on the results of a written examination only; but the practical tests which have this year been added afford a guarantee, which would otherwise be wanting, of the technical skill, as well as of the knowledge of the candidates. In the examination in "weaving," for instance, the candidate is required to design an original pattern, to prepare it for the loom, and to weave it in suitable material, besides answering questions on the analysis of patterns, the structure of the different kinds of looms, &c. In mine surveying, also, a practical examination was last year held at the Pease's West Collieries, in which the candidates were engaged, with the examiner, in surface and underground work during the three days. Whilst the Institute's examinations are thus conducted there can be no doubt of their efficiency, and of their affording a valuable supplement to those of the Science and Art Department. Most of the Institute's examiners complain of the candidates' want of skill in drawing; and it is satisfactory to note that the attention of the Education Department has been called to this general defect in the education given in our primary schools, and that it is likely to be remedied by the provisions for teaching linear drawing throughout the Standards contained in the New Code for 1885.

The Report of the Institute concludes with an appeal for additional funds. If the Council are to develop the work they have begun they require a much larger income than they now dispense. A good beginning has been made, but it is little more than a beginning, in the establishment of technical schools in this country. Leicester, Nottingham, Sheffield, and Manchester have received some assistance from the Institute; but there are many manufacturing towns still requiring help, and the wants of the metropolis are by no means satisfied. It is to be hoped, therefore, that the appeal of the Council, backed by the powerful support of the Lord Chancellor, will meet with a ready and adequate response.

THE PEABODY MUSEUM AT NEW HAVEN, U.S.

THE accompanying illustration of this fine museum is reproduced from *Science*. The Peabody Museum, Mr. Ingersoll informs us, stands on the corner of Elm and High Streets, just without the *campus* of Yale College. The building is due to the liberality of George Peabody, who gave a sum of money, in 1866, to erect a house for the collections. Thanks to the financial prosperity of Massachusetts, the bonds for a hundred and fifty thousand dollars had greatly increased, and those set aside for the first wing of the building had become worth a hundred and seventy-five thousand dollars when the trustees began to build. With that sum they have erected one of the finest buildings, for its purpose, in the United States—a lofty and ornamental structure of red brick and cream-coloured stone, whose broad and numerous windows

[1] Corrections to first notice in issue of March 19:—For *asphasia* read *aphasia*. P. 462, line 41 of second column, for *a few seconds*, read *for a few thousandths of a second*. P. 463, line 35 of first column, for *withont* read *with*.

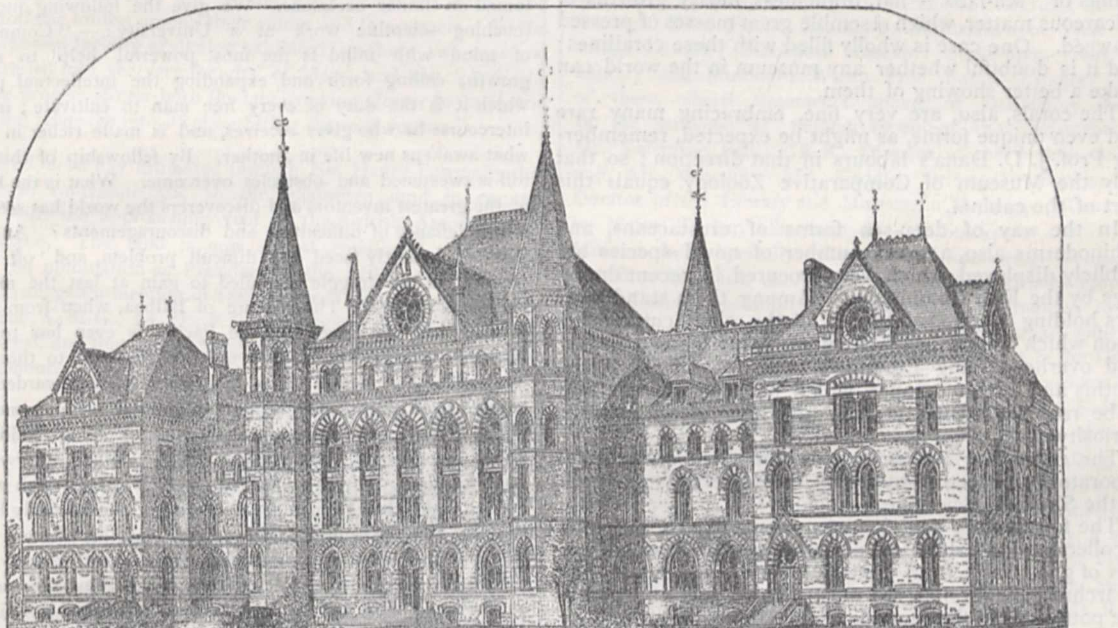
express the desire of the investigators within for all the light they can get.

Entering the basement-floor we find the possessions of the U.S. Fish Commission, deposited for sorting and examination under the eye of Prof. A. E. Verrill, who is chief of the zoological part of the museum, or by some of his associates. In another part of the basement, Prof. O. C. Marsh keeps "greate store" of fossils, cleaning the gigantic bones from Rocky Mountain quarries preparatory to study and display. Considerable palæontological property of the U.S. Geological Survey is under inspection here also.

Only favoured visitors go to the basement, or care to go. The public entrance is above, opening underneath a magnificent rose-window into a spacious court with tiled floor, and walls of variegated bricks. This region is garnished by great slabs of the celebrated footprint sandstones from the Connecticut valley, and a huge stump taken entire from a coal-bed. Iron staircases, clinging to the wall in spiral flight, lead to the top story, and the court is roofed with glass. On the right and left of the entrance are doors leading to business offices, the blowpipe laboratory, and the lecture-rooms of the Professors Dana (father and son), where large audiences frequently gather to hear the instruction designed for undergraduates alone; and in the rear of the court, on the ground-floor, is the exhibition hall for minerals, of which the museum possesses an almost unrivalled collection. This might be expected, considering the men—Dana, Silliman, Brush, and others—of whose labours it is the result.

The only thing in this room not locked up is a meteorite weighing 1600 lbs. The metal in one spot has been sawed off, and polished until it looks like burnished steel, and has been engraved with an historical inscription, from which it appears that this meteorite fell in Texas, presumably the only State in the Union large enough to receive it safely.

After the brilliant and many tinted ores, the endless



The Peabody Museum as it will appear when completed.

variety and beauty of the quartz crystals, and the substantial interest inspired by the metals, visitors always pause with new gratification before some curious rosetted crystals of a form of lime, though they usually quite overlook the "educational series," which has been spread with such pains for their instruction. This educational collection, which seems to be extremely apt and well selected, concentrates in a single case a practical glossary and text-book of mineralogy. To this epitome of the science all the rich and rare examples in the wall-cases are only attractive illustrations; and, the further to help the inquirer to understand them, several copies of Dana's "Mineralogy" will be found upon little tables near by. Here persons may sit and read, acquire and carry away the information, but not the *book*, for that is chained to an iron pillar.

The third floor is that most popular with the public, since it is devoted chiefly to modern animal life. The first thing to strike the eye in the south room is a fine series of comparative skeletons of primates, from civilised man down to the humblest of monkeys, all hanging in a beautiful row by hooks screwed into the tops of their heads. Beyond them, the whole side of the room is filled with cases containing an orderly succession of skeletons illustrating all the vertebrate orders; while the centre of the room is occupied by the skeletons and stuffed hides of the larger mammals, like the camel, rhinoceros, a very dejected polar bear, &c.

In the same room several cases are filled with stuffed skins of mammals, birds, and reptiles. Beside most of the land birds are placed their nests, with the eggs; or else the eggs are glued upon upright tablets of ground glass, in which position they show to excellent advantage. One large case is devoted to a collection of New England birds alone, excellently mounted upon the branches of a tree. This is the work of Prof. W. D. Whitney, who, before he became prominent as a linguist, was known as a good ornithologist; as, in fact, he still is.

Passing to the west room on the same floor, one sees invertebrate preparations most attractively displayed.

They are confined almost wholly, however, to the crustacea, mollusks, radiates, and marine protozoa. Of insects there is a very small showing—only enough to represent scantily the classification of that immense class. This is partly because it is unwise to display insects freely, since exposure to the light causes their colours to fade, but is due chiefly to lack of material, owing to the fact that no entomologists of note have been especially interested in the progress of this museum.

On the other hand, the special tastes of Profs. Verrill, S. I. Smith, J. H. Emerton, and others, and the intimate relations the Museum (through these gentlemen) have sustained with the Smithsonian Institution and the U.S. Fish Commission, have brought the department of marine invertebrates to an almost unrivalled perfection. In no room does the casual visitor linger longer than in this one; while its contents are unusually interesting to specialists, because of the large proportion of type-specimens included. In many instances these are unique; as, for example, some of those beautiful orange and scarlet gorgonias or "sea-fans"—flat, branchless, mossy growths of calcareous matter, which resemble great masses of pressed seaweed. One case is wholly filled with these corallines; and it is doubtful whether any museum in the world can make a better showing of them.

The corals, also, are very fine, embracing many rare and even unique forms, as might be expected, remembering Prof. J. D. Dana's labours in that direction; so that only the Museum of Comparative Zoology equals this part of the cabinet.

In the way of deep-sea forms of crustaceans, and echinoderms also, a great number of novel species are publicly displayed, which were procured in recent dredgings by the Fish Commission. Among them stand large jars holding alcoholic remains of the giant cuttle-fishes upon which Verrill has written so many learned pages; and overhead hang Emerton's paper models of Architeuthis and a huge octopus, which half the visitors take to be real devil-fishes stuffed, and gaze at with fearful curiosity.

The remaining rooms on this floor are occupied as laboratories or lecture-rooms by Profs. Verrill and Smith, of the Sheffield Scientific School.

The fourth story contains storerooms filled with fossils, a collection (on exhibition) of about two thousand antiquities of great value from Central America, and a fair show of archæological relics, the most notable part of which is the pottery from the mounds of the Ohio valley.

But the glory of the Yale Museum is its palæontological treasures, brought together wholly by Prof. O. C. Marsh. The few representatives of this collection visible in the second-floor rooms and in the hall-ways are alone sufficient to stamp the museum as pre-eminent in this line; but they are merely an advertisement of what cellar and attic contain. It is not too much to say that, in respect to vertebrate palæontology (outside of fishes), this museum is not surpassed in the world. Where other collections own fragments or single skeletons, Prof. Marsh boasts scores or hundreds of individuals, while many extinct races are known only by their fossil remains in his possession.

This is the result of wisely-directed energy, and the ability to spend money promptly and liberally. Marsh's frequent expeditions to the far west are well known to geologists. Many car-loads resulting from these were not only shipped home by himself, but his agents have been forwarding enormous quantities ever since from Wyoming and Colorado "quarries."

To Prof. Marsh's personal collection somewhat has been added at the museum by the U. S. Geological Survey, which will become the publisher of the outcome of his studies now in progress. A score or so of assistants are constantly on duty, either in study, or in the mechanical work of skilfully extracting fossils from the rocky matrix; in matching and mounting, by the aid of wire, clay, and plaster, for permanent preservation, the often badly-broken bones of some antique brute whose extinction most of the world can accept with resignation; or in making casts, models, and drawings of fossils, original and "restored."

Several quarto volumes are already under weigh, and scarcely an issue of the *American Journal of Science* appears without an advance note of some special discovery in vertebrate palæontology, anticipating the completer descriptions to be made from this museum's rich materials.

