THURSDAY, DECEMBER 4, 1884

THE CHOLERA BACILLUS

IN view of the investigations which are going on at the present time, it will be of interest to our readers to summarise the reasons which Koch gives for his conclusion that the comma-bacilli described by him are the cause of cholera. No doubt can remain in the minds of those who have read his paper on the subject, published in the *Berl. Klin. Wochenschrift*, No. xxxi., 1884, and the discussion thereon, that he has devoted an immense amount of time and labour to the question, and that he has dealt with the subject in a most open-minded and conscientious manner. His known character for accurate observation and care in drawing conclusions lend great weight to his statements. We will give a short sketch of his arguments under a series of headings.

(1) The comma-bacillus is a specific micro-organism having marked characteristics distinguishing it from all other known organisms.

Their length is from half to two-thirds of that of tubercle bacilli, but thicker and slightly curved: this curve is generally not more than that of a comma, but sometimes it may be greater, forming even half a circle. Sometimes several bacilli can stick together end to end, giving rise to the appearance of a spirillum. Koch thinks that this organism stands midway between a bacillus and a spirillum. They grow rapidly in meat infusion. They possess the power of active motion. They also grow well in other fluids, in milk more especially. They increase rapidly in blood serum. A very good medium is Koch's gelatinised infusion (peptone, gelatine, meat infusion, made neutral by carbonate of soda), and its cultivation in this material "renders its detection easy and very certain." Shaken up with the liquefied gelatine, poured out on a sterilised glass plate, and kept at a temperature at which the gelatine becomes solid, its colonies are very characteristic: when young, they appear as small, very pale drops, not quite round, but more or less irregular and jagged in contour; they also have a granular appearance, and when larger look like a heap of strongly-refracting pieces of glass; the gelatine becomes fluid in the immediate neighbourhood of the colony, the latter sinks into the gelatine, and thus a small funnel-shaped depression is formed, in the middle of which the colony is seen as a small white point. The liquefaction of the gelatine does not extend more than about one centimetre around the colony. If a tube of solid gelatine is inoculated by dipping a needle in the cultivation, and pushing it into the gelatine, the latter becomes fluid first at the point of entrance of the needle; the colony sinks more and more; a funnel-shaped depression is formed with an appearance as if an air-bubble were present at the top. They can also be cultivated in a meat infusion containing peptone, neutralised and rendered solid by agar-agar. They grow on potatoes, forming colonies closely resembling those of the bacillus of glanders, but not so brown as the latter. They grow best at a temperature between 30° and 40° C.; below 16° C. they cease to grow; freezing does not kill them. They only grow in presence of oxygen. They grow very fast; their vegetation rapidly reaches its highest point: it remains stationary for a time, and then as rapidly ceases, the bacilli dying. They will not grow in meat infusion or the gelatinised material if it is at all acid. They die very rapidly when dried, not retaining their vitality longer than three hours. They do not form spores, corresponding in this respect with spirilla rather than with bacilli; Koch has made an exhaustive series of investigations to ascertain this point. Micro-organisms presenting all these characteristics are the bacilli described by Koch; organisms presenting only some of the characteristics, such as microscopical appearance, but differing in other points, are not Koch's comma-bacilli.

(2) This bacillus is always present in cholera.

Koch states that this bacillus is always present in cases of cholera. He determines its presence not only by microscopical examination, but by cultivation in gelatinised meat infusion. In ten cases in Egypt they were found microscopically (he had not then worked out their characteristics on cultivation). In India he made forty-two post-mortem examinations, and found them in all cases, by cultivation and microscopical examination, in the intestinal canal. The dejections of thirty-two cholera patients were also examined in the same way, and the comma-bacilli were found in all cases; also, in two cases seen in Toulon, and microscopically in sections of the intestinal wall in eight cases sent to him previously from India and Egypt. In almost 100 cases carefully examined these organisms were found, and that in cases occurring in various parts of the world.

(3) It is the only form which is constantly present in this disease.

(4) It is present in greatest numbers in acute and uncomplicated cases.

Koch has found that this is the case, and that on the other hand, in cases which live longer, the bacilli are fewer, and more especially where hæmorrhage or other complications have occurred, other bacteria are most numerous.

(5) It is present in the parts most affected.

According to Koch the lower part of the small intestine is that most affected by the disease, and here the bacilli penetrate into the tubular glands and also in part between the epithelium and basement membrane; in some places they penetrated even more deeply into the tissue. Where death of portions of the mucous membrane had occurred, other bacteria were also present in the tissue, but the comma-shaped ones were always deepest, "giving the appearance as if they had prepared the way for the others."

(6) It is never present in other diseases, in healthy persons, nor has it been found outside the body when no cholera was in the neighbourhood.

This is the keystone of the research, and naturally Dr. Koch has devoted great attention to this point. All his investigations in this direction have been carried out by his usual methods—chiefly by cultivation, aided also by the use of the microscope. He has thoroughly examined thirty bodies of patients who had died of dysentery, intestinal catarrh, "biliary typhoid," one case of ordinary typhoid fever, and several cases where ulceration of the intestines has been present. In none of these did he find comma-bacilli. He failed to find them in a number of cases where he examined the dejections of patients suffering from dysentery, also in diarrhœa of children, in animals poisoned by arsenic, in impure water from various parts around Calcutta, indeed wherever he met with a fluid containing bacteria he examined it for comma-bacilli, without however finding any (except in one instance, see No. 8). He specially mentions that he has tested saliva and the material on the teeth and tongue, which is always full of bacteria, but always with a negative result. He further refers to his own previous large experience in the cultivation of bacteria, and that of others who have worked at cultivation, this experience being against the presence of this organism, except in cholera. From these facts he feels himself warranted in stating that "the comma-bacilli constantly accompany cholera, and are never found elsewhere."

(7) No other conclusion can be arrived at than that these bacilli are the cause of cholera.

(*a*) It might be said that the choleraic process merely favours the growth of this bacillus. But on this supposition every one must have comma-bacilli in his body, because they are present in cases of cholera occurring in widely-separated parts of the world. This, however, is not the case (No. 6).

(*b*) As the result of the disease, conditions arise which cause the transformation of some ordinary bacterium into comma-bacilli. There is no evidence of such rapid transformation of one form of bacterium into another. The only known case of alteration in the properties of these bodies is the attenuation of anthrax bacilli, &c., but this is merely an alteration in pathogenic action; their form and mode of growth remain unaltered. Outside the body Koch has not, during the course of his investigations, got the slightest evidence of any change in these bacilli.

(*c*) The only conclusion which remains is that the cholera process and these bacilli stand in close relation to each other—in a relation of cause and effect.

(8) Although by experiments on animals direct evidence that the comma-bacillus is the cause of cholera has not been obtained, there are various observations which are almost as good as experiments on man.

In one case in a village near Calcutta Koch examined the water of a tank which supplied the inhabitants with drinking-water, &c. A number of cases of cholera had occurred, and when the water was examined the epidemic was at its height. Comma-bacilli were found in the water in considerable numbers. At a later period, when there were only few cases of illness, the comma-bacilli were few in number, and only found at one part of the tank. This was the only instance in which Koch found these bacilli outside the body. He further refers to the occurrence of disease in washerwomen, and infection from clothing soiled with cholera dejecta.

(9) The natural history of the disease corresponds with the various characteristics of this organism.

The bacilli grow rapidly, soon reach their highest point of development, and then die: this corresponds to what occurs in the intestinal canal. Under ordinary circumstances these bacilli are destroyed in the healthy stomach. This corresponds to the clinical facts of cholera, for, of a given number of individuals exposed to cholera, only some are taken ill, and those almost all suffer from disturbance of digestion—either catarrh of the stomach or intestine, or overloading of the stomach, &c., with indigestible food. The disease dies out in places where the conditions for its continuance are unfavourable: the bacilli have no spores.

These are the facts on which Koch's views are based; lately, however, two researches have been published which strike at the root of the theory, and which try to show that these bacilli are not peculiar to cholera. Dr. Koch has also published a reply.

The first of these researches is that of Dr. Lewis, who finds bacilli in the mouth microscopically identical with the comma-bacilli. Koch's reply (*Deutsche Med. Wochenschrift*, No. 45, 1884) is that he is well aware of the fact that organisms somewhat resembling the cholera bacillus are present in saliva, but that he does not diagnose these bacilli by microscopical characters alone, that if these bacilli are cultivated they will be found to be quite different from those present in cholera. For instance, they will not grow at all in the neutralised cultivating gelatine in which the cholera bacilli grow rapidly. The other research is by Finkler and Prior, who stated that they had found the comma-bacillus in cases of cholera nostras, and who further described spore-formation in them. Koch succeeded in obtaining a specimen of their "pure" cultivations, and found, on shaking up a minute quantity with the liquefied gelatine and pouring it out on a glass plate, that they had a mixture of four different bacilli, and that none of them were the comma-bacilli described by him.

Koch further adds the interesting fact that he has again taken up the experiments on the lower animals (presumably, from the context, on dogs and guinea-pigs), and that by injecting minimal quantities (as little as the 100th of a drop) of the cultivations of comma-bacilli into the small intestine, the animals have as a rule died in one and a half to three days, and the post-mortem appearances of the intestine were the same as in acute cases of cholera, the fluid in the intestine also containing enormous numbers of comma-bacilli.

In two cases of cholera nostras, and in a diseased bee, the writer found bacilli which microscopically closely resembled the comma-bacilli, but it was found that they did not grow in the neutralised gelatinised material, and were therefore not the same organism.

THE HAYTIAN NEGROES

Hayti; or, The Black Republic. By Sir Spenser St. John, K.C.M.G. (London: Smith, Elder, and Co., 1884.)