NOTES

THE new Lord Rector of Glasgow University, Dr. Lushington, was installed on the 26th ult. The address, which was in every way worthy both of the University and of the Lord Rector, contrasted strongly, with its calm, deep utterances and its grasp of the needs of a complete academic life, with the more or less political utterances to which we have been too much accustomed on similar occasions. We give the following quotation touching scientific work at a University:—"Communion of mind with mind is the most powerful help to mental growth, calling forth and expanding the intellectual powers which it is the duty of every free man to cultivate; in such intercourse he who gives receives, and is made richer in giving what awakens new life in another. By fellowship of this kind toil is sweetened and obstacles overcome. What is the history of the greatest inventors and discoverers the world has seen, but a firm defiance of difficulties and discouragements? And who that ever honestly faced any difficult problem, and 'oft foiled, oft rose' in the struggle has failed to gain at last the meed of hard-won victory? The rapture of Balboa, when from a peak of Darien he first gazed on the Pacific, is even less touching than that austere joy, of contemplation destined to those who by steadfast and painful efforts, long seemingly unrewarded, have wrested from nature some hitherto unguessed secret, some truth which illumines and brings into closer union other familiar but as yet unconnected aspects of knowledge. When, after years of doubtful poring, the light flashed upon Newton which was for ever to make clear to man the dynamics of the heavenly bodies, showing how the same law sways every leaf that flutters in the gale and the remotest star-clusters, we can well conceive how the ecstacy of wonder and delight was a disturbing presence that overpowered him, and made him request a friend to finish the calculation he had begun. And every generation, every decade, almost every year, opens new vistas through which the piercing eye, armed with weapons inherited from earlier conquests, may look forward bright in the hope of adding something more to the store of accomplished good to mankind; for in knowledge, as in nature, nothing is unfruitful. Such hope cheered and upheld many daring pioneers of science, whose venerated names, now become household words, are linked together for ever in the history of human progress, known and honoured throughout the whole civilised world. Yet who in the age of Watt, even in the boldest flights of presaging imagination, could have foretold such wondrous conquests over space and time as the spectroscope, the electric telegraph, and the telephone have revealed? But I forbear from dwelling longer on the incentives to exertion held out to all by the numerous physical sciences which have so many gifted exponents, before whom it becomes a non-expert to be rather a listener than a speaker. May all honour and success be theirs in sounding the mysterious depths of nature, and drawing into light the essential order which underlies her seeming complexities, ruling them with the necessity of intelligible relations. Many and various are the marvels with which "the world of eye and ear" surrounds us, inviting adventurous search into their far recesses; but as human thought advances, winning ever wider triumphs in solving riddle after riddle, must not the further question force itself upon us, What of this power which reads and interprets nature? Beside and beyond the outward and visible, linked to it by mysterious connection, is the sphere of thought, of mind, the home and dwelling-place of thought. What is this being of ours which thinks, plans, and wills? What means it? Whither tends it? This, the question of questions, from far distant periods, souls possessed with profound genius have dared to ask and yearned for a reply. When no complete reply was gained, they yet toiled on, finding in the search food for deeper and more reverent wonder than even in the splendid picture which outward nature displays. They held fast the courageous and hopeful faith that for man who 'names the name Eternity,' 'there must be answer,' here or elsewhere to his trembling doubt, to his 'obstinate questionings.' Such searchers were the early Greek philosophers, who kindled a spark amid surrounding darkness, destined not to die out, but gradually to brighten by careful tendance, and grow into a light that will shine to all coming times, as successive generations of inquiring spirits look up to the great names of Plato and Aristotle as loftiest among their guides and forerunners. In the unsurpassed lucidity of diction exhibited by these two masters, we are led into the very foundry of ideas, and can follow the subtle process of new-born thought growing clearer to itself, and shaping language into its close-fitting outward vesture."

THE Queen has intimated through Sir Henry Ponsonby that she will contribute 50*l*. to the guarantee fund in connection with the approaching visit of the British Association to Aberdeen. The fund is now almost completed. We learn that the nomination as President of the British Association at the Birmingham meeting in 1886 has been offered to Sir William Dawson, C.M.G., LL.D., F.R.S., principal of McGill College, Montreal, and that he has telegraphed his intention of accepting the honour.

AN important meeting was held on Monday at Marlborough House, under the presidency of the Prince of Wales, in connection with the Colonial and Indian Exhibition of 1886. The Prince of Wales, in an address of some length, stated the objects of the Exhibition, which is likely to form one of the most attractive and instructive of any recently held at South Kensington. As the Prince stated, the objects for which her Majesty has been pleased to appoint this Commission are, briefly, to organise and carry out an exhibition by which the reproductive resources of our colonies and of the Indian Empire may be brought before the people of Great Britain, and by which also the distant portions of her Majesty's dominions may be enabled to compare the advances made by each other in trade, manufactures, and general material progress. No such opportunity of becoming practically acquainted with the economic condition of our colonies and the Indian Empire has ever been afforded in this country. A guarantee fund of 128,000*l*. has already been secured, though it is not likely that any of this will be required.

THE following are the Royal Institution lecture arrangements after Easter:—Prof. Gamgee, eight lectures on digestion and nutrition, on Tuesdays, April 14 to June 2; Prof. Tyndall, five lectures on natural forces and energies, on Thursdays, April 16 to May 14; Prof. Meymott Tidy, three lectures on poisons in relation to their chemical constitution and to vital functions, on Thursdays, May 21, 28, June 4; Mr. W. Carruthers, four lectures on fir-trees and their allies, in the present and in the past, on Saturdays, April 18 to May 9; Prof. Odling, two lectures on organic septics and antiseptics, on Saturdays, May 16, 23; and Rev. C. Taylor, two lectures on a lately discovered document, possibly of the first century, entitled "The Teaching of the Twelve Apostles," with illustrations from the Talmud. The Friday evening meetings will be resumed on April 17, when Prof. S. P. Langley, of the Alleghany Observatory, Pennsylvania, will give a discourse on sunlight and the earth's atmosphere.

ON March 25 the Sunday Society held a National Conference at St. James's Hall with the authorities and officers of museums, art galleries, and libraries which have been open in the United Kingdom on Sundays. There was a good attendance, those present for the most part being representative men; a large number of ladies were present. Prof. Corfield, the Chairman of the Committee, presided. The chairman having briefly opened the proceedings, official statements respecting the Sunday opening of the following institutions, which are supported by public money, were submitted by different speakers:—National Museum and Exhibition of Pictures at Kew; National Picture Galleries at Hampton Court Palace; National Picture Gallery at Greenwich Hospital; National Gallery, Dublin; National Museum of Science and Art, Dublin; Birmingham Art Gallery and Library; Manchester—six Free Public Libraries; Middlesborough Free Public Library; Newcastle-upon-Tyne Free Public Library; Stockport Museum; Stoke-upon-Trent Free Library and Museum; Wigan Free Public Library. Each of these official statements spoke of satisfactory results as the outcome of Sunday opening, the statements by Mr. Valentine Ball, F.R.S., Director of the Dublin Science and Art Museum; Mr. Caddie, Principal Librarian and Curator of the Library and Museum in Stoke-upon-Trent, and by Major Turner, Chairman of the Stockport Library and Museum, being specially exhaustive and interesting. The Rev. Septimus Hansard, M.A., rector of Bethnal Green, proposed the following resolution:—"That the facts submitted to this Conference respecting those public museums, art galleries, and libraries which have been opened on Sundays in the United Kingdom are most satisfactory, and it is hereby resolved that they be embodied in petitions to be presented to the Lords of the Treasury and the House of Commons, praying that the trustees of the British Museum and the National Gallery may be provided with the money required to enable them to open these institutions on Sunday afternoons." This was seconded by Mr. John Westlake, Q.C., LL.D., and supported by a great many speakers, including Mr. Wyles, of Coventry; Mr. Freak, of the National Boot and Shoe Riveters' Society; Mr. Steele, J.P., of Rochester; Mr. Faulkner, M.A., of Oxford; Mr. R. M. Morrell, Mr. H. Rutherford, and Mr. Mark H. Judge. The resolution was carried unanimously.

MR. THOMAS FLETCHER, of Warrington, gave a useful lecture on "Smokeless Houses and Manufactories" at the Parkes Museum on March 26. In concluding his lecture, Mr. Fletcher said:—"The ground has been cleared by independent experimenters, and I think it may fairly be said that both houses and all manufacturing industries can be profitably carried on absolutely without smoke, and it is simply a question of time as to when this state of things becomes general throughout the world. Some people are afraid that when after a short time the coal supply of England is exhausted, the predicted New Zealander, when he sits on the ruins of Westminster Abbey, will be able to live on the rabbits caught amongst the ruins; but if gaseous fuel is adopted in our houses and flameless regenerative furnaces are used in our manufactories it is probable that the coming New Zealander will have to defer his visit for a length of time which the present generation need not consider; in fact, we shall be able to import our fuel from unexhausted countries, and hold our own against them after our coal is all gone. The future of gaseous fuel is settled beyond all question on the best of all possible grounds, that it is profitable to use, and users of solid fuel will soon discontinue their present system when they learn their position in the matter."

FROM a letter addressed by the Rev. Edward Reynolds, of Rowland, Limestone County, Alabama, United States, dated September 23, 1884, to the Krakatoa Committee of the Royal Society, we take the following extract:—"Soon after becoming acquainted with the zodiacal light, I began to notice red sunsets. After a few years I noticed that they invariably followed the commencement of the zodiacal light, and continued about the same length of time—that is, about two or three months. I seldom failed to call the attention of my friends and neighbours to these phenomena. Until this last display of the zodiacal light, and its invariable attendants, the red sunrises and sunsets, I have always accounted for the redness by supposing it to be caused by the oblique passage of the sun's rays through his nebular train. But this season I have been obliged to give up that theory, because the redness has continued after the disappearance of the zodiacal light. It is now more than ten months since their commencement, about November 13. They still continue to show no signs of abatement, but rather increase in vividness. Hence, I infer that the immediate cause of the redness is within the atmosphere, rather than in the distant and invisible nebulous train of the sun. We have not this season had a single day nor hour of clear, blue sky, such as is common in ordinary years. We have had plenty of *cloudless* days, but none of the pure blue. There is a yellowish, creamy whiteness, especially far and wide about the sun, even at midday. In looking across a forty-acre lot there is, at all times of the day, a peculiar blueness in the atmosphere, whilst at night not more than a third or half of the stars can be seen. The freer from clouds the heavens are, the more distinctly do the red sunrises and sunsets appear; and so of the other appearances of the atmosphere I have mentioned. During the evenings following November 13 last I was able to see the zodiacal light but a few times, and then very indistinctly. I watched long for an opportunity to show it to my friends and neighbours, but failed to find an evening when it could be seen by unpractised eyes. It has never been so before, since my attention was called to this subject forty-four years ago."

THE following account, we learn from *Science*, of unusual phenomena was received, March 10, at the Hydrographic Office, Washington, from the branch office in San Francisco. The barque *Innerwich*, Capt. Waters, has just arrived at Victoria from Yokohama. At midnight of February 24, in latitude 37° north, longitude 170° 15′ east, the captain was aroused by the mate, and went on deck to find the sky changing to a fiery red. All at once a large mass of fire appeared over the vessel, completely blinding the spectators; and, as it fell into the sea some fifty yards to leeward, it caused a hissing sound, which was heard above the blast, and made the vessel quiver from stem to stern. Hardly had this disappeared, when a lowering mass of white foam was seen rapidly approaching the vessel. The noise from the advancing volume of water is described as deafening. The barque was struck flat aback; but, before there was time to touch a brace, the sails had filled again, and the roaring white sea had passed ahead. To increase the horror of the situation, another "vast sheet of flame" ran down the mizen mast, and "poured in myriads of sparks" from the rigging. The strange redness of the sky remained for twenty minutes. The master, an old and experienced mariner, declares that the awfulness of the sight was beyond description, and considers that the ship had a narrow escape from destruction.

THE United States Bureau of Education have printed and distributed an address, by the Rev. A. D. Mayo, on the subject of education in the South, which, balloon-like, may raise some heavy hearts by its very inflation! He urges the folly of casting upon the ignorant mass of either race the responsibility of educating itself, and he tries to rouse enthusiasm like his own among Southerners who are educated; urging the first call upon local taxes to which education is entitled; the amount of voluntary effort which may be made by both males and females, who appreciate his views and will qualify themselves for teachers; and the small importance of buildings, books, or apparatus, where a school has been commenced from the "soul end," a good teacher.

IT is unquestionable now that the new trigonometrical survey which has been made in the Netherlands (especially by the late Mr. Stamkart) for the European Commission since 1864 is not sufficient for the purpose for which it was undertaken, and the second chamber of the "Staten Generaal" has lately voted the money required for doing the work over again. Strange to say, it was the Minister himself who objected to this item, saying that as long as Mr. Stamkart lived, his colleagues (the other Dutch deputies to the European Commission) had made no objection to his work, and consequently he feared that perhaps later it might be said that the survey now proposed would also have to be done over again. Though it is to be regretted that such is the case, we cannot wonder at the Dutch Government objecting to such an expense, after its experience both in the Netherlands and in the Dutch East Indies.

THERE is a curious analogy in China to the English custom of burying suicides at cross-roads, with a stake through their body. The body of the *felo de se* who is so irreverent as to commit self-destruction within the precincts of that portion of Peking in which the Imperial Court is situated, is solemnly brought to some public place, such as a bridge, and there flogged.