WHATEVER theory may be adopted regarding the fundamental equality or disparity of the human races, a truthful and unbiased account of the present social condition of the Haytians, by a competent observer, must necessarily prove a valuable contribution to the study of psychological anthropology. These conditions are eminently satisfied in the work before us, written as it is by a man personally above suspicion of any unworthy motive, by a statesman who has associated for some five-and-thirty years with every variety of coloured peoples, by a distinguished diplomatist, who, as British Minister and Consul-General, has resided for twelve years in Hayti itself. On the other hand, no more favourable field could be selected for a study of the negro race than this western and smaller division of this large West Indian island, second in size only to Cuba, of which it forms a natural continuation eastwards to Porto Rico. Here the eastern and much larger division, known as Santo Domingo, has been mainly in the hands of a "coloured," that is, negroid or mulatto people, since the expulsion of the Spaniards and French early in the present century. But in Hayti the pure negro has always been in the ascendant, and his policy has persistently been to get rid of the white and coloured elements. The whites disappeared, either exterminated or driven into exile, during the struggle with France; and of the present population, roughly estimated at some 800,000 or 900,000, not more than one-tenth are mulattoes, and all the rest full-blood Africans. The Haytians may, in fact, be regarded as a section of the negro race transplanted bodily to their present domain, where they have had it all their own way since the close of the last century. Whatever differences may exist, are all in their favour; for they here find themselves separated from the old baneful associations, and surrounded on all sides by the civilising influences of more cultured peoples. The physical environment is also more favourable, the climate being on the whole decidedly superior to that of the African sea-board, while the well-watered lowlands are described as amongst the most fertile tracts on the globe.

And what is the outcome of fully three generations of political autonomy under these exceptionally advantageous conditions? Practically a reversion to, or, more correctly speaking, an almost uninterrupted perpetuation of, the African tribal organisation in its very worst aspects. Such is the general conclusion conveyed by a careful study of Sir S. St. John's work, which may be briefly described as a formidable indictment against the negro race as such, and a crushing reply to those sentimental philanthropists who go about preaching the doctrine of the inherent equality of all mankind. In a few well-digested chapters he deals comprehensively with the history, government, trade, industries, and social institutions of the "Black Republic," and on all these branches of the question his verdict is in the highest degree adverse. "I could not but regret," he writes, "that the greater my experience the less I thought of the capacity of the negro to hold an independent position. As long as he is influenced by contact with the white man, as in the southern portion of the United States, he gets on very well. But place him free from all such influence, as in Hayti, and he shows no sign of improvement. On the contrary, he is retrograding to the African tribal customs, and without exterior pressure will fall into the state of the inhabitants of the Congo. I now agree with those who deny that the negro could ever originate a civilisation, and that with the best of education he remains an inferior type of man. He has as yet shown himself totally unfitted for self-government, and incapable as a people of making any progress whatever. To judge the negroes fairly, one must live a considerable time in their midst, and not be led away by the theory that all races are capable of equal advance in civilisation" (pp. 131-132).

This general conclusion is amply supported by overwhelming evidence collected at first hand by a shrewd observer, whose official position enabled him to obtain accurate information regarding every phase of Haytian political and social institutions. That the successive "empires" and "republics" were mere burlesques; that the administration of justice has always been a farce; that civic virtues are absolutely unknown; that, in a word, "politically speaking, the Haytians are a hopeless people" (p. 133), will probably be accepted without demur by the intelligent reader. But that fetish worship, cannibalism in its most repulsive forms, and all the abominations associated with the secret "Vaudoux" rites, are still rampant, and encouraged if not actually practised by the very highest State functionaries, including Presidents themselves, would certainly be received with a smile of incredulity, were the facts not attested by evidence of the most unimpeachable character. Even so the revelations made in connection with this loathsome subject almost exceed the bounds of belief, and could not be accepted, were we not assured that they are "founded on evidence collected in Hayti, from Haytian official documents, from trustworthy officers of the Haytian Government, my former colleagues, and from respectable residents—principally, however, from Haytian sources" (Introduction).

To the question, Who is tainted by the Vaudoux[1] worship? the answer is, "Who is not?" Yet a prominent feature of this horrible cult is the sacrifice of "the goat without horns," that is, of some human victim, often supplied by the parents themselves, who also share in the feast at which their murdered offspring is devoured. At a trial held in 1864, four women were convicted on their own confession of having killed and eaten a girl, six years old, delivered to them by the aunt, and of feeding up another child to be sacrificed and eaten on the Feast of the "King of Africa." A Spanish official present at the trial reported that, if the public prosecutor had done his duty, "not only the witnesses but the mother of the victim herself would have shared the fate of the cannibals proved guilty of having eaten her." Another woman, reproached with having devoured her own offspring, retorted, "And who had a better right? Est-ce que ce n'est pas moi qui les ai fait?" And in 1878 a case came under the notice of the author, in which two women were caught in the act of eating the flesh of a child raw. "On further examination it was found that all the blood had been sucked from the body" (p. 225).

In common with many other observers, the author noticed "that negro boys up to the age of puberty were often as sharp as their coloured fellow-pupils," adding that "there can be no doubt that the coloured boys of Hayti have proved, at least in the case of one of their number, that they could hold their ground with the best of the whites" (p. 266). But it is equally certain that after reaching puberty further progress appears to be arrested, so that the negro remains intellectually a child to the last. This remarkable phenomenon is probably due to the premature closing of the cranial sutures in the negro race, as suggested by Filippo Manetta, who also noted the sudden arrest of development in adults. "The intellect seemed to become clouded, animation giving place to a sort of lethargy, briskness yielding to indolence. Hence we must needs suppose that the evolution of the negro and white proceeds on different lines. While with the latter the volume of the brain grows with the expan-

[1] Apparently a corruption of the West African word *Vodun*, implying a species of ophiolatry, in which the great serpent, an all-powerful supernatural being, on whom all things depend, is worshipped by secret rites, nocturnal orgies, and human and animal sacrifices.

sion of the brain-pan, in the former the growth of the brain is on the contrary arrested by the premature closing of the cranial sutures and lateral pressure of the frontal bone." [1]

The chapter on the curious French Creole patois current amongst the Haytians will be found instructive by students of such jargons. Its euphonic laws and peculiar structure, or rather absence of structure, are illustrated by a number of passages from popular songs and proverbs, such as the characteristic—

> " Nègue riche li mulatte,
> Mulatte pauvre li nègue."

That is—

> " Negro enriches mulatto,
> Mulatto impoverishes negro."

Beyond oral compositions of this sort there is no local literature, and the public records, diplomatic communications, and correspondence of all sorts are written in more or less grammatical French. None of the full-blood blacks have aspired to the honours of authorship, or attempted any sort of literary composition beyond an occasional political essay or manifesto. In this as in all other respects there seems to be an impassable gulf even between them and the coloured portion of the population.

The book is furnished with a useful map of Hayti; but there are neither illustrations nor index.

A. H. KEANE

[1] " La Razza Negra nel suo stato selvaggio, &c. " p. 20. (Turin, 1864.)

OUR BOOK SHELF

Hilfsbuch für den Schiffbau. Von Hans Johow. (Berlin: Julius Springer, 1884.)

THIS handsome volume belongs to the class of publications known as "pocket-books," of which there are many examples, in English, adapted to the use of various branches of engineering. It is essentially a compilation of facts, formulæ, and methods likely to prove useful to ship-builders in the course of their ordinary work; and it will bear favourable comparison with anything of the kind previously published. In the range of its information, and the extent as well as variety of the sources drawn upon, Mr. Johow's book surpasses all others intended for the use of ship-builders; evidencing wide research and a thorough acquaintance with the literature of the profession. It cannot fail to prove valuable as a book of reference in the offices of all ship-yards, and should be of great assistance to draughtsmen, especially in carrying on calculations or details of design.

The arrangement of the book is excellent, and it is admirably produced, the numerous tables and diagrams, as well as the mathematical investigations, being clearly printed and easily followed in reading. This has been accomplished without making the volume large or expensive. Five principal sections embrace the contents.

The first section contains a mass of general information and tables, designed to facilitate reference and save labour. In the mathematical subdivision of this section appear tables of the squares, cubes, square root, cube root, &c., of numbers up to 1000; trigonometrical tables; algebraical and trigonometrical formulæ of various kinds. Another subdivision deals with "mass and weight," giving full particulars of the weights and measures of various countries, and tables for conversion of one system to the others. Tables of weights of materials follow, and are very extensive and well arranged; in addition, there is a brief summary of the principles of strength of materials, including Wöhler's valuable investigations on the "fatigue" of metals. Brief chapters are also devoted to the theory of heat, chemistry, and galvanism; and finally a good deal of information is given on details of design, fastenings, &c.

The second section deals with the theory of shipbuilding. It gives particulars of various systems of mechanical construction for the forms of ships; deals with the problems of buoyancy and stability, and describes methods of calculation; gives approximate formulæ for use in preliminary investigations; and deals in a practical fashion with ocean waves, propulsion of ships by sails, the action of the rudder, fluid resistance, and propulsion by steam power. Under the last heading appears a most comprehensive summary of the various methods proposed for approximating to the engine-power required to give steamships their assigned speeds. Lastly there is a chapter on compass-correction.

The third section deals with more practical questions relating to the lading and freeboard of ships; their outfit of anchors, chains, boats, pumps, &c.; the armaments of war-ships; the methods of testing materials used in shipbuilding, &c.

In the fourth section are contained detailed information relating to the propelling machinery, boilers, and propellers of ships; the rules of the Board of Trade for boilers; and tables, &c., for use in trials of speed.

The fifth and last section contains details of the laws and regulations affecting German and foreign shipping, various rules for calculating tonnage, and our Board of Trade regulations for passenger-steamers. An excellent index concludes the book.

It cannot be supposed that such a great mass of information has been brought together and greatly condensed without some sacrifices and possible errors; but the author has evidently taken pains to insure accuracy, and his book should command a wide circulation both in Germany and abroad.

W. H. W.

A Synopsis of Elementary Results in Pure and Applied Mathematics: containing Propositions, Formulæ, and Methods of Analysis, with Abridged Demonstrations. By G. S. Carr, M.A. Vol. i., Sections x., xi., xii. (London: Francis Hodgson, 1884.)

OUR notices of the former sections will be found in vol. xxii. (p. 582) and vol. xxvi. (p. 197). These sections are occupied with the Calculus of Variations (pp. 441 to 459), Differential Equations (pp. 460 to 545), and the Calculus of Finite Differences (pp. 546 to 560). In the first section we have not detected any mistakes of any importance, in fact only one or two typographical faults. The second section commences with an unfortunate slip in the numbering of the articles, which is not pointed out until the next sheet is commenced (p. 473). In this section there are numerous errata, of which we indicate a few. In § 3276 the first term in the last line should have the mark of differentiation with regard to x affixed. We note mistakes in §§ 3342, 3382, 3392, 3394, 3399, 3407, 3431, 3447, 3499, 3520, 3521, 3537, 3570. These corrections are mostly for wrong references, and the articles are cited for the benefit of students. The last section appears to be quite right, with the exception of a typographical error in § 3703. We have not undertaken to work out and verify each article, but we have gone through each, and the above small list of mistakes will give an idea of the care exercised in the editing of this part. We repeat our former advice, viz. that a student who wishes to refer to the "Synopsis" for refreshing his knowledge of the above-named branches should at the time of his reading his text-book have this manual by him for verification. The sections are mainly based upon Jellett (for Variations), and Boole (for the two latter sections).

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.]

Natural Science for Schools

I WAS glad to see that "Science Master" had pointed out some of the difficulties in the way of applying the principles laid down in Prof. Armstrong's valuable paper in your number for November 6 (p. 19). The difficulties to which he has adverted relate mainly to those gratuitously thrown in the way of sound and useful practical teaching in grammar-schools by boards of examiners. Another difficulty I ventured to point out in the brief discussion upon Prof. Armstrong's paper at the Educational Conference of the International Health Exhibition, but it did not receive the attention which I think it deserved—partly, perhaps, owing to press of business, and partly, perhaps, also to the fact of the naturally somewhat strong representation of South Kensington interests at a conference held within the shadow of the Brompton Boilers. Prof. Armstrong appeared specially to recommend his mode of teaching "in science classes, such as those held under the auspices of the Science and Art Department," and towards the end of his paper he seems to recognise only one difficulty in the way of introducing it generally, viz. it "undoubtedly involves more trouble to the teacher than that ordinarily followed," and he appears to hint that the present method is mainly due to the incapacity of the teacher, as he says, "I do not believe that it is because the Department consider it" (the system) "a satisfactory one; but they know full well that it would be unwise to legislate far in advance of the intelligence and powers of the majority of the teachers." There are many teachers who are only too anxious to teach, not chemistry merely, but physics and other branches of science upon a sensible system, and who would willingly take considerable *trouble* to attain that end, but the difficulty is that, were they to do so, they would not get paid for their work. The insane system of *payment by results* is responsible for the greater part of the bad and indifferent teaching of science in this country, and the real trouble is, not that something better is in advance of the intelligence and powers of the majority of *teachers*, but that it is in advance of the intelligence and powers of the majority of *examiners*. The Department accept as their primary axiom that no teaching is to be paid for except that which can be exactly tested and appraised by certain examiners; and so no teaching, whatever its educational value, is counted worth anything by them except that which is susceptible of being weighed and measured. I took the liberty at the discussion of asking Prof. Armstrong whether he had ever taught a class on his methods, and if that class was presented to the Department for examination, and if so what was paid for it, and I made bold to express my own opinion that the result would be either *nil* or despicably small. My question received no answer, but I got plentifully snubbed—firstly, that a science teacher should even think of such a subject as remuneration, and secondly, I was informed that practical teaching always paid best. But as it appeared that my critics had misapprehended the point at issue, and were not speaking of the kind of teaching advocated by Prof. Armstrong at all, but thought that *practical* teaching meant allowing the class to see certain experiments performed by the teacher himself—a mode of teaching which I am quite agreed with the reader of the paper in considering quite *unpractical*—I did not feel satisfied that my question was answered, and with your permission will again propound it. It is not a sufficient answer to say that the most practical teachers earn the best results—I am a science teacher of quite sufficiently long experience to know that—*provided it is strictly on the lines laid down by the Department*. What I doubt is whether *sensible* practical teaching would produce any pecuniary results.

Certainly, in what is called (*lucus a non lucendo*) practical chemistry it would not: there nothing but test-tubing can be weighed and measured; and whereas in former years a knowledge of the modes of preparing and experimenting with certain of the more common elements and compounds counted for something in the elementary stage, it has lately, by successive alterations in that direction in successive issues of the Directory, become more exclusively test-tubing.

In physics I presume the intelligent teacher would be glad to teach his class in light, heat, and sound, to make some of the more important measurements, to verify the laws of reflection and refraction, to measure the refractive index of glass, to calculate the foci of various lenses, to determine the latent heat of water and steam, and the specific heat of one or two substances and a few other similar things, not many of which could be introduced in a course of thirty lessons of one hour each; in electricity and magnetism, to establish the laws of intensity, to construct an electroscope, a galvanometer, and a Wheatstone's bridge, to measure the resistance of a few lengths of wire, to determine the E.M.F. of a "cell," &c., in which case the same limits would soon be reached. But would such a course pay? I venture to say not, and the Department have not even given to practical physics the scant encouragement which they afford to so-called practical chemistry. I say *scant encouragement*, because, by a series of red-tape regulations, which are strictly adhered to, they do their best to render the study of practical chemistry needlessly expensive to the committees and unremunerative to the teachers.

I shall probably be told—firstly that the teacher of a science class has no need to limit himself to thirty hours for a course; and secondly, that he should not make remuneration his first consideration. On the first point I reply that he is practically limited in most cases by the length of time during which it is possible to get students to attend: the month of September is as early as it is practicable to commence a course, and the examinations are early in May, so that one lesson a week, allowing for necessary holidays, cannot much exceed thirty lessons. To give two lessons per week would be to occupy the time of two classes for the remuneration—generally poor enough—of one; this, of course, virtually brings us to the second point, as to which I would say that, as in other professions men do not work for inadequate remuneration, I do not see why the science teacher should be expected to be more philanthropic; that neither the clergyman, the lawyer, nor the physician professes to regard money as his chief consideration, yet that the remuneration of each of these professions is far before that of the science teacher, at all events of him who works for the Science and Art Department; and lastly, that that particular line of criticism does not usually come from those who are themselves working from philanthropic motives, but from those who are pretty well paid for their labours, and who would despise the modest reward of the "*payment by results*" teacher.

I hope I shall not be misunderstood as disagreeing with Prof. Armstrong's views; it is, on the contrary, because of my full agreement with them and that I am anxious that those science teachers who are sufficiently advanced in intelligence (and I am persuaded that they are not so rare as Prof. Armstrong seems to think) to adopt a truly educational mode of teaching, should have no needless obstacles thrown in their way, that I venture to address you and to repeat before a larger audience those arguments which I made use of before the smaller auditory at the Health Exhibition.

I for one should be only too glad to see the scope of the science teaching under the Science and Art Department widened, and to know that encouragement was given to the intelligent and advanced teacher to get out of the grooves in which it appears to be the present policy of that Department to retain him.

WALTER A. WATTS

Farnworth Grammar School, November 20

Do Flying-Fish Fly?

I CANNOT pretend to the great experience of Mr. R. W. S. Mitchell in observations on aërial movements of the flying-fish when for a brief space he leaves his native element; but during one voyage from the Isthmus of Panama to England *viâ* the West Indies I lost no opportunity (of many) of watching these beautiful creatures, sometimes very close indeed to our steamer. The opinion I formed at the time and still retain was that there was constant very rapid motion of the great lateral fins whilst out of the water, so rapid, indeed, that the strokes of the fins could not be counted. From what Mr. Mitchell says, he evidently counted the strokes of the wings (pectoral fins), not by seeing the movements of these, but by the "impressions made on the oily surface of the water," impressions apparently similar to those made by a cormorant or other diver when taking wing from the sea.

The movements of the side fins whilst the fish was in the sea or touching the surface, would be much slower than would be the case when it was wholly in the air, because, to be of any use then, the strokes would have to be so rapid as to be scarcely countable, as is the case with certain sea fowl (notably auks) which use their wings (with a comparatively slow stroke) whilst swimming *under* water, but when flying move them so rapidly that the strokes can either be counted with difficulty or not at all. On watching flying-fish whilst in the air, I noticed a flickering of the fins, indicating what I believe to have been rapid motion.

As Mr. Mitchell's observations, on which he chiefly relies, were made when looking down from the high bows of a steamer, the "waving from side to side" of the tail of the fish, being a lateral motion, was clearly seen, whilst the movements of the side fins would be less easily discernible.

Finally, could the impetus acquired by the fish, when springing from the water, carry it through the air "50 or 100 yards" (Mr. Mitchell's estimate) without the aid of any additional propelling force during its fight? If so, the initial velocity must have been very great. JOHN RAE

4, Addison Gardens, W., November 27

The "Jeannette" Drift

IN NATURE of November 20 (p. 66) you give an account of the finding of some relics of the *Jeannette*, which have been picked up on an ice-floe at Julianhaab, in lat. 61° N., long. 46° W., near the south point of Greenland, and which must have drifted from the New Siberian Islands in lat. 75° N., long. 155° E., where the *Jeannette* was squashed three years ago. This I consider a most important find with regard to Arctic navigation and discovery. The question arises, How did the ice-floe get to Julianhaab? I propose the following solution. The Siberian Islands bear nearly due north from Julianhaab, and in a straight line up Davis's Strait, Baffin's Bay, Smith's Sound, Lincoln Sea, &c., and across at a distance of about 250 knots from the Pole. I think it most probable that the floe may have drifted through "the unknown," or what Osborn calls "the land of the white bear," the large unexplored area to the west of Banks's Land, and have got into Baffin's Bay through one of the sounds on its west coast—either by Jones's Sound, where the tide runs eastward at the rate of two knots an hour ("Inglefield," p. 77), or by Banks's Strait and Lancaster Sound.

We know that the icebergs come *down* Baffin's Bay and Davis's Strait into the Atlantic, and the floe has had fair success in navigating through a distance of 2700 knots to reach Julianhaab in three years.

I cannot for a moment suppose that this ice-floe has come from the Siberian Islands, *viâ* Francis Joseph Land, Spitzbergen, Iceland, to Greenland, a distance of 3600 knots, for that course would have been directly *against* the Gulf Stream, in which no floe could last three years, even if it were 26 feet thick, as Inglefield found them in Jones's Sound, or 40 feet thick, as McClure found them in Banks's Strait. McClure found the current west of Point Barrow going 2 knots per hour to the south, evidently making for Behring's Strait, while of the north-west point of Banks's Land the drift was north-east 1 knot an hour, evidently going towards Lancaster Sound.