THE inargural address of the President of the Leicester Literary and Philosophical Society on the jubilee of the Society, which has been published separately (Leicester: Clarke and Hodgson) is characterised by a circumstance which is probably unprecedented in the history of societies. The President for the year is Dr. George Shaw, who was the President, and who delivered the first address to the Society fifty years ago; the same President of a society at its formation and at its fiftieth anniversary is a coincidence of peculiar interest. Dr. Shaw was naturally retrospective, for he described the labours of the founders, and the progress which has been made in the half century. The little pamphlet should be of use to all interested in steering young societies through the rocks and shallows which beset all enterprises in the earlier stages of their existence. In the case of the Leicester Society the stages were: (1) the papers were too dry and abstruse, and no one attended—learning was suffocating the infant; (2) they became popular, less philosophical, and more literary, to the detriment of severer study—the infant's constitution was being destroyed by sweets; (3) popular public lecturers began to be employed in an increasing ratio, and their presence was indicative of a want of energy amongst its members. After his biography of the Society, Dr. Shaw discusses the spirit of the present age, and the members of the Leicester Philosophical and Literary Society were to be congratulated if their presidential address fifty years ago were anything like so vigorous, encouraging, and abreast of time as that on their jubilee.

MR. ADAM SEDGWICK has in preparation a new book, to be entitled "The Elements of Animal Biology," which is intended to serve as an introduction to the study of animal morphology and physiology. Messrs. Swan Sonnenschein and Co. are to be the publishers.

DR. BULLER, of Wellington, New Zealand, is preparing for the press a new and enlarged edition of his "History of the Birds of New Zealand." The "history" will comprise a general introduction on the ornithology of New Zealand, a concise diagnosis of each bird in Latin and English, synoptical lists of the nomenclature, and a popular history and description of all the known species, brought down to the latest date. It will be published in parts, each containing not less than ten coloured plates. The size will be large quarto.

MESSRS. ASHER AND CO. announce as just ready "The Chittagong Hill Tribes," results of a journey made in the year 1882 by Dr. Emil Riebeck, Ph.D., F.R.G.S., translated by Prof. A. H. Keane.

THE Oyster Fishery in the United States employs 53,805 persons, and yields 22,195,370 bushels of oysters, worth 30,438,852 dollars. In France 32,431 persons are engaged in the industry, which produces 43,307*l.*, and in Great Britain 3,000,000*l.* The oyster industry is rapidly passing from the hands of the fishermen into those of oyster culturists, and in the United States is carried on in so reckless a manner that the Government are being urged to interfere in the matter.

WE have received a copy of "Ellis's Irish Education Directory." The part of the book relating to "National Education" has been remodelled so as to make it a complete guide to the National System. The "Irish Educational Guide and Scholastic Directory" has now been incorporated with "Ellis's Irish Education Directory."

AT the last meeting of the Seismological Society of Japan (as reported in the *Japan Weekly Mail*) Prof. Koto read a paper on the "Movement of the Earth's Crust," as these have been observed in Japan. It appears that the south and east coasts are gradually rising, while the north and west coasts are subsiding. This phenomenon is directly connected with the intensity of seismic activity along the eastern seaboard, almost every earthquake felt in the capital cooming from a region extending from north-east to south-east or nearly south, while hardly any originate in the west. Mr. Sekiya described in detail the great earthquake of October 15 last year. It was attended by unusual barometric variations. The thermometer, which averaged 16° C. during the month, rose to 27° immediately before the shock, while the wind blew with a force of 43 kilometres per hour. The shock occurred at 4′ 21″·54 after midnight, and lasted for 5′ 20″, during which time no less than 200 complete vibrations were recorded. During the first second the motion of the earth measured only 2·5 mm., but rose to 13 mm. in the third, and reached its maximum intensity of fully 42 mm. in the fourth second. The shock was then travelling with a velocity of 200-280 mm. in the second. Over a hundred reports were received by the Meteorological Bureau from various parts of the country, from which it appeared that the area affected by the shock was 24,728 square miles. Eighty-six per cent. of the pendulum clocks in Tokio were stopped, and much damage of the kind usual in these shocks was done. Mr. Sekiya states that this earthquake was the severest since February 22, 1880, to which it was remarkably similar in many ways. Both originated somewhere on the east side of the Bay of Yedo, and both affected the same area. In both instances the origin of the shock was in all probability due to the formation of a subterranean fissure.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Miss Pyne Hamilton; a Blaubok (*Cephalophus pygmæus*) from South Africa, presented by Mr. A. Best; a Russ's Weaver-bird (*Quelea russi*) from West Africa, presented by Mr. J. Abrahams; a Long-eared Owl (*Asio otus*), a Common Buzzard (*Buteo vulgaris*), a Common Kestrel (*Tinnunculus alaudarius*), European, presented by Mr. Scott B. Wilson; two Ravens (*Corvus corax*), British, presented respectively by Mr. J. Bradley, jun., and Mr. Gerard Sloper; a Common Lizard (*Lacerta vivipara*), British, presented by Mr. Stanley S. Flower; a Wattled Starling (*Dilophus carunculatus*) from South Africa, purchased; a Common Otter (*Lutra vulgaris*), British, received on approval.

OUR ASTRONOMICAL COLUMN

A STAR WITH LARGE PROPER MOTION.—Dr. Gould notifies the probable existence of very large proper motion in a star of a little below the eighth magnitude, which is No. 1584 of Hour xxiii. in the Cordoba Zone Catalogue; the position for 1875·0 is in R.A. 23h. 58m. 1·85s., Decl. −37° 58′ 18·8″, consequently in the constellation Sculptor. From observations between 1872 and 1884 Dr. Gould infers an annual proper motion of +0·4823s. in right ascension, and −2·4479″ in declination, or 6·2057″ in arc of a great circle in the direction 66° 46′ east of south. This direction, he remarks, differs from that of Lacaille 9352 (which is 15° distant) by 34°. The large proper motion of Lacaille's star, one of 7·5m., was also detected by Dr. Gould; it amounts to 6·9565″; so that it had moved over 14¼ minutes of arc between the year 1752 and the time of the Cordoba observations about the end of 1876.

The annual proper motion of the star, Groombridge 1830, the largest yet remarked in a star north of the equator, is 6·976″, as determined by Argelander in 1843.

WOLF'S COMET.—This comet was observed for position with the 8-inch refractor at the Observatory of Kiel, on March 12, when its distance from the earth was 2·24, and that from the sun 1·94, so that the theoretical intensity of light was just one-tenth of the amount on the night of discovery, September 17. As there is a possibility that the comet may yet be observable with larger instruments during the next period of absence of moonlight, Dr. Lamp has continued his ephemeris from Prof. Krüger's second elements, and a few places are subjoined—

At Berlin Midnight.

	R.A. h. m. s.	Decl. ° ′	Log. Distance from Earth.	Log. Distance from Sun.
April 3	4 19 44	+3 7·3	0·4030	0·3144
5	24 6	3 16·9		
7	28 28	3 26·1	0·4118	0·3193
9	32 49	3 35·0		
11	37 9	3 43·5	0·4204	0·3242
13	41 28	3 51·5		
15	4 45 47	+3 59·2	0·4288	0·3290

THE APRIL METEORS.—The earth will arrive at the descending node of the first comet of 1861, with which the Lyra-meteors of April have been supposed to be connected, on the morning of the 20th inst. In 1861 the comet at this node passed only 214,000 miles within the orbit of the earth, and the elements assign for the radiant R.A. 270·7°, Decl. +33·5°. If the present form of the comet's orbit is due to planetary action at some distant epoch, it is quite as likely that the planet Saturn was the disturbing body, as that it should have been the earth. With the elements of 1861 we find that at a true anomaly of 144° 43′, the comet's distance from the orbit of Saturn is only 0·11, and this point would be reached 2·48 years after perihelion passage. The period of revolution, according to the definitive investigation of Prof. Oppölzer, is 415 years.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *APRIL* 5-11

(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 April 5

Sun rises, 5h. 28m.; souths, 12h. 2m. 38·2s.; sets, 18h. 38m.; decl. on meridian, 6° 15′ N.: Sidereal Time at Sunset, 7h. 35m.

Moon (at Last Quarter on April 7) rises, 23h. 49m.*; souths, 4h. 19m.; sets, 8h. 48m.; decl. on meridian, 17° 56′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	5 46	13 11	20 36	15 22 N.
Venus	5 23	11 37	17 51	1 58 N.
Mars	5 13	11 22	17 31	1 2 N.
Jupiter	13 41	20 58	4 15*	13 56 N.
Saturn	8 11	16 17	0 23*	21 55 N.

* Indicates that the rising is that of the preceding and the setting that of the following day.

On April 9 at 3h. 48m. there is a near approach of 14 Capricorni to the Moon at 339° from the vertex to right, for inverted image.

Phenomena of Jupiter's Satellites

April	h. m.		April	h. m.	
5 ...	0 13	I. occ. disap.	7 ...	22 45	III. occ. reap.
	3 26	I. ecl. reap.		23 13	III. ecl. disap.
	21 32	I. tr. ing.	8 ...	2 40	III. ecl. reap.
	23 52	I. tr. egr.		21 34	II. occ. disap.
6 ...	18 40	I. occ. disap.	9 ...	2 29	II. ecl. reap.
	21 55	I. ecl. reap.	10 ..	22 13	IV. ecl. disap.
7 ...	2 28	II. tr. ing.	11 ...	2 37	IV. ecl. reap.
	19 7	III. occ. disap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, April 5.—Outer major axis of outer ring = 39″·8 ; outer minor axis of outer ring = 18″·1 ; southern surface visible.

April 8, 2h.—Mercury at greatest elongation from the Sun, 19° East.

GEOGRAPHICAL NOTES

A COMMITTEE of the Geographical Society of Vienna has been appointed to carry out the business arrangements of Prof. Lenz's proposed expedition to Central Africa. It is reckoned that 25,000fl. will be wanted for the expedition. At first it was thought that Herr Lenz might go out as the representative of the united Geographical Societies of Vienna, Berlin, and Munich, but the Society of Berlin has decided to send out an explorer of its own, Dr. Fischer, who will start next month. Dr. Fischer will go for the same purpose as Herr Lenz—that is, to explore the watershed of the Upper Congo, and to find traces of the four missing Europeans. But instead of starting from the west coast, as Dr. Lenz proposes to do, he will proceed from the east coast, going from Zanzibar to Uganda.

THE fifth German Geographical Congress (*Geographentag*) will be held in Hamburg on April 9 to 12. Among the points which will be brought before the Congress are the following: Antarctic investigations by Drs. Neumayer and Ratzel; the importance of the Panama Canal to the trade of the world, and deliberations on a new edition of Dr. Neumayer's "Guide to Scientific Observations on Travel." The afternoons will, as hitherto, be devoted to questions connected with school geography. The exhibition directed by Prof. Pagenstecher promises to be especially interesting and exhaustive. It is intended to exhibit new maps, especially in the domain of hydrography, and all the maps and descriptions of the free town of Hamburg and the adjoining districts. The instruments and apparatus used by travellers will be collected in a single group. Rich public and private collections of African and Central American ethnographical and archæological objects will be exhibited, and in part explained by their owners. An exhibit of the products and articles of trade of the various colonies has been rendered possible by the co-operation of large mercantile firms in Hamburg; and zoological, botanical, and geological collections will be so grouped that the character of single countries and continents will readily strike the eye. Some excursions will also be made, especially one to the marshes of the lower Elbe.

WE have received a reprint of a paper recently read before the Philosophical Society of Glasgow by the Rev. Alexander Williamson, the well-known traveller in North China. In the compass of thirty octavo pages the writer describes rapidly the extent, physical conformation, means of intercommunication (especially the rivers, the enormous importance of which is pointed out with much force), the nature of the soil and its products, meteorology, textile fabrics, oil-producing plants, dyes, the geology, trade routes, the race, population, and finally discusses the future. The portions of the subject to which Dr. Williamson devotes especial attention are precisely those which are wholly passed over, or only hastily glanced at in popular works in China. The section dealing with the geology of China gives some remarkable results, based on the investigations of Pumpelly and Richthofen. These show that under every one of the eighteen provinces of China, each of which is about as large as Great Britain, there are large deposits of coal. In some provinces it underlies the whole country in all descriptions—bituminous, anthracite, cannel, and lignite. The extent of these coal-measures may be gathered from the following statement:—Their total area is about 400,000 square miles in China proper. The coal-field in Hunan alone is greater than the aggregate of the coal-fields of the greatest coal-producing countries in Europe; the Shansi coal-field is one and a half times larger than this aggregate, while in other parts of North China we have coal-fields seven times greater than all the coal districts in Great Britain. And, side by side with all the coal-fields investigated, Mr. Pumpelly found iron ores and ironstone of all descriptions. As regards the important geographical and commercial questions involved in trade-routes with South-Western China, Dr. Williamson is in favour of the route from Moulmein through the Shan States, crossing the Chinese frontier into Yunnan at Ssu-mao (Esmok); but he does not despair of the road by the Irrawaddy to Bahmo, and so by Ja-li to the Yang-tse, more especially as the latter would create a trade for itself—viz. that with Sse-chian. Then there is the ancient route between Central Asia and China, which passes through Hinan, Shensi, and Kansu, the southern branch of which leads through Yarkand, Kashgar, and Khoten to India and Persia, and which was used by caravans prior to the Christian era, while the other branch goes in a north-westerly direction to Bar-Kul, Kuldja, and thence to Russian territory.

MR. STANFORD, of Charing Cross, has published a Catalogue of Maps, and other geographical publications, calculated to be of great service to all who may have occasion to inquire after such things. The catalogue covers seventy-two pages, is carefully classified, beginning with maps of the world; after the title of each map is an account of its special features, its size, number of sheets, scale in miles to an inch, and price, according to method of doing up. The Catalogue, we may say, contains the maps of all the leading publishers in Europe. As Mr. Stanford is now sole agent for the Ordnance Survey Maps, a special section of the Catalogue is devoted to this department, and contains a very useful index map.

MESSRS. W. AND A. K. JOHNSTON have also sent us a copy of their new catalogue of the many geographical and other works published by that well-known firm. We have also from the same firm a very excellent wall-map of Egypt, embracing the country down to the south of Lake Victoria Nyanza; it is brought so well up to date as to contain the leading features of Masai Land discovered by Mr. Joseph Thomson's second expedition. Accompanying the map is a useful Handbook of the Geography of Egypt.

THE Arctic ship *Alert*, when returned by the Government of the United States to the Admiralty at Halifax, will be placed at the disposal of the Canadian Government, for the purpose of continuing the exploration in which they are now engaged of the Hudson Bay and Straits.

A COMMITTEE, consisting of members of the Italian Senate and Chamber of Deputies and other influential persons, has been formed at Turin for the purpose of furnishing Sig. Auguste Franzoi with the means of enabling him to carry out his proposal to explore the country between the Abyssinian province of Kaffa and the Lakes of Equatorial Africa.

THE most important paper read before the Paris Society of Commercial Geography at its meeting on the 17th ult. was one by M. Delouell, the explorer of the northern part of the Malay peninsula. He described his discovery of a large lake, during his survey of the isthmus of Krao, called Tabé-Sab, which is bordered by fertile plains, where elephants and buffaloes abound. The people inhabiting this region have hitherto been unknown; they appear to be mestizos, half Siamese, who call themselves Samsams.

AT the last meeting of the Geographical Society of Marseilles M. Brémond read a detailed account, with itineraries, of his travels in the kingdom of Choa.

THE first number for the current year (Band viii. Heft 1) of the *Geographische Blätter* of the Bremen Geographical Society contains papers on the forest districts of Bavaria, the abodes and wanderings of the Esquimaux of Baffin Land, by Dr. Boas, Schwatka's exploration on the Yukon, New Zealand past and present, the German journey of exploration through South America, and numerous smaller communications.

THE last number (Band xx. Heft 1) of the *Zeitschrift* of the Geographical Society of Berlin contains the following papers:—A description by Dr. von Langegg of Old Cairo, situated about four kilometres to the south-west of the Arab quarter of modern Cairo; an account of the mission station of Otyimbingue in Damaraland, by C. G. Büttner; the first part of a discussion of the methods and task of ethnology, by "Achelis"; a map of the Congo, with accompanying description, by Herr Richard Kiepert; and a note on the additions and changes made in the Chinese administrative organisation of the Thienshan region. The *Verhandlungen* (Band xii. No. 2) of the same Society contains a criticism by Herr Erman, who has for some years had charge of the historical and geographical departments of the Royal Library at Berlin, of the methods in which the work of compiling a bibliography of the geographical works relating to Germany—a "Bibliotheca geographica Germaniæ"—is being carried out.

AT the meeting of the Geographical Society of Paris on March 20, a letter was read from the French Consul at Asuncion in Paraguay, giving details of the expedition sent by the Argentine Government to explore the Pilcomayo, and to ascend to the Bolivian frontier if possible. It has been found that, owing to impassable rapids, the river cannot be utilised as a route between Paraguay and Bolivia. The only practicable route is that by land, the possibility of which was recognised in 1883 by M. Thouar's expedition. M. de Cailland described the Pescadore archipelago in the Formosan channel. The islands have excellent roadsteads, and form the key to Formosa. M. Simonin read a note on the Indian population of the United States; and M. Jules Garnier described his project of an aërial railway for Paris.

A NEW ARRANGEMENT OF THE APPARATUS OF THE ROTATING MIRROR FOR MEASURING THE VELOCITY OF LIGHT[1]

HAVING now been engaged for a number of years in measuring the velocity of light by means of the rotating mirror, I have succeeded in rearranging the apparatus in such a manner as, by means simply of two mirrors, one fixed, the other movable, placed at a distance of a few metres from each other, to obtain, even with a very moderate velocity of rotation, a deviation of the image of a fixed object as large as may be desired in theory and limited in practice only by the intensity of the light and the perfection of the optical apparatus.

To describe in a few words the plan of L. Foucault's celebrated experiment:—The rays issuing from a narrow aperture fall, at a distance of 1 m., on a rotating mirror 14 mm. in diameter, and, on being reflected there, traverse an object-glass placed as near the mirror as possible. This object-glass throws an image of the aperture on a spherical concave mirror having a radius of 4 m. placed at a distance of 4 m. from the rotating mirror. A second mirror, in all respects perfectly corresponding with the first, receives the reflected pencil, which produces a fixed image of the rotating mirror, and transmits a movable image of the aperture to a third mirror, and so on. Foucault's apparatus comprised five similar mirrors. The last, in which a fixed image was formed, reflected on the fourth the light, which retraced its previous course and so came back to the rotating mirror, which again in turn transmitted it deviated in respect of its rotation by an angle twice as large as that at which it had turned when performing the double passage of the mirrors, *i.e.* twice 20 m. The velocity of rotation being 400 revolutions per second, Foucault obtained a deviation of 7 mm.

One of the objections taken to Foucault's experiment and the values he deduced from it respecting the velocity of light, is the smallness of that deviation. It is known how he ingeniously cleared the difficulty by substituting for the measurement of the deviation that of the distance of the aperture from the rotating mirror producing a determined deviation. He did not, however, disguise the fact that the advantage of this substitution is perhaps more specious than real, and he brought forward the plan of an apparatus compo ed of a series of objectives and of a concave mirror, by means of which the passage of the light might be extended to several hundreds of metres. He had even selected, at the Observatory, the place where his new experiments might be carried out.

I have to confess that, in endeavouring to take advantage of Foucault's scheme, whether by means of object-glass or of mirrors, I struck on such difficulties as caused me to desist from the prosecution of my researches by either of the methods indicated.

In the United States in 1879 Mr. Michelson put in operation the experiment of the rotating mirror at great distances, but under an arrangement which brings the experiment much nearer to the celebrated one of MM. Fizeau and Bréguet than that of Foucault. The aperture from which the light issues was placed at a distance of about 30 English feet (9·15 m.) from the rotating mirror, the diameter of which amounted to 1¼ inches (3·2 cm.). A simple non-achromatic lens, 7 inches (17·8 cm.) in diameter, and having a focus of 150 feet (45·75 m.) was placed in such a manner as to throw an image of the aperture, seen by reflection in the rotating mirror, on the surface of a plain mirror, 7 inches in diameter, placed normally to the line passing through the centres of the two mirrors and the lens, at a distance of 1986·23 feet (605·80 m.) from the rotating mirror. The pencil then returns on itself, and gives an image of the aperture coinciding with it, point for point, when the mirror is fixed, deviated as soon as it rotates. The lineal displacement of the image during a rotation of 258 revolutions per second amounted to 114·15 mm. The advantage, however, of such a large displacement seems to be counterbalanced by the inferior quality of the image. A lens 7 inches in diameter, and with a focus of 150 feet will, even under the best conditions, necessarily give an image bounded by very large fringes of diffraction, which atmospheric agitations transform into a luminous blot so ill-defined that, as Mr. Michelson himself confesses, it is impossible to study the effect of the parallax due to the defect of coincidence of the plane of the image with that of the lines of the micrometer; in other words, there is no defined focus.

In all my experiments, therefore, it has been my aim to maintain the perfect accuracy of optical effects, such as had been achieved by Foucault, believing that it is of greater advantage to measure even the small deviations of a perfect image than the exaggerated displacement of a blot of light. I have consequently sought to amplify the deviations of Foucault without increasing the distance to be traversed by the light, and without having recourse to great velocities of rotation on the part of the mirror.

I call to mind, by the way, that Bessel noted, as a means of increasing the deviation, the return of the deviated ray on the rotating mirror. This method, which has never yet been applied, might be utilised by means of a series of little plain mirrors placed in couples on one side and the other of the rotating mirror, in such a way as to transmit the pencil alternatively on one and the other of the two parallel faces of the rotating mirror. With each reflection the deviation increases by a quantity equal to its primitive value.[1] But this process would greatly complicate the measurement of the path traversed by the light. The advantage contemplated by it may, besides, be secured by a method much more elegant and simple.

The apparatus I bring under the notice of the Academy consists purely of two mirrors, one fixed, having a diameter of 0·20 m., the other movable, 0·05 m. in diameter, the two placed at a distance of 5 m. from each other. Both are concave and spherical, and have the same radius of curvature, 5 m. The source of light is a narrow aperture cut in the silver, in the centre of the large mirror. The pencil emanating from it and entirely covering the rotating mirror is reflected by the latter, and returns to form on the surface of the fixed mirror a movable image of the aperture and of the same size. In each of its positions this movable image becomes a source of light; the rays return to the movable mirror, which concentrates them anew into a fixed image: this is the image of Foucault, which coincides with the aperture when the rotation is very slow, which is deviated in respect of the rotation when the latter is a little rapid. Suppose the velocity of the rotating mirror to be such that the lineal deviation is equal to the breadth itself of the aperture, the image will then come to be formed on the fixed mirror, rim to rim with the aperture itself. There it falls on the reflecting surface of the silver, becomes then a source of light exactly similar to the first, producing a second image deviated by the same quantity. The latter in its turn acts like the first, in such a manner that, if one could look on the surface of the fixed mirror, one would there be able to see, issuing from the aperture itself, an indefinite series of identical images placed rim to rim and indistinguishable from each other, except in respect of their regularly increasing brightness. If the velocity of rotation is increased, all these images will be found to separate from each other and form on the fixed mirror a series of equal luminous lines, separated by equal intervals from each other, and

[1] Paper, by M. C. Wolf, in the *Comptes Rendus* for February 9.

[1] These plain mirrors, disposed in couples, might also be used to collect and transmit in one constant direction the light scattered in all directions by the rotating mirror. By this means the advantage would be obtained of observing the doubled deviation of a much more brilliant image.

which will continue increasing their distance from each other, proportionately with the increase of the velocity. If one succeeds in determining micrometrically the distance of one of these lines from the original aperture, he will measure no longer the single deviation of Foucault, but as high a multiple of that deviation as may be desired. The distance of my two mirrors from each other being 5 m., and the velocity of the rotation of the mirror only 200 revolutions per second, the deviation will be five-eighths of that obtained by Foucault—*i.e.* five-eighths of 0·7 mm., or nearly 0·44 mm. The tenth image will consequently be at 4·4 mm. from the aperture.