I therefore conclude that the *Jeannette* relics could not have come westward, they *must* have come eastward, and this proves that there is a course open which is unknown to us.

I would suggest that a number of very strong buoys, capable of resisting ice-pressure, should be set adrift on ice-floes on various parts of the Siberian coast, each numbered indelibly, so that when recovered it could be ascertained whence they started, and their course *might* possibly be ascertained from the Eskimo, who may have seen them, or by other means. This experiment is worth a trial. R. S. NEWALL

Ferndene, November 30

A Meteor Visible in the Daytime

AT Waterpark, just below Waterford City, about 4 p.m. on October 15, my attention was attracted by a flash of increased light. Looking up, I saw in the south-south-west, about half way between the horizon and the zenith, a bright meteor slowly sailing nearly due west, its apparent size about half that of the full moon, intensely white in colour at the centre, passing into blue at the circumference. It described a low arc, and was in sight for several seconds, leaving a trail of indigo blue with lighter luminous edges. The meteor disappeared behind some clouds which concealed the sun at a considerable altitude above the horizon. JAMES GRAVES

November 27

Noon-Glow

WHILE waiting at the telescope shortly before noon this date to note place of sun-spots at meridian passage, masses of cloud formed suddenly in a clear sky overhead, and drifting slowly due south, obscured a peculiarly brilliant sun. No sooner had direct light been intercepted than the upper air above cloud and sun's place appeared filled with the latterly common white glare (as of attenuated peat-smoke highly illuminated), which soon became suffused with the now familiar rose-tint, apparent also between the clouds and on south-south-west horizon, but not beneath the sun on meridian. The sun's apparent meridian altitude being 16°, the superior limit in altitude of rose-tint was 39°; the colouring being monotone throughout, and not to be confounded with that of halos. Fearing ocular deception, as often happens from fatigue of eyesight, I asked an intelligent companion to verify observation, more especially as the diffused white glare at first slightly masked the tinting as compared with that of other "glows." It seems, however, plain that the terms "fore-glow" and "after-glow" no more cover the entire field than the Krakatoan dust. D. J. ROWAN

Kingstown, November 24

Rosy Glow about the Moon

AFTER watching for some time this evening a lovely twilight in the west, which though bright and luminous was not remarkable for strong colour, I turned toward the south-east, when the moon, now well up, was shining through detached fleecy clouds, and was surprised to see about her a rosy-coloured glow, very like that so often seen about the sun; the nearer clouds, though very high, telling as a cold almost greenish grey upon it. This glow, of course, was much lower in tone than that about the sun, but both in character and extent just like it, and quite distinct, and broader than those prismatic hues often seen about the moon, and called by sailors "cock's eyes" or peacock's-eyes. This was at 4.45 p.m., and as the twilight faded the glow disappeared, from which I infer that it was caused by vapour lying high enough in the south-east to catch some of the very last rays of the sun, but too far east to give a glow in the west.

I see that a correspondent of the *Standard* telegraphed that on the evening of the 25th "a sunset equal in splendour to those of last autumn was seen over the Yorkshire wolds. The predominating hue was a rich crimson." The weather here was cloudy that evening, but between narrow openings in the clouds the sky was the colour of rich painted glass of a ruby-red tint about 4.30 p.m. ROBERT LESLIE

6, Moira Place, Southampton, November 28

Wild Fowl Decoy

MAY I ask if any of your readers who are interested in wild-fowl decoys will send me the names and positions of any past and present ones they may happen to know or have heard of. I am endeavouring to save the history of decoys from oblivion, and though I have many hundred letters, maps, and sketches connected with this interesting subject, still I may have a great deal of information yet to obtain. I think the subject deserves a standard work, or I would not trouble you.

RALPH PAYNE GALLWEY

Cowling Hall, Bedale, November 24

Prehistoric Man

DURING October last, the sanitary authorities of Gloucester City had occasion to make some excavations in the timber-yard of Messrs. Booth and Co., and in the Bristol Road adjoining this yard, for the purpose of laying down a new sewer. In the course of this operation the workmen disinterred, from a bed of plastic clay, three human skeletons, occupying a position which appears to suggest that the remains in question are probably those of prehistoric man.

Arriving accidentally on the spot some two or three days after the actual find, I learned, to my great regret, that the skulls, two of which had passed through my friend Mr. Wm. Booth's hands, had been cast on one side, reduced to fragments, and finally buried in the concrete foundation of the new sewer, no one supposing that the discovery represented anything more than some modern interment.

My friend had, however, seen one of the skeletons complete and *in situ*, extended at full length, face downwards, in the clay, while I succeeded in gathering a basketful of bones, including fragments of four left-hand femora, thus, probably, attesting the presence of more individuals than the number to which the workmen deposed.

Some of these bones I extracted from the clay itself, the remainder being found among the excavators' ejecta. Almost all of them are broken and have their cavities, even the spongy tissues and diploë of the cranium, completely filled with the clay in which they were discovered. They are easily broken into fragments by hand, have little organic matter remaining in them, and a few exhibit indications of having been gnawed by animals.

The clay-bed itself showed no signs of disturbance, such as would indicate a burial. On the contrary, it was evident that the bones had been quietly covered with river deposits as they lay, and, although near each other, the skeletons did not occupy a common resting-place.

The remains occurred at a depth of 5 feet 6 inches below the surface, 36 feet above Ordnance Datum, and 3 feet above the highest known modern flood-line, given on the authority of Mr. Martin, engineer to the Severn Navigation Commissioners.

It is clear, therefore, that the clay-bed in question must have been deposited at a time when the River Severn ran, and its flood-loams were laid down, at levels higher by many feet than those of the present day, or, in other words, at some time antecedent to the historic period, during which there is no reason to suppose that our rivers ever met the sea except at existing horizons. DANIEL PIDGEON

Holmwood, Putney Hill, November 22

Fly-Maggots Feeding on Caterpillars

AFTER Mr. McLachlan's remarks in NATURE for November 20 (p. 54), on Dr. Bonavia's note upon the above subject, it is hardly necessary to say that your correspondent, F. N. Pierce (November 27, p. 82) is undoubtedly mistaken in saying that he has bred the house-fly, *Musca domestica*, from Lepidopterous larvæ. If he has really bred *Musca domestica*, it is a new fact, and I should be very glad to see a specimen. I have had some considerable experience in breeding Lepidoptera, and have frequently bred out Dipterous parasites; these have invariably been *Tachinids*, mostly of the genus *Exorista*. To the ordinary observer they very closely resemble *Musca domestica*, but the same observer would very probably call all the various species of *Musca*, *Anthomyia*, *Homalomyia*, *Stomoxys*, &c., which frequently occur in houses, "house-flies." The general appearance of many of these genera is very much the same, and the term "house-fly" is such a vague one that I remember a good microscopist once showed me a slide labelled "upper and lower wing of house-fly"! some Hymenopteron caught on a window apparently furnishing the materials.

The Diptera are unfortunately much neglected in this country, and many groups are very little known. This is especially the case with the *Tachininæ*, and Lepidopterists who breed them would benefit science by pinning the specimens and sending them to one or other of the few students of this order of insects.

4, East Street, Lewes, November 29 J. H. A. JENNER

YOUR correspondent, Mr. F. N. Pierce, in NATURE for November 27 (p. 82) merely continues the error suggested by Dr. Bonavia's note on this subject. It is not the larvæ of the house-fly (*Musca domestica*) that he has found as parasites on his butterfly and moth caterpillars, but the larvæ of a *Tachina*, a Dipterous genus of the *Muscidæ*, too well known among even mere collectors, I should have thought, for such a mistake to be made. There is of course a superficial resemblance.

M. E. S.

The Forbes Memorial

MAY I make use of your widely circulated pages to say that I purpose in a few days to send to press a list of the subscribers to the Forbes Memorial, to be bound up with the issue of the zoological memoirs of our lamented friend; the Memorial Volume is now nearly ready, and I shall be glad to hear from any of the friends of Mr. W. A. Forbes who have not already communicated with me on the subject. May I add that it was agreed by the Committee that subscribers should receive a copy of the volume for every guinea subscribed.

F. JEFFREY BELL

5, Radnor Place, Gloucester Square, W.

THOMAS WRIGHT, M.D., F.R.S.

IT is perhaps hardly sufficiently recognised how much the progress of science has been helped by the leisure-hour occupations of busy professional men. No branch of science has profited more from this source than geology, and no calling has furnished so many helpful labourers as medicine. The career of Dr. Wright, whose recent death is so sincerely regretted, supplies one of the most notable examples of a life apparently absorbed in the laborious duties of a medical practitioner, yet wherein time was found for the pursuit of a long series of original and valuable researches in palæontology. To those who knew him only as a doctor, it might well seem that his whole time and thought were given to the duties of his medical practice. Those, on the other hand, who met him as a geologist and palæontologist could hardly realise that he had any other occupation than the study of the fossils which he treasured and described with such enthusiasm.

Dr. Wright was born in Paisley in 1809. Having a near relative engaged in the practice of medicine, he chose the same profession for himself, and received the earlier part of his education at Glasgow. Before he had completed his studies, he was induced to quit medicine and take part in the development of the manufacturing arts, then making rapid strides in Scotland. But finding the change unsuited for his temperament he turned back with a sense of relief to the profession he had abandoned, resumed his medical studies in Dublin, and finally graduated in 1846. Soon thereafter, circumstances led him to settle in Cheltenham, where he has since spent the whole of his long and honoured life. His devotion to the healing art, and his bent towards a scientific treatment of his subject, were soon recognised, and he became successively attached to the Dispensary and General Hospital, and finally Medical Officer of Health for Cheltenham and surrounding districts. He was twice married, and leaves a son and two daughters by the second marriage.