To assure myself, above everything, of the existence of these multiple images, I employed Foucault's mode of observation, and placed before the luminous aperture, at a little distance from the fixed mirror, a plate of glass with parallel faces, inclined at an angle of 45° to the direction of the axis of the mirror. By this means there is thrown back laterally a portion sufficiently faint, it is true, but still a portion, of each of the deviated pencils which one receives in a microscope. There will then be seen, so soon as the velocity of rotation is great enough to give a continuous image, appearing on the rim of the image of the aperture a second, less distinct image, next a third at the rim of the second, increasing in breadth in proportion as the first is more and more deviated, and ending by separating from one another. With the electric light generated by a small gas-machine of half-horse power, or with the wan sun of these late days, I have managed to see as many as three images and catch a glimpse of the fourth. The actual result very well corresponded with my anticipations. What remains to be done is to improve the method of observation and increase the quantity of light.[1]

Suppose the tenth image is sufficiently intense to be observed, I cut away the silver of the mirror from a little rectangle with rims parallel to those of the aperture. The tenth image will come to be formed in this rectangle, all the following images will be suppressed, and the deviated pencil traversing the glass of the mirror, the posterior face of which is plain and polished, will be received behind on a prism of total reflection, which will transmit it into the micrometric microscope. The distance of the rim of the image from the rim of the rectangle will be measured; then, by an independent operation, the distance of this rim from that of the aperture; the sum of the two will give the line of magnitude of the deviation. It remains to ascertain the order m of this deviation. For this purpose the rotation of the mirror will be accelerated till the image of the order $m - 1$ comes to be substituted for that which was observed. Let n and n' represent the numbers of revolutions of the mirror per second, δ and δ' the lineal values of the simple corresponding deviations, then

$$\delta = kn, \quad \delta' = kn' \quad \text{and } m\delta = (m-1)\delta',$$

thence

$$mn = (m-1)n'.$$

whence

$$m = \frac{n'}{n'-n}.$$

The number of revolutions is measured electrically by the methods M. Cornu has so carefully discussed in his work on the velocity of light; I need not dwell on it. Finally, the measurement of the passage of the light is easily got at; it is that of the distance from each other of the centres of the surfaces of the two mirrors.

In order to observe a deviation of a rather high order, all that is needed is a sufficiency of light. Now, in this case, I manage to augment considerably the proportions of utilised light. In the first place the rotating mirror may be made to reflect on its two faces, care being only taken that both have exactly the same radius of curvature. In the second place, having suppressed every object-glass, I am able to utilise the pencil reflected by the rotating mirror throughout the whole space in which it gives a good image of the aperture, and this space is considerable, because the astigmatism resulting from the obliquity does not sensibly affect the rectilineal form of this image. It is, next, possible to tack on to the mirror of 0·20 m., of which I have spoken, a series of other identical mirrors placed at the same distance in the plane of rotation of the pencil. The condition of identity of the radius of curvature is, besides, much less rigorous for these mirrors than in the case of the two faces of the rotating mirror. It is, however, always indispensable that the movable image given by this latter is reflected exactly on to the surface of each of the fixed mirrors.

I have also to remark that it is necessary that the lineal distance of the image observed from the aperture is large enough to allow the observation to be made. For in the thickness of the glass of the mirror and on its two surfaces there will inevitably arise a diffusion, as also reflections of the incident light, to embarrass and even frustrate the exact vision of the deviated image when it is too near the aperture. I have just shown that the actual apparatus ought, under good conditions, to show an image of the sixteenth order, perhaps even one as high as the twentieth—that is to say, at 8·8 m. from the aperture. It would be useful, however, to have recourse to an apparatus of more considerable proportions.

If 20 m. is taken for the radius of curvature of the mirrors and for the length of the simple passage of the light, the movable mirror ought to have a diameter of 0·20 m. Let there be impressed on it a velocity of rotation of only fifty revolutions per second, the deviation calculated according to the experiment of Foucault will be:—

$$0{\cdot}7 \text{ mm.} \times \frac{40}{40} \times \frac{20}{1} \times \frac{50}{400} = 1{\cdot}75 \text{ mm.}$$

The displacement of the twentieth image will then be 35 mm., which, measured to the hundredth of a millimetre, will give an approximation of $\frac{1}{3500}$. Now I do not think it impossible to turn a mirror of 0·20 m. as many as fifty revolutions per second without causing deformation of its surfaces. The turbines and the movable pieces of the dynamo-electric machines of the present day frequently attain a similar velocity.

It is my duty to make known to the Academy that the funds necessary for my first and long experiments were generously supplied to me by M. de Romilly, to whom I am happy to make this public testimony of my gratitude.

[1] The quantity of light utilised by this mode of observation on a glass is hardly the tenth of the actual quantity. The ratio of the geometrically decreasing progression representing the intensities of the successive images being 0·656, allowing 0·90 for the reflecting power of the silver, the brightness of the third image seen by reflection from a plate of glass is inferior to that of the eighth image seen directly. The reflecting power of new silver being 0·96, it would be possible by its means to attain to the sixteenth image.

ACCIDENTAL EXPLOSIONS PRODUCED BY NON-EXPLOSIVE LIQUIDS[1]

III.

THE only real danger which may attend the use of the little sponge lamps arises from accidental spilling of spirit used for filling them in the neighbourhood of a flame, or from carrying out the operation of filling in the vicinity of a light. Indeed, such casualties as have been attendant upon the use of petroleum-spirit as an illuminant have been mainly connected with the keeping and handling of the supplies of this very volatile liquid, and are largely attributable to want of caution or to forgetfulness. The salutary regulation prescribed by law, that vessels containing the spirit shall bear a conspicuous label indicating its dangerous character, has undoubtedly operated very beneficially in diminishing the frequency of accidents with it, by constantly admonishing to caution. It is a matter for much surprise and regret that the manufacturers of a class of miners' safety lamps, consisting of modifications of well-known types, with the ordinary oil lamp replaced by the sponge lamp, in which petroleum-spirit is burned, should have allowed trade interests to induce them to mislead those who use these lamps with regard to the nature of the illuminant supplied with them, by devising a name for it which gives a false indication of its nature, being designed to create the belief that it is an article of special manufacture, allied in character to a comparatively very safe oil largely used in miners' lamps, while in reality it is a well-known article of commerce, the safe storage and use of which demand special precautions and vigilance.

The lecturer took occasion to point out here, ten years ago, that a large proportion of the accidents arising out of the employment of petroleum- or paraffin-lamps were not actually due to the occurrence of explosions. Thus the incautious carrying of a lamp, whereby the liquid is brought into contact with the warm portion of the lamp close to the burner, may give rise to a liberation of vapour which, in escaping from the lamp, may be

[1] Address delivered at the Royal Institution of Great Britain, Friday, March 13, 1885, by Sir Frederick Abel, C.B., D.C.L., F.R.S., M.R.I. Continued from p. 496.

ignited, causing an outburst of flame which may alarm a nervous person and cause the dropping or overturning of the lamp. The accident which occurred in some apartments in Hampton Court Palace, in December, 1882, and gave rise to a somewhat alarming fire, appeared almost beyond doubt to have originated from the employment by a domestic servant of a contrivance in which petroleum spirit was used for heating water; but, as petroleum-lamps were used in the particular residence where the fire actually occurred, public correspondence ensued regarding the dangers attending the use of such lamps, although all which were known to have been on the premises were forthcoming after the fire and found to be intact. There was, at any rate, no evidence whatever adduced in support of an assumption that the casualty was due to the explosion of a lamp, and other instances might be quoted in which the breaking out of a fire, or the destruction of or injury to life, which had evidently been caused by upsetting or allowing to fall a petroleum lamp, has been erroneously ascribed to an explosion.

There are, however, numerous casualties which have been unquestionably caused by the occurrence of explosions in lamps, and which have in many cases been followed by the ignition of the oil, and the consequent loss of life or serious injury to those in the immediate vicinity of the accident. Careful inquiries have of late been instituted into casualties of this kind, and in many instances the explosions have been distinctly traceable to some immediate cause. In the great majority of cases they occur some considerable time after the lamp was first kindled, and when the supply of oil remaining in the reservoir has been but small. Occasional examples of the reverse are, however, met with. Thus, last spring, a man and his young son were sitting at a table reading, his wife being also close at hand, when a paraffin lamp, which had just been lighted, exploded, and the room was at once set on fire by the burning oil which escaped. The husband and wife fled from the room, both being slightly injured, but the child was unable to escape from the flame, and was burned to death. The oil used in the lamp was of a well-known brand, having a flashing point ranging from 73° to 86° F., and assuming that the recently lighted lamp had been filled with oil, and was untouched at the time of the explosion, no satisfactory explanation can be given of the accident, unless, perhaps, the reservoir had been so completely filled with oil, that the expansion of the liquid, on its becoming slightly warm, exerted sufficient force to determine the fracture of the glass at some part where a flaw or crack existed.

A lamp accident which occurred last July at Barnsbury, causing the death of a woman and her husband, appears, on the other hand, distinctly traceable to the production of an explosion in the reservoir of the lamp. The latter was stated to have been alight but a short time, when, the husband being already in bed, the wife, in her night-dress, attempted to blow out the flame of the lamp; the man heard a report, and, looking towards the lamp, saw his wife in flames. He proceeded at once to her rescue, and was severely burned in extinguishing the flames in which she was enveloped. The woman died in a few hours, and the man succumbed three days later to the injuries received. There being no witness to the accident, there is no evidence against the supposition that, on the occurrence of a slight explosion in the reservoir in the lamp, the woman, having hold of it when attempting to blow it out, may have upset it, or tilted it so as to cause the oil to flow out and become inflamed. The lamp may have become fractured by the explosion; but whenever such a result has been produced, the lamp had always been burning some time, so that there was considerable air-space which could be filled by an explosive atmosphere, whereas, in this case, the evidence appears positive as to the lamp having been full of oil when lighted.

In another fatal case of a lamp explosion in the same month, at Mile End, the accident was also caused by the attempt on the part of a woman to blow out the lamp before going to bed. In this case the lamp had been burning for three hours; the husband of the sufferer was in bed asleep in the room at the time, and, the woman being unable to give any account of the occurrence, the only information elucidating it was furnished by the daughter, to the effect that the lamp had been burning for three hours, and that it was the habit of her mother to extinguish the lamp by first lowering the wick and then blowing down the chimney.

Another fatal accident, caused by the explosion of a lamp, took place at Camberwell last January, and was brought about, as in the two preceding cases, by attempts to extinguish the lamp by blowing down the chimney. The husband and two sons of the sufferer were witnesses of this accident; the lamp had been burning for six or seven hours, when the woman took it in her hand, and having partially turned it down, proceeded to blow down the chimney; an explosion at once occurred, the glass reservoir was broken, and the inflamed oil flowed upon her dress, burning her most severely.

A lamp explosion which occurred last December in a van used as a bedroom by an itinerant showman, at the so-called World's Fair held at the Agricultural Hall, Islington, and which caused the death of an infant, was of a somewhat different character to the foregoing. The lamp, which was of the duplex-form and was attached to a bracket, had been alight for some hours, when a woman went, from a neighbouring van used as the dwelling room, to extinguish it. She observed that while the lamp, or wick, was only burning faintly, the oil in the reservoir was alight. She placed her apron over the top of the chimney to extinguish the lamp, when it at once appeared to explode, and the burning oil set the interior of the van on fire. The woman ran out for help, and a lad, protecting his head with his coat, rushed in and brought out the infant which was lying upon the bed, and which died from injuries received. The oil used in the lamp was believed to be of high flashing point, being obtained by the retailer who supplied it, from a firm dealing in a Scotch shale oil manufactured by the Walkinshaw Company (known as the "electric light" brand). A sample of the oil, as supplied by the wholesale dealers, had a flashing point of 114° F., but a portion of the oil actually purchased by the owner of the lamp had a flashing-point of only 63° F., and evidently consisted of a mixture of the heavy oil and of benzoline. The oil in question would naturally become exhausted of the volatile spirit after the lamp had burned for some time, and the flame would then have burned low in consequence of the heavy character of the residual oil; the lamp and its contents would have thus become highly heated, and some accidental disturbance of the surrounding air must have caused vapour generated from the heated oil and contained in the air-space of the reservoir, to become inflamed, the oil itself being thereby ignited. By placing her apron hastily upon the top of the chimney, the woman forced air into the reservoir, and thus either caused a slight explosion to take place or determined the breaking of the glass by the sudden change of temperature. A lamp explosion, apparently due to the same cause, occurred quite recently in the cabin of a small steam-launch on the Medway, near Chatham.

Several cases of undoubted lamp explosions, fortunately unattended by serious consequences, have come to the lecturer's knowledge as having occurred in the billiard-rooms of barracks where petroleum or paraffin oil was employed as an illuminant. These lamps are fixed over the billiard-tables, and generally speaking the rooms have top- or sky-lights. In every instance the lamp had been burning for several hours, and had probably become more or less heated, especially as shades of sheet tin were placed over them as reflectors. In each case a portion of the glass reservoir was blown out by the explosion, and the oil, becoming ignited, burnt portions of the table on which it fell.

A careful investigation of accidents of which the foregoing are illustrations,[1] together with a critical examination of the construction of various lamps, and the results of many experiments have, up to the present time, led the lecturer and Mr. Redwood to arrive at several definite conclusions with respect to the immediate causes of lamp-explosions and to certain circumstances which may tend to favour the production of such explosions.

If the lamp of which the reservoir is only partly full of oil be carried, or rapidly moved from one place to another, so as to agitate the liquid, a mixture of vapour and air may make its escape from the lamp in close vicinity to the flame, and, by becoming ignited, determine the explosion of the mixture existing in the reservoir. This escape may occur through the burner itself, if the wick does not fit the holder properly, or through openings which exist in some lamps in the metal work, close to the burner, of sufficient size to allow flame to pass them readily. A sudden cooling of the lamp, by its exposure to a draught or by its being blown upon, may give rise to an inrush of air, thereby increasing the explosive properties of the mixture of vapour with a little air contained in the reservoir, and the flame of the lamp may at the same time be drawn or forced into the

[1] Mr. Alfred Spencer, of the Metropolitan Board of Works, has obligingly furnished me with the official details of several of the accidents above referred to.—F. A. A.

air-space filled with that mixture, especially if the flame has been turned down, as the latter is thereby brought nearer to the reservoir. The sudden cooling of the glass, if it had become heated by the burning of the lamp, may also cause it to crack if it is not well annealed, and this cracking, or fracture, which may allow the oil to escape, may convey the idea that an explosion has taken place. If the evidently common practice is resorted to of blowing down the chimney with a view to extinguish the lamp, the effects above indicated as producible by a sudden cooling may be combined with the sudden forcing of the flame into the air-space, and an explosion is thus pretty certain to ensue, especially if that air-space is considerable. If the flashing-point of the oil used be below the minimum (73° Abel) fixed by law, and even if it be about that point or a little above it, vapour will be given off comparatively freely if the oil in the lamp be agitated, by carrying the latter or moving it carelessly; the escape of a mixture of vapour with a little air from the lamp, and its ignition, will take place more readily, but on the other hand it will probably be feebly explosive, because the air will have been expelled in great measure by the generation of petroleum vapour. If the flashing-point of the oil be high, the vapour will be less readily or copiously produced, under the conditions above indicated, but, as a natural consequence, the mixture of vapour and air existing in the lamp may be more violently explosive, because the proportion of the former to the latter is likely to be lower and nearer that demanded for the production of a powerfully explosive mixture. If the quantity of oil in the lamp reservoir be but small, and the air-space consequently large, the ignition of an explosive mixture produced within the lamp will obviously exert more violent effects than if there be only space for a small quantity of vapour and air, because of the lamp being comparatively full. If the wick be lowered very much, or if for some other reason the flame becomes very low, so that it is burning beneath the metal work which surrounds and projects over the wick-holder, the lamp will become much heated at those parts, and the tendency to the production of an explosive mixture within the space of the lamp will be increased, while, at the same time, heat will be transmitted to the glass, and it will be correspondingly more susceptible to the effects described as being exerted by its sudden exposure to a draught. Experiments have demonstrated that a lamp containing an oil of high flashing point is more liable to become heated than a comparatively light and volatile oil, in consequence of the much higher temperature developed by the combustion, and of the comparative slowness with which the heavy oil is conveyed by the wick to the flame. It therefore follows that safety in the use of mineral oil lamps is not to be secured simply by the employment of oils of very high flashing point (or low volatility), and that the use of very heavy oils may even give rise to dangers which are small, if not entirely absent, with oils of comparatively low flashing points. The occurrence of such an accident as that in the training-ship *Goliath*, already referred to, which was brought about by a boy letting fall a lamp which had been alight all night, and which was so hot that he could no longer hold it, appears to be primarily ascribable to the use of an oil of very high flashing point; and the accident at the Agricultural Hall furnished another illustration of the kind of danger attending the use of such an oil.

The character of the wick very materially affects not only the burning quality of the lamp, but also its safety. A loosely plaited wick of long staple cotton draws up the oil to the flame regularly and freely, and so long as the oil be not very heavy or of very high flashing point, and therefore difficultly volatisable or convertible into vapour (by so-called destructive distillation), the flame will continue to burn brightly and uniformly, with but little charring effect upon the wick—that is to say, the extremity of the latter will only be darkened and eventually charred to a distance of much less than a quarter of an inch downwards, and it will not be until the partial exhaustion of the oil-supply diminishes the size of the flame and induces the user to raise the wick, that the latter will become more considerably charred. But, if the wick be very tightly plaited, and made, as is not unfrequently the case, of a short staple cotton of inferior capillary power, the oil will be less copiously drawn up to the flame; as a consequence, the length of exposed wick will be increased by the user of the lamp, and as the evaporation of the oil will take place more slowly from each portion of the wick which furnishes the flame, the heat to which the cotton is exposed will be greater, and the charring, which is fatal to the proper feeding of the flame by destroying the porosity of the end of the wick, will take place more rapidly and to a much greater extent.

Even with wicks of the higher qualities, considerable differences exist in the rapidity with which the oil is raised to the flame. In Mr. Redwood's experiments, conducted with a specimen of English wick of good quality and with a very superior American wick, of corresponding dimensions, the quantity of oil siphoned over by the latter in a given time, was from 35 to 47 per cent. greater (according to the nature of oil experimented with) than that carried over by the English wick.

If the wick be at all damp when taken into use, its power of conveying the oil to the flame will be decidedly diminished, the capillaries of the fibre being more or less filled with moisture, and similarly, if the oil accidentally contain any water, the latter, passing into the wick, will interfere with the proper feeding of the flame. As the oil is very thoroughly filtered or strained during its transmission through the body of the wick to the flame, it is obvious that any impurities suspended in the liquid will be deposited within the wick and will gradually diminish its porosity. For this reason the same wick should not be used for a great length of time, and it is decidedly objectionable to use a much greater length of wick than is necessary to reach to the bottom of the reservoir, and to continue its use until it has become too greatly shortened by successive trimmings. On the other hand, the wick should always be of sufficient length to be immersed to a considerable distance in the oil. It is evident that the copious supply of oil to the flame will become reduced as the column of liquid which covers the wick in the reservoir becomes reduced in height; hence the supply of oil in the lamp should never be allowed to get very low, not only because it is undesirable to have a large air-space which may be filled with vapour and air, but also because the burning of the lamp is injuriously affected thereby.

Some lamps of patterns first constructed in the United States are provided with what may be called a feeding wick, in addition to the wick or wicks which furnish the flame. This wick is generally simply suspended from the lower surface of the burner, and reaches nearly to the bottom of the reservoir, being so placed that it hangs against one flat side of the regular wick, and thus aids considerably the copious and uniform absorption of oil by the latter. In certain lamps of recent construction the reservoir which contains the main supply of oil is so arranged (upon the principle of the old study- or Queen's oil-lamp) that it regularly maintains at a uniform level the supply of oil, which surrounds the wick in a small central reservoir or cylinder, separated from the main reservoir (excepting as regards a small channel of communication) by an air-space, which presents the additional advantage of preventing the transmission of heat to the oil vessel. This kind of lamp is constructed entirely of metal; this is the case now with a very large proportion of the lamps in use, and unquestionably adds greatly to the safety of lamps, which, if constructed of glass or porcelain, are always liable to accidental fracture, quite apart from the question of possible explosion.

It has been proved experimentally that if the reservoir of a burning lamp be warmed, so as to favour the emission of vapour into the space above the oil, and a small opening in the top of the reservoir be then uncovered, air will be drawn into the latter and form an explosive mixture with the vapour, which, escaping from the lamp close to the wick-holder, will be fired, and produce an explosion in the lamp. It is an interesting illustration of the very imperfect appreciation, by some lamp-designers, of the conditions which, in the construction of a lamp, secure safety or determine danger, that the reservoirs of some petroleum-lamps are actually furnished with an opening in the upper surface, which is closed with a more or less badly-fitting metal cap, and is intended to be used for filling the lamp with oil. Independently of the great element of danger which this fitting presents, in consequence of the obvious temptation to the users to replenish the reservoir while the lamp is actually burning, it is very likely sooner or later to be the means of admitting to the reservoir, in the manner above indicated, the supply of air necessary to determine the explosion of vapour therein existing.

Another source of danger introduced in the construction of lamps which should be sufficiently obvious, and to which reference was made when first discussing the causes of lamp explosions, consists in the provision in many lamps, of openings of considerable size close to the burner, apparently with the object of affording a passage for the air or vapour in the reservoir, which may expand as the lamp becomes somewhat warm. Other devices with the same object in view, consisting of small channels or shafts brought up from the top of the reservoir to the seat of the lamp flame, are adopted in some American lamps. If these openings or channels were protected, in accordance with the well-known principles which govern the construction of miners' safety lamps, so as to preclude the possibility of flame passing them, they would obviously be unobjectionable, and indeed in one or two instances of modern lamps the openings which have been provided for the escape of expanding air or vapour are of such dimensions that flame could not pass. A simple arrangement which would effect the desired object with perfect safety, and would at the same time protect the lamp wicks from deterioration by the grosser impurities sometimes contained in portions of a supply of oil, is to attach to the bottom of the burner a cylinder of wire gauze of the requisite fineness (twenty-eight meshes to the inch) which would contain the wicks, and would allow the passage of air or vapour through it towards the burner, while it would effectually prevent the transmission of fire from the lamp-flame to the air-space of the reservoir.

Some of the more prominent points elicited by the inquiry in progress, as to the causes of explosions in petroleum lamps, and the conditions which regulate their efficiency and safety, having now been noticed, it remains to offer a few simple suggestions, attention to which cannot but serve to reduce the risks of accident which attend the use of petroleum and paraffin oil :—

1. It is desirable that the reservoir of the lamp should be of metal. It should have no opening or feeding place in the reservoir, nor should there be any opening or channel of communication to the reservoir at or near the burner, unless protected by fine wire gauze, or packed with wire, or unless it is of a diameter not exceeding 0·04 inch.

2. The wick used should be of soft texture and loosely plaited ; it should fill the entire space of the wick-holder, and should not be so broad as to be compressed within the latter ; it should always be thoroughly dried before the fire, when required for use. The fresh wick or wicks should be but little longer than sufficient to reach to the bottom of the reservoir, and should never be immersed to a less depth than about one-third the total depth of the reservoir.

3. The reservoir or lamp should always be almost filled before use.

4. If it be desired to lower the flame of the lamp for a time, this should be carefully done, so as not to lower it beneath the metal work deeper than is absolutely necessary ; but it should be borne in mind that even then the combustion of the oil will be imperfect, and that vapour of unconsumed petroleum will escape, and render the lamp very unpleasant in a room.

5. When the lamp is to be extinguished, and is not provided with an extinguishing arrangement (of which many excellent forms are now applied to lamps) the flame should be lowered until there is only a flicker ; the mouth should then be brought to a level with the top of the chimney, and a sharp puff of breath should be projected *across* the opening. The lamp should remain on a firm support when it is being extinguished.

The lecturer hopes that, pending the more thorough treatment of this subject by Mr. Redwood and himself when these investigations are completed, the points dealt with in this discourse which relate to accidents with petroleum lamps may, on the one hand, tend to dispel groundless alarm as to the dangerous nature of petroleum and paraffin oil as illuminants, and may, on the other hand, serve to convey some useful information respecting the causes which lead to accidents with lamps and the readiness with which they may be avoided.