In the early days of his career Dr. Wright manifested his love for scientific investigation. While still a student in Dublin he devoted himself with ardour to the study of human anatomy, and especially to the application of microscopic research in that department of inquiry. His eyesight, however, not proving strong enough to bear the strain of microscopic work, he finally exchanged that pursuit for the cultivation of palæontology, which from the position of Cheltenham in the midst of richly fossiliferous rocks, lay temptingly open to him. Ranging over the abundant organic remains of the Lias and Oolites of his neighbourhood, he chose the Echinoderms as his special subject, and began to publish the results of his observations. His early papers gained for him the friendship and co-operation of Edward Forbes. It was arranged that the two naturalists should conjointly describe the Echinoderms of the British Secondary formations, Forbes taking the Cretaceous, and Wright the Jurassic forms. The former did not live to carry out his part of the programme, which was accordingly completed by his colleague. The monographs on the Secondary Echinoderms were published by the Palæontographical Society, and form an enduring monument of Dr. Wright's patient and minute research. But while engaged in these investigations, he did not neglect other departments of Jurassic palæontology. In particular, he devoted himself with unwearied industry to the collection and comparison of the Cephalopods of the Lias, and at length, after some forty years of preparation, began his great monograph on "The Lias Ammonites," a work of much research, of which the concluding part is about to be issued, and which forms an enduring landmark in the history of English palæontology. In the course of the inquiries rendered requisite for this exhaustive treatise, he not only made himself acquainted with the fossil localities and public and private collections in this country, but paid visits to many parts of the Continent to study the contents of foreign museums and to confer with his fellow-labourers in the same field scattered over France, Switzerland, and Germany. He was engaged, at the time of his death, upon a monograph of British Cretaceous Starfishes, which he had nearly completed.

The value of his scientific work has been fully recognised by his contemporaries. He was early elected as a Fellow of the Royal Society of Edinburgh. Subsequently he joined the Geological Society of London, and from that body eventually received its highest honour—the Wollaston Medal. In 1879 he was elected into the Royal Society. He was President of the Geological Section of the British Association at the Bristol meeting in 1875. His published papers and memoirs are numerous, but the largest and most important are his monographs in the publications of the Palæontographical Society.

It was not alone by original research that Dr. Wright strove to foster the progress of his favourite science. As one of the fathers of the Cotteswold Field Club, as President of the Literary and Philosophical Association of Cheltenham, as a frequent lecturer on scientific topics not only in Cheltenham, but in Bristol, Bath, Worcester, and other towns; and generally by the enthusiasm with which, amid all the obstacles of his busy professional life, he contrived to find leisure for the cultivation of science, he was unquestionably one of the living forces that stimulated the growth of science all over the West of England. His death is therefore a serious deprivation, and will be mourned by all in that region to whom scientific progress is dear.

To a narrower but still a wide circle his removal from among us is the loss of a leal-hearted friend. Those who were thus privileged will cherish the memory of that cheery face with the bright twinkle of eyes that were as brimful at one time of merriment as, at another, they were suffused with sympathy; the joyous laughter that rang out clear and strong from a heart in which there was no guile; the earnest brow and hand upturned behind the ear as the talk went on over his favourite pursuits; the bursts of enthusiasm as some new fact or novel deduction dawned on him, and the play of humour that was ever ready to break out like a beam of summer sunshine. Dr. Wright made his final expedition in August last year, when he joined the writer of these lines in the Island of Arran. Already the symptoms of his fatal malady had shown themselves, and he knew what they foreboded. But he carried with him nevertheless his characteristic sunniness of nature. Seated on the bare mountain-side with the purple heather and yellowed bracken around him, the sea in front, and his own native Renfrewshire hills in the blue distance, he became almost a boy again as he told his reminiscences of old times and watched the sports of children among the gray boulders. Ripe in honours as in years, it seemed as if he had come back to his early northern air to drink it once more, and review his past before he should quit us for ever. He would saunter for hours in the quiet glen, with no companion but his own thoughts and the sights and sounds of Nature, which were an ever-gushing fountain of pleasure to him. Cherished is every memory of him, but most of all those parting days spent with him at the foot of the mountains and by the shore of the restless sea.

A. G.

ROBERT A. C. GODWIN-AUSTEN, F.R.S.

IN many respects Mr. Godwin-Austen stood out apart from his fellow-geologists in this country. He wrote comparatively little, but what he did write was always weighty and full of suggestiveness. Instead of loading the literature of science with a pile of little papers, each containing some trifling addition or supposed addition to the sum of knowledge, or some criticism well- or ill-founded of the work of others, he allowed his ideas to mature, and published them from time to time in luminous essays which many years afterwards may be read over again with profit as well as pleasure. He began to write about half a century ago, his earliest papers being devoted to the geological features of Devonshire, of which, at that time, very little was known. By degrees he extended the area of his observations eastwards into the south-eastern counties. His essays "On the Valley of the English Channel" (1850), and "On the Superficial Accumulations of the Coasts of the English Channel, and the changes which they indicate" (1851), were among the most thoughtful contributions that had ever been made to the elucidation of the existing outlines of sea and land. This department of inquiry was one that peculiarly fascinated him. Hence, when his friend Edward Forbes died and left his "Natural History of the European Seas" only half completed, he himself chivalrously finished it, and supplied some chapters which only an accomplished and far-sighted geologist could have written. His various papers on drift-gravels, on boulders in the Chalk, and other superficial phenomena, are all marked by the same grasp and breadth of treatment.

But perhaps the paper which has chiefly contributed to give Mr. Godwin-Austen his ascendency among English geologists and to make his name known beyond geological circles is his now well-known essay "On the Possible Extension of the Coal-Measures beneath the South-Eastern Part of England" (1855). In this remarkable memoir he brings to bear his detailed knowledge of the rocks of the south-west of England, the north of France, and the adjoining tracts of Belgium. He marshals all his facts in such a way as to enable us, as it were, to strip off the thick cover of Mesozoic formations and trace the deep-seated connection of the Palæozoic area of Southern England and the Continent. At the time when he wrote, nothing was actually known of the subject, but he predicted that a submerged Palæozoic ridge would be found extending from the south-west of England into France and Belgium. The results of the deep borings of recent years have fully verified this prediction.

Mr. Godwin-Austen, in his prime, was a frequent speaker at the meetings of the Geological Society, where his keen penetrative criticism and caustic sarcasm formed a prominent and valuable feature in the debates. Some of his most suggestive and pregnant views of geological questions were thrown off in the course of these debates, and were never otherwise published by him. He never courted publicity, but rather shrank from it as an incumbrance under which he would not willingly be fettered. For many years past he has lived as a retired country squire at his beautiful residence near Guildford, taking full interest in the progress of science, and glad to see his fellow-workers in geology under his roof, but seldom venturing into the turmoil of town and the disputatious atmosphere of learned societies. It is some consolation to geologists, who mourn the quenching of one of their luminaries, that his place is taken by a son who, by scientific labours in India and in this country, has proved himself a worthy successor.

CHARLES CLOUSTON

THE Rev. Chas. Clouston, LL.D., of Sandwick Manse, near Stromness, who died on the 10th ult. at the very advanced age of eighty-four years, was a man who deserves more than a passing notice in our columns. To name one only of his many claims to scientific recognition, he commenced meteorological observations in Stromness in the year 1822, and continued them, either there or in the adjacent parish of Sandwick, to within a fortnight of his death in 1884.

He belonged to the old Norse stock in Orkney, coming from the township of Clouston in Stennis. Two families of this name now live in the township, having succeeded to their farms, by direct descent, for over 400 years. He studied in Edinburgh University, and had at first been destined for the medical profession. He became a Licentiate of the R.C.S. in Edinburgh in 1819, and at his death was probably the father of the College. When in 1826 he entered on his duties as assistant and successor to his father, in the combined parishes of Stromness and Sandwick, there was no medical man in the latter place. For nearly fifty years he acted as the local doctor, in addition to his clerical duties, giving advice and medicines *gratis*. His father had been minister of Stromness for over sixty years, so that father and son had kept up a continuous ministry for 120 years. He received the degree of LL.D. from the University of St. Andrew's many years ago.

In the year 1862 Dr. Clouston's reputation as a careful meteorological observer was so well established that Admiral FitzRoy intrusted to his charge an anemometer, which has been kept in constant operation for the space of twenty-two years. The original instrument was replaced by a new one in 1869. A discussion of the results of the first five years' records (1863-68) appeared in the *Quarterly Weather Report* for 1871. In addition to his regular observations and deductions therefrom, which he occasionally published, he wrote an essay, "An Explanation of the Popular Weather Prognostics of Scotland, on Scientific Principles," which gained the prize allotted by the Marquis of Tweeddale in 1867. His observations for the last thirty years, at least, have been regularly published by the Registrar-General for Scotland.

Dr. Clouston was not only a meteorologist, but an ardent follower of every branch of science which came in his way. In his "Guide to the Orkney Islands," a reprint of a portion of "Anderson's Guide," he modestly says, "Taking the Orkney Flora, as Dr. Neill left it, to include 462 specimens, and adding our own contribution of 156, it now contains 618 species." In archæology he took an active part in the exploration of Maes How, and the House of Skaill, both of them within a walk of his home.

Dr. Clouston leaves a widow, two sons, and two daughters, but more than one member of his family passed away before him. In conclusion, we can only say that a visit to Sandwick was ever a rare treat; the warm hospitality of the manse, and the interest of the conversation carried on round the table, could not fail to leave an impression which will not easily wear away.

ON THE AUTUMNAL TINTS OF FOLIAGE

AFTER the fine display of autumnal tints which we have lately seen it may, I trust, be of interest to some of the readers of NATURE if I give an account of the chief conclusions to which I have been led by carefully studying the subject for many years.