DR. KLEIN ON CHOLERA

AT a recent meeting of the Abernethian Society of St. Bartholomew's Hospital, Dr. Klein briefly reviewed the accepted theories as to the ætiology of cholera, and stated the views concerning it which he had been led to adopt since his visit to India. His address is of importance as embodying the conclusions of the Indian Commission of Inquiry into this disease. Two main theories are held with regard to the cholera —the one, which is supported by a large section of the Indian medical staff, being that cholera is non-infectious and non-communicable ; the other, which is upheld by European authorities, being that it is both infectious and communicable. In support of the former theory may be quoted the numerous cases of sporadic cholera which occur, and the fact that when troops are attacked in a military cantonment and are at once marched out into camp, no new cases occur other than those which are already incubating. Lastly, in many places in India, in spite of all conditions favourable to a spread of cholera by the evacuations, it is rare for any but sporadic cases to occur. In support of its communicability and infectiousness it is unquestionable that when an outbreak of cholera has occurred, it has in most instances been introduced from a district where cholera was rife, as instanced by the late outbreak at Marseilles, which was shown to have been introduced from Egypt. Some have maintained that it may be conveyed by winds ; against this may be adduced the fact that epidemics have occurred in Malta without any occurring at the same time in Gozo. Now, Gozo is nearer to Egypt than Malta, and yet no epidemic at Malta has ever been preceded by an epidemic at Gozo. The upholders of the theory of infectiveness are divided into two schools—the contagionists, who consider that the disease is directly communicable from the sick to the healthy, and that the virus is contained in the discharges from the alimentary canal ; and the localists, who believe that the evacuations contain a germ which is capable of elaborating the virus under suitable conditions of climate and soil. Against the contagionists' view must be considered especially these facts—that it is very rare for attendants to be attacked early, and that they only succumb at a late period of the epidemic ; and that cholera patients are treated in the general wards of a large hospital in Calcutta, and yet no cases of contagion have occurred. Dr. Koch, in studying this disease, found that the lower parts of the small intestine of patients who died from cholera swarmed with peculiar bacilli (comma bacilli), which passed out with the evacuations, and which he considered were capable of manufacturing the cholera virus when introduced into the small intestine of an unhealthy patient. He also believes that this bacillus is destroyed by the acid secretion of the stomach of a healthy person, and, further, that this bacillus is destroyed by drying ; and hence that this disease could not be propagated by soiled linen after this had been dried. The German Commission believes these bacilli to be the cause of the disease. Dr. Klein, by a series of experiments, has proved that these comma bacilli are not destroyed by an acid solution of the same strength as that of the gastric juice ; but that, on the contrary, they thrive after having been immersed in such a solution. Further, that though these bacilli, in common with all germs (except spores of bacilli), are destroyed by thorough and scientific drying, still soiled linen never becomes thoroughly dry. Klein thinks that even the location of these bacilli in the lower part of the small intestine should of itself suggest suspicion, inasmuch as bacilli and micrococci in great numbers are contained in it even in health, and the more because this locality is not the exclusive seat of the disease. More conclusive evidence, however, was collected by him in India. For instance, three of the houses situate in a certain street in Calcutta contained in all eight cases of cholera. Leading out of the street was a narrow lane to a large water-tank, around which was built a squalid rookery. The water of this tank was used in the rookery for all purposes, and contained the comma-bacilli. Now, the houses in the street were not supplied with water from the tank, and yet eight cases of cholera occurred in the square, while none were found in the rookery, which was inhabited by about 200 families. The English Cholera Commission has also found a bacillus apparently similar with the cholera-bacillus in the intestines of children and adults suffering from diarrhœa. Dr. Lewis, of Netley, has found the same in the saliva of healthy persons. With regard to the evacuations containing the virus, Dr. Klein found that in India many of the public-built wells were contaminated by sewage, and that the water, though nominally not used for drinking purposes, for expediency was generally so used, and especially at night time. Again, at Benares a large sewer opens into the Ganges at a spot where the pilgrims and natives perform their religious ablutions, these including especially the washing out of the mouth with the river water. In spite of this only sporadic cases of cholera occur. Dr. Klein has been led to the conclusion with regard to the cholera—that Koch's bacillus cannot be the cholera germ.

SCIENTIFIC SERIALS

American Journal of Science, March.—Prof. Marsh's monograph on the Dinocerata, by L. P. B. This valuable contribution to American palæontology forms a sequel to the author's work on the Odontornithes, or birds with teeth, and contains a full account of the peculiar order of mammals discovered by him during the last fifteen years in the early tertiary formations of the great central plateau in Wyoming. The old lacustrine basin of this region, where alone the remains of Dinocerata have hitherto been found, have already yielded parts of over 200 individuals, which are now grouped in three genera: Dinoceras, Marsh; Tinoceras, Marsh; and Uintatherium, Leidy. The last-named appears to be the most primitive type, and Tinoceras the most specialised, Dinoceras being intermediate. Of species the number cannot yet be determined, but thirty more or less distinct forms have already been recognised. In stature and movements it appears to have resembled the elephant as much as any other known type, differing from it especially in the shape of the skull, remarkably small brain, longer neck, and more bent fore limbs. It was by far the largest of all known Eocene animals. The paper is enriched with numerous illustrations, and with a map showing the region of Dinoceras beds.—On Taconic rocks and stratigraphy, with a geological map of the Taconic region, by James D. Dana. In this paper the author embodies the results of a fresh study, begun in 1882, of the Taconic region extending over parts of Massachusetts, Connecticut, Vermont, and New York. The rocks described comprise the Taconic skirts of the Taconic range, and subordinate ridges within the adjoining limestone area; the limestone formations on the east and west sides of the Taconic range; and the quartzite adjoining or within the limestone area. All these rocks are regarded as belonging to one system of Lower Silurian age, with the Taconic schists as the upper member of the series. The map is to a scale of half an inch to the mile.—Variations of latitude, by Asaph Hall. The author deals with Signor Fergola's recently-proposed plan for investigating variations of latitude by special series of observations made with the best prime vertical transit instruments on selected lists of stars. A chief feature of the plan is that the work is to be mainly differential, two observatories under the same or nearly the same latitude co-operating.—Notes on the Jurassic strata of North America, by Charles A. White. The paper is mainly a reply to the objections raised by Mr. J. F. Whiteaves, of the Canadian Geological Survey against the classification of certain exposed formations frequently occurring throughout Colorado, Wyoming, Dakota, Utah, and Montana, and usually referred to the Jurassic period.—Meteoric iron from Coahuila, Mexico, by M. T. Lupton. An analysis of a fragment of this meteoric mass, weighing about 192 lbs., yielded: iron, 91·86; nickel, 7·42; cobalt, 50; phosphorus, ·27.—Optical projection of acoustic curves, by W. Le Conte Stevens. Optical presentations of a concord and a discord are shown projected on a screen by a simple and ingenious process.—Measurement of strong electrical currents, by John Trowbridge.—Divisibility of the Archæan formations in the North-West, by R. D. Irving. The region here investigated occupies, as indicated by the accompanying sketch-map, a tract some sixty miles in length between Lake Numakagon, in North Wisconsin, and Lake Gogebic, in North Michigan. The Archæan rocks of this district are referred to the Huronian and Laurentian systems.—Mineralogical notes, by W. E. Hidden. Specimens are described of phenacite and Xenotine, from new localities; of Fayalite, from Colorado; of Zircon, from Canada; and of zutile and emeralds, from North Carolina.

Nachrichten von der K. Gesellschaft der Wissenschaften und der Universität zu Göttingen, August to December, 1884.—A contribution to the theory of the absorption of light in crystals, by W. Voigt.—Remarks on the theory of the cycloid and on all forms of cycloidal curves, by A. Enneper.—Researches on the symmetrical relations and elasticity of crystals, by B. Minnegerode.—On the histology of the Asteridæ, by Dr. Otto Hamann.—On some derivatives of urea, by R. Leuckart.—On the preparation of orthodinitrobenzol in large quantities, by Paul Jannasch.—A contribution to the theory of complex dimensions developed from *n* unities, by K. Weierstrass.—Researches on the optical structure and properties of leucite, by C. Klein.—On some noteworthy archæological object in Treves, by Friedrich Wieseler.—Remarks on Gauss's algebraic series, by J. Thomæ.—On the titrimetric analysis of urea, by Dr. Th. Pfeiffer.—On the development of the reproductive organs in *Limax agrestis*, by J. Brock.—On the classification of the genus Loligopsis, Lam. (*Leachia Lesueur*), by J. Brock.—Remarks on the *Acta Mathematica*, edited by Dr. Gösta Mittag-Leffler, by Ernst Schering.—On the electro-magnetic rotation of a fluid, by Eduard Riecke.—On the inflexion of the present participle and comparative in Mœso-Gothic, by Leo Meyer.

SOCIETIES AND ACADEMIES

London

Royal Society, March 19.—"On 'Transfer-resistance' in Electrolytic and Voltaic Cells." By G. Gore, LL.D., F.R.S.

The existence of this phenomenon has been a matter of doubt ever since the year 1831, and the question has been examined by many investigators. In the present paper are described a series of methods by means of which its reality has been determined. Other methods are given for measuring the amounts of such "resistance," either collectively at the two electrodes of an electrolytic cell, or separately at each electrode. Modes of obviating the interference of polarisation, and of securing success in the measurements, are also described.

The influence of various circumstances upon the phenomenon were investigated—viz. strength and density of current; total resistance; density of current and size of electrode; composition of the electrolyte; strength of ditto; combined electrolytic cells; temperature; and chemical corrosion. The relations of the phenomenon to size of plate in voltaic cells, to the positive and negative plates respectively, and to strength of current in those cells, were also examined, and the results are given.

The following are the chief facts established by this research:—That a species of electric "resistance," distinct from that of polarisation and of ordinary conduction-resistance, varying greatly in amount in different cases, exists at the surfaces of mutual contact of metals and liquids in electrolytic and voltaic cells. That this "resistance" varies largely in amount with different metals in the same solution, and with the same metals in different solutions; in dilute solutions of mineral acids of different strengths, or of different temperatures, and is usually small with easily corrodible metals which form quickly soluble salts, and large with those which are not corroded; and is disguised in the case of those which by corrosion form insoluble salts.

The results of the experiments also show that the same voltaic current was "resisted" in different degrees by every different metal when employed as an anode, and when used as a cathode; also by the same metal when used as an anode and cathode respectively; and that the proportions of such "resistance" at an anode and cathode of the same metal varied with every different metal in every different electrolyte (and strength of electrolyte), and at every different temperature; and that the resistance at the anode was usually smaller than that at the cathode; in some cases, however, where a film was formed upon the anode, an apparently reverse effect occurred; that a current from a given positive plate of a voltaic cell was differently resisted by every different metal used as a negative plate in that cell; and that by rise of temperature "transfer-resistance" was usually and considerably reduced.

They further show that this species of "resistance" was largely reduced by increasing the strength of current; and was thus conspicuously distinguished from ordinary conduction-resistance of the electrolyte. In consequence of this effect, "transfer-resistance" was greatly influenced by every circumstance which altered the ordinary resistance, and thereby the strength of current. The usual effect of diminishing the density of current alone, by enlarging both the electrodes and keeping the strength constant, was to diminish the "transfer-resistance;" and of enlarging one only, was to diminish it at that electrode and increase it at the other, the effect being greatest at the altered electrode; but the influence of density was very much smaller than that of strength of current. The current was usually less "resisted," and larger with a small positive plate and a large negative one, than with those sizes reversed. Alterations of size or kind of metal at one plate of an electrolytic or voltaic cell affected the "transfer-resistance" at the other, by altering the strength and density of the current.

"Transfer-resistance," therefore, appears to vary, not only with every physical and chemical change in the metals and liquids, but also with every alteration in the current. Such "resistance" throws light upon the relative functions of the positive and negative plates of voltaic cells, and illustrates the comparatively small influence of the negative one in producing strength of current. Nearly all these conclusions are based upon results represented by average numbers obtained by series of experiments.

Linnean Society, March 19.—Sir John Lubbock, Bart., President, in the chair.—Dr. J. Grieve and Mr. Chas. T. Druery were elected Fellows of the Society.—Dr. G. J. Romanes exhibited two human crania from South Africa; one was that of an aboriginal bushman from Kruis River, Cango district, Gudtsboora, obtained through Dr. Stroud.—Mr. J. G. Baker drew attention to a specimen of a supposed hybrid between the two genera *Aloe* and *Gasteria*, and grown in the Glasgow Botanic Gardens. He also showed a curious new fern, *Polypodium* (*Niphobolus*) *polydactylon*, Hance, discovered by Mr. W. Hancock, F.L.S., in the Island of Formosa.—A paper was read on new hydroids from the collection of Miss Gatty, by Prof. Allman. Thirty-eight species distributed among twelve genera are described as new. Among these the plumularian genus, *Podocladium*, is very remarkable, not only by the possession of both fixed and movable nematophore, in accordance with which, like *Heteroplon*, of the *Challenger* collection, it holds a position intermediate between the typical Eleutheroplean and the Stetoplean genera, but by the fact that every hydrocladium is supported on a cylindrical jointed peduncle. Among other remarkable and significant forms is one to which the author gives the name of *Thuiaria heteromorpha*. In this are found combined on the same hydrophyton no less than three morphological types, which, if occurring separately, would be justly regarded as representing three genera, *Thuiaria*, *Dermoscyphus*, and *Sertularia*. Notwithstanding this singular combination of forms, the author does not believe that the characters of the specimen justifies the construction of a new genus; and he regards the generic position of the hydroid as determined by that one of the three forms which most decidedly prevailed in it. *Thuiaria heteromorpha* thus shows in a very marked way the indefiniteness of the boundaries between different zoological groups, and calls to mind a phenomena known to occur among plants, as in certain epiphytical orchids, in which the same stem has been observed to carry flowers referable to several generic types.—Then followed a paper by Capt. William Armit, F.L.S., viz. on plants met with by him on Moresby, Basilisk, O'Neill, and Margaret Islands, South Eastern New Guinea, and in which a list of over 130 species are given.