As a general rule the colour of leaves in their normal condition depends on a variable mixture of two perfectly distinct green pigments and of at least four perfectly distinct yellow substances. The development of the autumnal tints is mainly due to the disappearance or change of the green constituents and to the production of highly-coloured pigments by the oxidisation of previously existing very pale or colourless substances. It is, in fact, due to a more or less complete loss of the vitality which previously counteracted these chemical changes, and the order in which the tints are developed can be easily explained, if we assume that the death of the leaves takes place somewhat gradually. The first visible effect of the reduced vitality is the change in the green pigments. In many cases they appear to be converted into colourless products, since the resulting bright yellow leaves differ from the normal green in the absence of chlorophyll, and merely contain the usual previously-existing yellow pigments. At the same time it is quite possible that an increased quantity of some of these yellow substances may be formed as a product during the change, but of this there is no positive proof. In the case of such trees as the alder, the chlorophyll does not thus disappear, but is changed by the presence of a weak acid into a very stable brownish-green product which resists further change. The production of bright yellows or dull browns thus clearly depends on whether the chlorophyll does or does not disappear before being modified by the action of acids, as may be verified experimentally by exposing suitable solutions to sunlight. It is, however, very clear that the manner in which it changes depends very much on the conditions of the case. Thus, if chlorophyll is exposed to sunlight dissolved in bisulphide of carbon, a reddish-coloured product is formed, and though this differs very greatly from the red pigment met with in many autumnal leaves, it seems probable that under some conditions the chlorophyll in leaves is changed by the action of light into a red substance. By taking green sorrel leaves and keeping them somewhat fresh by sticking the stalks into moist ground, I found that those exposed to the sun with the under side upwards turned to a bright red, whereas those kept in the shade did not develop any fine colouring. We may often see that partially broken leaves or twigs undergo this change when all other parts of the tree remain green, and this and various other facts lead me to conclude that the change of chlorophyll into a red product depends on a certain amount of reduced vitality as well as on little-understood conditions varying in different kinds of plants. Though I fully admit that there are some facts not easy to understand, yet on the whole it seems to me that these principles fairly well explain why certain leaves turn red in autumn. Slight frosts reduce their vitality in such a manner that the chlorophyll is changed by the action of the light into a red product. Thus, according to the character of the season and the nature of the plants, the first effect of the reduced vitality in the leaves is that the chlorophyll is removed so as to show their normal yellow colour, or is changed into a red pigment, or is altered into a comparatively stable dull brown green product. These are the three extreme changes, but in many cases intermediate mixed results give rise to such less perfect and well-marked tints as dirty yellows and reds.

The next series of changes is best studied in the case of those leaves which in the first instance turn to a bright yellow, and it appears to me that they depend mainly, if not entirely, on the production of deeply-coloured pigments by the oxidisation of tannic acid and other more or less colourless substances. The difference in the resulting tint seems to depend on the nature of these substances. Thus, for example, the tannic acid in the yellow oak leaves changes into a brown substance, whereas the quinotannic acid in yellow beech leaves changes into the fine orange-brown colour which makes those trees so ornamental in autumn. On the contrary, the bright yellow poplar leaves rapidly pass to a dark dirty brown by the alteration of another constituent. Other kinds of leaves give rise to tints of an intermediate and less well-marked character. In many cases it is almost impossible to draw the line between the colour of this stage in the change and the final dark and dirty browns of dead and decaying leaves. For fine effect very much depends upon the production of each special tint in a fairly pure state, so as to show bright yellows, reds, and browns. This seems to be influenced by the character of the weather.

It is also, of course, important that the half-dead leaves should hang long on the trees, so as to develop their full colouring before being blown off by the wind.

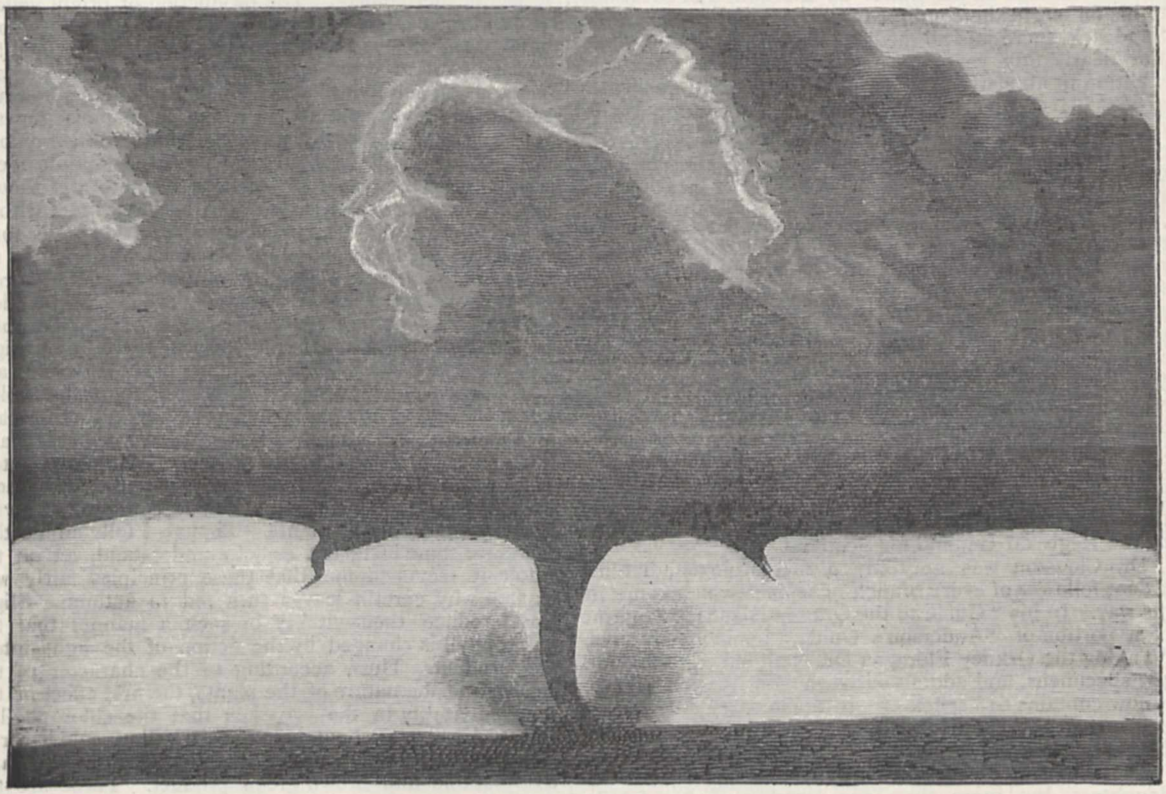
Taking thus all the facts into consideration, it appears clear that all the bright and beautiful tints of autumn are merely the earliest stages of decomposition, and are due to the more or less considerable triumph of chemical forces over the weakened or destroyed vitality of the living plant. One cannot but feel that this is a very unpoetical way in which to regard the magnificent tints of a fine autumnal landscape, but it is no less true than that the coloured clouds of evening mark the departing day.

H. C. SORBY

A TORNADO PHOTOGRAPHED

I SEND you to-day a photograph of a genuine Dakotah cyclone, or, rather, tornado, which was taken by F. N. Robinson, Howard, Miner County, D.T., August 28, 1884. The storm passed twenty-two miles west of the city. It was first noticed at 4 o'clock p.m., moving in a south-easterly direction, remaining in sight over two hours; killing several people, and destroying all property in its course. I believe it to be unique as a portrait of this class of storms, and I have thought you might care to reproduce it for NATURE. EDWARD S. HOLDEN

Washburn Observatory, University of Wisconsin, Madison, November 14



METEOROLOGY OF MAGDEBURG[1]

THE second report, just published, of the Meteorological Observatory of Magdeburg presents some special features of interest. The observations with the instruments in more general use are given in very convenient forms in detail and abstract.

Magdeburg was one of the first observatories to adopt the barograph of Dr. Sprung, which is certainly one of the best barographs we possess. After the purchase-cost of 40*l.*, the annual outlay in working it and preparing its curves of continuous registration for the lithographer is trifling. The curves are also of high value as accurate representations of the variations of atmospheric pressure. The whole of these curves are reproduced by Dr. Assmann in an elaborate series of lithographs, on which the inch of pressure is on a scale of four inches, and the twenty-four hours of the day extend over five inches and a half. By this large scale the minuter changes of pressure are represented with great distinctness, and their relations to changes of wind, cloud, and other weather conditions can be more clearly seen. Dr. Assmann draws attention to five of the small changes from August 27 to 30 as disturbances due to the Krakatoa eruption.

The hourly values have been taken from these curves, and the means for the months calculated and added to the report. From these means and those of the previous year, a first approximation to the diurnal oscillation of the barometer for this part of Europe is obtained. The result is peculiarly interesting from the transitions it shows in the hourly variations of the summer pressure as compared on the one hand with the variations which occur at the stations of the German Seewarte on the North and Baltic Seas, and on the other with those which occur at places more in the interior of the Continent. Unfortunately for the prosecution of several inquiries raised by these differences, hourly hygrometric observations are not available from any of these first-class meteorological observatories.

Another interesting feature are the twelve lithographs which represent the continuous registrations of the sunshine recorder, on the scale of 0·4 inch for each hour These lines, which show the sunshine and inferentially the state of the sky in respect of cloud, give valuable information regarding certain hygrometric states of the atmosphere. Hence, with the aid of these and the barometric curves, the influence on the diurnal curve of

[1] "Jahrbuch der Meteorologischen Beobachtungen der Wetterwerte der Magdeburgischen Zeitung." Herausgegeben von Dr. R. Assmann. Jahrgang II. 1883. (Magdeburg, 1884).

pressure of such widely-contrasted states of weather as continuous strong sunshine and continuous cloud may be investigated.

The direction and force of the wind for each hour of the year is given in full. As regards force, the results show for each month a minimum during the night, or, rather, early morning, and a maximum at noon or shortly thereafter. The extremes of difference occurred in December and June, the maximum being only one-fifth greater than the minimum in December, whereas in June the wind blew with more than double the velocity during the hours about noon than it did from 2 to 4 a.m. It may be remarked here that also in June the sunshine attained to the annual maximum. The relations of the hourly variations of wind direction and force to some of the more decided disturbances of the barometric curves are interesting and striking; and still more striking and important would have been the comparisons of the minute disturbances in the barometric curve with similar disturbances shown by continuous registrations of direction and velocity of wind.

The rest of the report is taken up with observations, either once or thrice a day, of the temperature of the soil at depths, in metres, of 5, 3, 1, 0·15, 0·05, and 0·00; daily observations with maximum and minimum thermometers under a thin covering of earth, exposed on bare soil, and immediately over short grass; daily observations with five maximum and five minimum thermometers at heights, in metres, above the ground, of 0·05, 0·20, 0·40, 0·60, 0·80, and 1·00; observations with the solar radiation thermometer at a height of 102 feet, and on the evaporation,—all indicative of the spirit of activity and research which happily characterises this Observatory.

ON A HYDRIFORM PHASE OF "LIMNOCODIUM SOWERBII"

IT is now four years and a half since Mr. Sowerby first discovered the fresh-water jelly-fish in the tank at Regent's Park, and since that time no definite advance has been made towards clearing up the mystery of their life-history.

Prof. Lankester has continued to make observations and experiments of various kinds, in which I have assisted him, but we have hitherto had no opportunity of examining the tank after the withdrawal of the water. This year, however, Prof. Lankester arranged with Mr. Sowerby that we should be present at that operation. This took place on Thursday last. We collected a large quantity of the sediment and portions of the roots of various plants, and Prof. Lankester kindly placed the whole of this material in my hands for further investigation. I soon discovered upon some of the *Pontederia* roots numerous specimens of a minute organism which proved to be hydroid in nature, and evidently a phase in the life-history of *Limnocodium*.

Further particulars, including an account of its remarkable structure, and the possible theories as to its connection with the Medusiform person, I reserve till next week, when Prof. Lankester has kindly offered to communicate them for me to the Royal Society.

I may add that Mr. Sowerby has kindly made arrangements at the Botanic Gardens for keeping the *Pontederia* roots in water in the warm tank during the winter, and that, with Mr. Thiselton Dyer's kind permission, I have placed one of the roots in the Royal Gardens at Kew.

ALFRED GIBBS BOURNE

NOTES

THE Lords of the Committee of Council on Education have received information, through Her Majesty's Principal Secretary of State for Foreign Affairs, that Her Majesty's Consul at Antwerp has been appointed British Commissioner for the International Exhibition which is to be held at Antwerp next year, and that Mr. P. L. Simmonds has been appointed by the Executive Council of the Exhibition at Antwerp their Agent-General for Great Britain and Ireland. The Exhibition in question is a national undertaking under the immediate patronage of His Majesty the King of the Belgians and of the Belgian Government. The President of the Exhibition is H.R.H. the Count of Flanders, and the Vice-President the Minister of Agriculture, Industry, and Commerce. The office of the Agent-General is at 35, Queen Victoria Street, and communications from intending exhibitors should be addressed to him there.

A REMARK was made at the Royal Society dinner on Monday touching the rapidly increasing number of awards of Royal medals not only to Cambridge men, but to men at Cambridge. In connection with it we may refer our readers to an appreciative article in Tuesday's *Times* on Natural Science at that University, in which the immense progress made during the last twenty years is well brought out. The results which may follow from the growth of a Medical School, and of Girton and Newnham, are indicated. The article concludes with the statement that the new studies, for good or ill, have taken root firmly. "They have already exercised a strong depolarising effect upon the cherished traditions and practices of the older studies. Everything is looked at in a new light, from a scientific point of view; and nothing which cannot stand the scientific test is allowed to pass unchallenged. The outcome of all this can be but dimly foreseen."

AT the annual meeting of the Fellows of the Royal Society of Edinburgh, held on Monday, the 24th ult., the following were elected office-bearers for next year:—President: Thomas Stevenson, M.I.C.E.; Vice-Presidents: Rev. W. Lindsay Alexander, D.D., Robert Gray, A. Forbes Irvine of Drum, Edward Sang, LL.D., David Milne Home, John Murray; General Secretary: Prof. Tait; Secretaries to Ordinary Meetings: Prof. Turner, Prof. Crum Brown; Treasurer: Adam Gillies Smith, C.A.; Curator of Library and Museum: Alexander Buchan, M.A.; Councillors: Prof. Cossar Ewart, Prof. James Geikie, Rev. Dr. W. Robertson Smith, Stair Agnew, Prof. Douglas Maclagan, M.D., Hon. Lord Maclaren, Rev. Prof. Flint, D.D., Prof. T. R. Fraser, M.D., Prof. Chiene, J. Y. Buchanan, Prof. Chrystal, Prof. Dickson.

THE University of Edinburgh has just suffered a severe loss by the sudden death of its Principal, Sir Alexander Grant. Many men of science in all parts of the world, who attended the Tercentenary Celebration last April, will remember the prominent and successful part played by the Principal in that remarkable gathering. Full of fresh zeal from this recent triumph of the University, he only a month ago opened the winter session by giving an address to the students, and seemed likely for many years to keep his post and witness a still further increase of that unexampled prosperity which the University has enjoyed under his rule. But this was not to be. He was struck down by an apoplectic attack on Sunday last in his fifty-eighth year.

M. COCHERY, the French Minister of Postal Telegraphy, has ordered the employment of the pneumatic system, which has now been completed in Paris, for the conveyance of ordinary letters to the several railway stations after the closing hours of the different post-offices, the charge being fixed at three deniers for each letter. This is said to be a step preliminary to the carriage of letters, instead of postal cards, by the tubes at an accelerated rate.

WE have received from Messrs. De La Rue and Co. their Diaries—pocket and otherwise—for the ensuing year, and also a charming collection of Christmas cards. The former are as beautifully finished and as full of scientific information and data as usual. Some of the new series of Christmas and New Year's cards have also a scientific side to them, as they refer to flowers and birds, form and colour being carefully studied, and perhaps even more carefully given than they are in many books of botany and natural history. The series which gives us the story of a fox hunt by monkeys on dogs contains some very masterly drawing.

MR. NEWALL has forwarded to us a sketch of the face of one of several watches which he designed and had made some years ago by Mr. D. Glasgow, of Myddleton Square, President of the Horological Institute. The "hours" are replaced by a large round dot, which is easily seen even on a dark night in the Observatory, and there is no need for figures or a double row of them to count up to 24 o'clock, as has been suggested.

WE have received vol. xx. of the *Transactions* of the Royal Society of Victoria, being a record of the work of the Society for last year. The longest paper in the number is one by Mr. Howitt, on the rocks of Noyang; two communications by Messrs. Blunt and Jamieson deal with the influence of light on bacteria, while Mr. Ralph discusses the occurrence of bacteria (bacilli) in living plants. In a paper on modern fireproof and watertight building materials, Mr. Behrendt refers specially to Trägerwellblech ("bearing corrugated iron plates") and asphalte. Mr. Ellery, the President of the Society, communicates notes on the recent red sunsets, which he attributes to the prevalence of vapour in the higher regions of the atmosphere; on the rainfall map recently issued by the Government of Victoria; and on the early history of telegraphy, the invention of which he attributes to Mr. Edward Davy, at one time of the Assay Office in Melbourne. Mr. MacGillivray gives the fifth and sixth instalments of his lists and descriptions of new or liitle-known Polyzoa. The remaining papers printed in the volume (although many more were read before the Society) are:—On the caves perforating marble deposits, Limestone Creek, by Mr. Stirling; incandescent lamps for surgical and microscopical purposes, by Mr. Joseph; electric lighting for mines, by the same author; notes on the dressing of tin ore, by Mr. Newberry; and notes on hydrology, by Mr. Steane.

A PROJECT which, if executed, would render the Paris Exhibition of 1889 for ever memorable, has been published by M. Eiffel, the French engineer, and is described in *La Nature*. It is to erect in the grounds of the Exhibition an iron tower 300 metres in height, that is, twice as high as the Great Pyramid, and more than twice the height of the Strasburg Cathedral; 160 metres he considers as the limit of height possible in a structure of which stone is the principal material, and hence iron is proposed. The base of the tower is of pyramidal shape, and is to be 70 metres high, and the superficial area at this height will be 5000 square metres; above this there are to be three other stages, or stories, in which will be rooms which it is proposed to use for various purposes, scientific and other. The towers of Notre Dame will be mere pygmies beside this colossal structure, and will not reach to its first floor. The projector points out that, in addition to its monumental character, the structure will be useful for strategical purposes in war time, on account of the vast range of view, for meteorological and astronomical observations, for at such a height the clearness of the air and the absence of fogs would render observations possible which cannot be made on the ground. The tower might also be used for the electric light. The whole exhibition and the surrounding neighbourhood might thus be lighted from a central point. Many scientific problems may, it is suggested, be investigated from the tower, such as the resistance of the air to different weights, certain laws of elasticity, the study of the compression of gas or vapours, of the oscillation of the pendulum. In shape it is to resemble an enormous lighthouse, gradually tapering from a wide base to the summit.

WE learn from *Science* that the Norwegian bark *Loveid*, recently arrived in Philadelphia, reports a very peculiar squall experienced October 18, in lat. 39° 49′ N., long. 69° 5′ W. During fine, clear weather, with a light breeze from the northwest, heavy banks of clouds of most threatening aspect suddenly appeared, driving in every direction. Almost immediately a heavy squall of wind and rain struck the vessel, the wind shifting quickly all around the compass. In the midst of this disturbance, which lasted about an hour, a single peal of thunder was heard, and simultaneously a bolt of lightning struck the foreroyal mast-head, and ran down the mast to the royal yard, which was almost destroyed. The lightning, which looked like a ball of fire, then ran out on the horn of the cross-trees, and "burst" with a loud report, scattering sparks all over the vessel. The barometer fell suddenly from 30 to 28·60, and then rose as rapidly, the weather becoming pleasant immediately afterwards. This is rather a peculiar squall, considering the locality and the season.

THE New York *Financial and Mining News* contains an account of the extraordinary effect of an explosion of a large quantity of nitro-glycerine in what appeared to be an extinct oil-well in the Pennsylvanian oil-fields. A careful examination of the soil in the shaft failed to reveal any trace of oil or gas, and at length, as a last resource, it was decided to try the effect of an explosion of a shell containing fifty quarts of this explosive. First a column of water rose eight or ten feet and then fell back; a few moments later the burnt glycerine, mud, and sand rushed up the derrick in a black stream, the blackness gradually changing to yellow. Then, with a roar, the gas burst forth in a cloud which for a moment hid the derrick from sight, and as it cleared away revealed a solid golden column half a foot in diameter shooting from the derrick floor eighty feet through the air, till it broke into fragments on the crown pulley and fell in showers of golden rain for many yards around. This column of oil continued for an hour rushing in a torrent into the air. The branches of the trees around were like huge yellow plumes, and a large stream ran down the hill to a road, where it nearly filled the space beneath a small bridge. In two hours the neighbouring flats were covered with a flood of oil, and the hillside looked as if a freshet had passed over it, while heavy clouds of gas hung low over the woods. Dams were built across the stream in order that the production might be calculated, but they were borne away almost as soon as erected. The people living near the flats fled to the hills; fires had to be extinguished in the district to prevent a conflagration. The outflow was estimated at 8000 barrels in twenty-four hours. Ultimately the stream was diverted into the banks, after much labour and some danger. It was noticed that all the wells in the neighbourhood declined as soon as the outflow here mentioned commenced, the gauges in some of them showing at the end of three days a fall to half their previous depth.