Physical Society, March 14.—Prof. Guthrie, President, in the chair.—Capt. Abney read a paper upon recent researches on radiation. In general a hot body loses heat in three ways: by conduction, by convection, and by radiation. In the case of the carbon filament of an incandescent lamp the loss of heat by conduction is insignificant, and a series of experiments has been made to determine the amount of radiation—that is, the energy expended as radiant heat for every unit of electrical energy expended in the lamp. Mr. Crookes has investigated the subject of radiation in high vacua, the cooling bodies being thermometer bulbs, and has come to the conclusion that, at pressures between 40 millionths and 1 millionth of an atmosphere, the radiation varies as the mean molecular free path. In the author's experiments incandescent lamps of thin glass were exhausted to different degrees, the radiation being measured by a thermopile. It was found that, from 40 millionths to 10 millionths of an atmosphere the radiation increases uniformly with decrease of pressure, but that beyond this point it becomes nearly constant. A more important question is to determine the amount of radiation for any particular ray under the above conditions. This was effected by placing a small thermopile in the different parts of the spectrum. Plotting the results with watts as abscissæ, and radiation as ordinates, the curves for each kind of ray are found to be very accurately hyperbolas with vertical axes. This result gives a method for rendering identical the quality of the light emitted by two lamps. We have only to find the radiation corresponding to a particular kind of light for one lamp, and then, by examining the curve corresponding to that ray for the other lamp, find for what number of watts the radiation is the same.—Prof. J. A. Fleming read a paper on characteristic curves of incandescent lamps. The author has collected a number of statistics connecting the life, resistance, efficiency, and potential difference of incandescent lamps, and has examined them with a view of showing the mutual relations of these variables by empirical equations. A curve showing the relation of any one of them to any other is called a characteristic curve of the lamp. Among the various results arrived at was the confirmation of the law, announced by Profs. Ayrton and Perry at the last meeting of the Society, that for a certain class of lamps the potential difference, minus a constant, varies as the cube-root of the efficiency, the latter quantity being measured by candles per horse-power. The constant, which, in the lamps examined, is about 28·7, is nearly the potential difference at which the lamp begins to emit light; hence the law may be put into this form: The effective potential difference varies as the cube-root of the efficiency. Using the results obtained, the author then solved the problem of determining the conditions for a minimum cost per candle, and obtained a result closely agreeing with that communicated at the last meeting by Profs. Ayrton and Perry. In answer to Lord Rayleigh, Dr. Fleming stated that he had not calculated the increase of cost due to a variation from the most favourable conditions; it had been shown, however, by Messrs. Ayrton and Perry that the increase of cost due to a variation of potential difference amounting to 3 or 4 per cent. upon either side of the value corresponding to least cost was very small.—Mr. C. Cleminshaw described some further experiments on spectrum analysis. These consisted of methods of obtaining the inversion of the sodium line in the spectrum of the limelight. The first consisted in concentrating the rays from the slit by a lens, just beyond the focus of which is a spoon in which sodium is ignited by a Bunsen flame. In the second method the burner and sodium are introduced between the lime and the slit, and carbonic acid is introduced into the flame. The result in either case is to cause the inversion of the D line. Prof. Guthrie, alluding to the pale blue flame produced by common salt in a coal fire, suggested that there might be more than a mere mechanical action produced by the carbonic acid. Mr. Cleminshaw, however, believed that the action was purely mechanical.—An abstract of a communication by Dr. John Hopkinson on Sir W. Thomson's quadrant electrometer was read by the Secretary. According to Maxwell, the deflection produced by a given difference of potential between the quadrants is given by the formula—

$$d = \lambda(A - B)\left(C - \frac{A + B}{2}\right)$$

where A and B are the potentials of the quadrants, and C that of the needle. Dr. Hopkinson finds, however, that the constant λ should be $\frac{\lambda}{1 + kC^2}$, the quantity k being due to and depending on the unsymmetrical position of the needle with respect to the quadrants.

Zoological Society, March 17.—Prof. W. H. Flower, LL.D., V.P.R.S., President, in the chair.—Mr. Sclater exhibited and made remarks on a duck shot on Lord Bolton's estate in Yorkshire which appeared to be a singular variety of the Scaup (*Fuligula marila*).—Mr. W. B. Tegetmeier, F.Z.S., exhibited and made remarks on a pair of abnormal deer's antlers obtained in India.—Dr. F. H. H. Guillemard read a paper on the ornithology of the Sulu Archipelago, showing that the *ornis* of that group is purely Philippine, and that the line of separation between the latter archipelago and Borneo lies between the islands of Sibutu and Tawi-tawi. Dr. Guillemard added fifty species to the list of birds hitherto known from Sulu, two of which were new to science.—A communication was read from Mr. T. Kirsch, of the Royal Zoological Museum, Dresden, containing descriptions of some new butterflies obtained by the collectors of Mr. Riedel in Timor-Laut.—A communication was read from Prof. W. Nation, C.M.Z.S., containing some notes on the Peruvian cliff-swallow (*Petrochelidon ruficollis*).—A communication was read from the Rev. H. S. Gorham containing a revision of the Phytophagous Coleoptera of the Japanese fauna, of the sub-families *Cassidinæ* and *Hispinæ*.—A communication was read from Lieut.-Col. C. Swinhoe, F.Z.S., being the second of his series of papers on the Lepidoptera of Bombay and the Deccan. The present paper treated of the first portion of the Heterocera.—Dr. Hans Gadow, C.M.Z.S., gave an account of the anatomical differences observed during an examination of examples of the three species of rhea (*Rh. americana*, *macrorhyncha*, and *darwini*).

Chemical Society, March 19.—Dr. W. H. Perkin, F.R.S., President, in the chair.—The following papers were read:—On the presence of choline on hops, by Dr. Griess, F.R.S., and Dr. G. H. Harrow.—Fluorene, Part III., by Dr. W. R. Hodgkinson.—Combustion in dried gases, by H. Brereton Baker, B.A.

Entomological Society, March 4.—The President in the chair.—Four new members were elected.—Mr. T. R. Billups exhibited specimens of *Ceraleptus lividus*, Stein, from Chobham. —Rev. W. W. Fowler exhibited the unique specimen of *Cerylon* *atratulum*, Reitt.; and specimens of an Indian *Cassida* in which the colours were preserved. Dr. Sharp remarked on the colouring matter of the *Cassididæ*. Mr. Fowler likewise exhibited a microscopical movable stage, suited to entomological purposes.—Mr. W. F. Kirby exhibited a variety of *Spilosoma lubricepeda*, Esp., which had been found in the British Museum (Natural History), South Kensington.—Mr. A. G. Butler communicated a few observations touching M. De Nicéville's recent suggestions on seasonal dimorphism in the Lepidoptera, which gave rise to some discussion.—Dr. D. Sharp remarked on the recent discovery of two different forms of spermatozoa in *Helops striatus*, Fonsc.—Papers read:—A monograph of British *Braconidæ*, Part 1, by the Rev. T. A. Marshall.—Descriptions of new species of Languriidæ, by the Rev. W. W. Fowler.—On the discovery of a species of the Neuropterous family, *Nemopteridæ*, in South America, with general considerations regarding the family, by Mr. R. McLachlan.

Mineralogical Society, March 10.—The Rev. Prof. Bonney, D.Sc., F.R.S., President, in the chair.—Messrs. James Currie, Alfred Harker, and M. Alfred Lacroix were elected members.—The Secretary read a paper by M. H. Sjögren (communicated by Dr. Hugo Müller) on the crystalline character of graphite.—Mr. W. Semmons read a paper on a new discovery of connelite.—The balance sheet of the Society for the year 1884, which will be issued with the next part of the *Journal*, showed the Society's financial position to be satisfactory.

Institution of Civil Engineers, March 24.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The paper read was on the electrical regulation of the speed of steam-engines and of other motors for driving dynamos, by Mr. P. W. Willans.

EDINBURGH

Royal Physical Society, March 18.—Mr. B. N. Peach, F.R.S.E., F.G.S., President, in the chair.—The following communications were read:—On certain peat and tarn deposits in the North of England, by Mr. Hugh Miller, F.G.S., Assoc.R.S.M.—Mr. Robert Kidston, F.G.S., described three new species of Fossil Lycopods from the carboniferous formation: *Sigillaria M'Murtrie*, from Redstock; *Sigillaria Coriacea*, from the Newcastle coalfield; and *Lepidodendron Peachii*, f om Falkirk.—On the chemical composition of some samples of Scotch ensilage, by Mr. W. Ivison Macadam, F.C.S., F. Inst. Chem.—Specimens and sections of caseous tumours, found in the muscles of a hake, were described and exhibited by G. Sims Woodhead, M.D., F.R.C.P.E., who had received them from Dr. R. H. Traquair, F.R.S. These caseous masses were composed of broken-down muscular fibre, which appeared to have undergone a peculiar waxy or vitreous degeneration. Surrounding these was an area of young cellular tissue, with a considerable number of blood-vessels, and around this cellular area the muscles were undergoing the same peculiar waxy change. No parasite could be found, and it was suggested that the change might be due to violent muscular action. Dr. Woodhead also showed specimens of the liver of a fowl, in which were numerous caseous nodules. In these bacilli were found in very considerable numbers, giving the same reactions as Tubercle and Lepra bacilli. Mr. Owen Williams, M R.C.V.S., in the discussion which ensued, mentioned that tuberculosis was often found in highly-bred fowls, and in rabbits.

PARIS

Academy of Sciences, March 23.—M. Bouley, President, in the chair.—Remarks on the map of France issued by the Dépôt de la Guerre to the scale of 1 : 200,000, with specimen sheets of a new map of France to the scale of 1 : 50,000 by Col. F. Perrier. Of the War Office map, the six first sheets, embracing the districts of Metz, Nancy, Vesoul, Troyes, Dijon, and Châlons-sur-Marne, are finished. The whole, comprising eighty sheets, 0·64m. by 0·40m., is to be completed within the year 1889, and will form a superb specimen of modern cartography.—Experimental researches on the electric excitability of the brain, properly so-called, by M. Vulpian. The author's experiments on the dog, cat, monkey, and other animals, lead him to infer that the arguments hitherto used to prove the excitability of the grey cortical substance at certain determined points are groundless, and fail altogether to support the hypothesis of local cerebral functions.—Remarks in reply to some criticisms of M. Friedel on the existence of the hydrate of chloral in the state of vapour, by M. L. Troost.—A comparative study of vessels from the standpoint of the propelling force, by M. A. Ledieu.—A simple demonstration of Lambert's theorem on the mutual action of the sun, the earth, and of a celestial body observed from the latter, by M. E. Vicaire.—On the integers of total differentials, by M. E. Picard.—Description of an electric pile acting with a single bichromate fluid, and presenting special conditions of constance, by M. Mascart.—Chemical and physiological effect of light on chlorophyll, by M. C. Timiriazeff.—Relations between the ultra-violet spectrum of the vapour of water and the telluric bands A, B, *a* of the solar spectrum, by M. H. Deslandres.—On the preparation of ammoniac gas, by M. Isambert.—On a monochlorurетted and monobromuretted isomerous camphor, by M. P. Cazeneuve.—On the di-ethylamido-α-butyric acid, by M. E. Duvillier.—On the existence of three ganglia in the auditory nerve of man, forming a zone of cellules analogous to one of those found in the retina, by M. E. Verrier.—On a new type of Cordaiteæ largely represented in fossil vegetation, by MM. B. Renault and R. Zeiller.—A contribution to the study of the Eocene ferns in the West of France, by M. L. Crié.—On the upheaval of the Côte-d'Or range, by M. J. Martin. Contrary to the generally-received opinion, which assigns this range to a period intermediate between the Jurassic and Cretaceous, the author argues that it is in reality posterior to the latter.—Supplementary remarks on the gigantic turtles of Madagascar, by M. L. Vaillant. From the remains found by M. Grandidier at Etsere and Ambulitsate the author determines two distinct species, which he names *Testudo Grandidieri* and *Testudo abrupta*.—On the production of a new crystallised phosphate of magnesium and the corresponding arsenate, by M. A. de Schulten.—Description of the cylindrograph, a new photographic apparatus which, by a simple rotation of the objective, enables the surveyor to obtain views of the landscape embracing an angle of about 170°, by M. Moessard.

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