M. JAMIN, Perpetual Secretary of the Paris Academy of Sciences, has been elected a member of the Société française de Navigation aérienne. He will take his seat next Thursday, the 11th inst., and is to deliver a speech on the occasion. He is at present engaged in writing an exhaustive article on aërial direction, which will very shortly appear in the *Revue des deux Mondes*.

ON Saturday night Mr. H. M. Stanley, on leaving Berlin after attending the West African Conference, was entertained at a banquet by the Central Society for Commercial Geography. A peculiar feature of the banquet was an ethnological study in the shape of a group of mummers representing some races of Africa, presumably those of the Cameroon and Angra Pequena regions.

AN earthquake was felt on Sunday and Monday, November 23 and 24, near Briançon, in the valley of Queyras on the banks of the Guil, a torrent discharging into the Durance, in the Department of the Hautes Alpes. Three days afterwards, on Thursday the 27th, a severe shock was felt at Grenoble, about 100 km. west-south-west from the Queyras valley. It lasted thirty seconds, passing in a direction from west to east. All the houses were shaken, but no injury is reported beyond the fright sustained by the inhabitants. The same night, almost at the same hour, six shocks were felt at Lyons, moving in the same direction; and commotions of a similar kind are announced from Turin and the sea-coast of Provence, at Cannes and Nice in particular.

WE regret to hear that M. Duprez de Lonce, the celebrated naval engineer and Member of the French Academy of Sciences, is dangerously ill, and that his life is almost despaired of.

WE regret to announce the death, at Paris, at the age of seventy-four, of M. Quet, a distinguished French mathematician, well known for his works in connection with capillarity, electricity, &c., most of which have appeared in the *Comptes Rendus* of the Paris Academy of Sciences.

M. W. DE FONVIELLE has published a pamphlet on "L'Aérostat dirigeable de Meudon," in which he endeavours to show that the reports current in the French Academy respecting the experiments in question are exaggerated, though at the same time he seeks to do justice to his distinguished countryman, who has twice succeeded in proving that by means of electricity the power of resistance may be imparted to balloons. He concludes by recommending that, the electric fluids having done their part, *la parole est à le vapeur.*

INTERESTING researches with so-called Paradise fish (*Macropus venustus*) were made at the Berlin Aquarium recently. The fish is a native of China, its body, only a few centimetres long, is of the brightest hues, and its bluish-green fins are so enormously large that the fish seems almost to succumb under their weight. It is easily kept, and breeds frequently in captivity; the temperature of the water it is kept in must, however, not be allowed to sink below 20° C.

ONE result of the recent expedition sent from Quetta under Sir Oriel Tanner to punish the inhabitants of the Zhob Valley is stated in a telegram from Calcutta to be a complete survey of the whole of that valley. It has been ascertained that the best road from the Gomul Pass to Candahar does not lie, as had been supposed, through the Zhob Valley, but through the valley of the Khwandar, and that the route is practicable for a large army.

DR. OTTO FINSCH left Sydney on September 10 by the steamer *Samoa, en route* for the Phœnix and Union Islands, where he intends staying for some time and making extensive ethnographical collections.

THE *Boletin* of the National Academy of Sciences in Cordova, Argentine Republic (Buenos Ayres, 1884), has a very long paper by Señor Ameghino on his geological and palæontological investigations in the province of Buenos Ayres. The only other paper is by Herr Doering, and deals with the sinking of artesian wells in the Argentine Republic.

THE Rev. Henry H. Higgins publishes in a separate form a paper on "Museums of Natural History," read before the Literary and Philosophical Society of Liverpool. After an experience of over a quarter of a century, during which he passed several times every week through museum rooms, the author calculates that out of a thousand visitors to the Liverpool Museum, ten to twenty were students, 780 interested observers, and 200 loungers.

MR. CHARLES C. SHERRINGTON, B.A. of Caius College, Cambridge, has been elected to the vacant George Henry Lewes Studentship.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. W. J. Bennett; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. Samuel Levi; an Ocelot (*Felis pardalis*) from America, presented by Mr. H. B. Whitmarsh; two King Parrakeets (*Aprosmictus scapulatus*) from New South Wales, presented by Mr. E. Meek; a Cheer Pheasant (*Phasianus wallichii* ♀) from North India, presented by Mr. E. Buck; a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, deposited; a Rufous-necked Weaver Bird (*Hyphantornis textor*) from West Africa, received in exchange; four Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

THE ROYAL SOCIETY ANNIVERSARY

THIS meeting took place on Monday last, the time-honoured date—St. Andrew's Day—falling on Sunday. In the regretted absence of the President, Prof. Huxley, who, the Fellows were rejoiced to learn, is rapidly recovering his health from his sojourn in Italy, the Treasurer, Mr. John Evans, occupied the chair and read the following address:—

The absence of our President from his post to-day must of necessity cast a certain amount of gloom over the proceedings at this our anniversary meeting, and, personally, I feel additional regret that it devolves upon me, as your Senior Vice-President and Treasurer, to be the unworthy occupant of the chair on the present occasion. My regret at the absence of the President is, however, in one respect tempered by a strong hope, in which I am sure that you will all fervently join, that the timely retirement from arduous work which has been enforced upon him by his medical advisers may produce those beneficial results which we all so cordially desire, and that we may ere long again see among us our accomplished and valued President in renewed health and strength.

I must, however, turn from the expression of our hopes for the future, to that of our regrets for the past, and for a short time dwell upon the mournful list of vacancies which the ever-active hand of death has caused in our ranks during the past twelve months. In one respect only can a topic of consolation be found in this list. It is that in extent it is less than that of last year, the total number of our deceased Fellows being only eighteen on the home list and two on the foreign list, while those numbers were twenty-one and two respectively at our last anniversary.

Both the foreign members whose loss we have on the present occasion to deplore were men of the highest distinction in chemical science. Both were residents at Paris, and both had Chairs in the French Academy, of which the one had been since 1868 one of the permanent secretaries. I cannot dwell upon the discoveries and the remarkable career of M. Jean Baptiste André Dumas, whose energy and perspicuity, even when past the limit of fourscore years, all those who of late have had the opportunity of being present at a meeting of the French Academy must have found reason to admire. An appreciative memoir of him by one of our own Fellows, who of all men living is perhaps the best qualified to judge of the value of his labours—Prof. Hofman—written while Dumas was still among us, will be found in the pages of our own *Proceedings* (vol. xxxviii. x.), and those of NATURE (vol. xxi. February 6, 1880). It will give some slight idea of the extent of time over which the labours of M. Dumas have extended if I mention that, so long ago as in 1843, he received the Copley Medal at our hands, at a time when his chemical and physiological researches had already extended over a period of twenty-two years. M. Dumas died at Cannes on April 11 last, and among the most touching of the speeches at his obsequies was that of M. Würtz, whose own decease took place on the 12th of the following month.

Although nearly twenty years younger than M. Dumas, M. Karl Adolph Würtz had for a long time been one of the most distinguished leaders of modern chemical science, especially in the department of organic chemistry, aud his merits were recognised by this Society in 1864, when he was elected one of our foreign members, and again in 1881, when the Copley Medal was awarded to him.

Among our English Fellows was a contemporary of Würtz, who, like him, had been a pupil of the illustrious Liebig, but whose bent was more on the practical than on the theoretical side of chemistry—I mean Dr. Angus Smith, whose official labours in favour of pure air and pure water combined both tact and zeal, and were productive of highly beneficial results.

One other chemist has been taken from among us, Mr. Henry Watts, the well-known editor of the "Dictionary of Chemistry," and of more than one issue of "Fownes's Manual."

Our other losses extend over various departments of science. In botany our ranks are thinned by the death of Dr. John Hutton Balfour, formerly Professor of Botany at Glasgow and the Emeritus Professor of that Chair in the University of Edinburgh; and of the veteran Mr. George Bentham, who had nearly completed his eighty-fourth year. During his long and varied experiences of life, botany was his constant pursuit and study; and some thirty years ago, after presenting his fine collections and library to the Royal Gardens at Kew, he devoted himself to labouring there on the Floras of Hong Kong and Australia, and in conjunction with Sir Joseph Hooker, on the "Genera Plantarum," until his health gave way in the spring of last year. The exceptional value of his botanical work was recognised by this Society in 1859, when a Royal Medal was awarded to him, and his regard for the Society has been testified by his making a bequest of 1000*l.* to our Scientific Relief Fund.

Among mathematicians we have lost Dr. Isaac Todhunter, whose educational treatises have for many years been recognised as standard works, and whose elaborate histories of different branches of mathematical science have earned for him a high reputation; and Mr. Charles W. Merrifield, who, in addition to achieving distinction by his educational works on arithmetic and mathematics, did much in the direction of the practical application of science, and at the Royal School of Naval Architecture and Marine Engineering successfully laboured in improving the stability and the sea-going powers of the British Navy.

Another distinguished mathematician whom we have within the last few weeks had the misfortune to lose, was the Rev. Richard Townsend, Professor of Natural Philosophy in the University of Dublin, whose labours in the more abstruse fields of geometrical speculation extended over a period of nearly forty years. Mr. James Rennie was also a votary of mathematical research.

Among practical men of science, the veteran Mr. Charles Manby, who for forty-five years had been Secretary or Honorary Secretary of the Institution of Civil Engineers, will deservedly take a high place.

The anatomical and physiological labours of Prof. Allen Thomson had extended over the longer term of fifty-four years, and few possessed the power of clearer exposition than he, while for acts of personal kindness there must be many besides myself who owe him a deep debt of gratitude.

Among others connected with the medical profession we miss the distinguished surgeon Mr. Cæsar Hawkins, Dr. Alexander Tweedie, and Sir Erasmus Wilson, whose name will long survive, not only in connection with dermatology and the Chair of Pathological Anatomy at Aberdeen, but with the Egyptian obelisk, known as Cleopatra's Needle, the presence of which in London is entirely due to his liberality.

In Mr. R. A. C. Godwin-Austen we have lost one who for nearly fifty years had ranked among the foremost of English geologists. His manifold observations will be recorded elsewhere, but as an instance of his critical powers, I may mention his now classical paper on the possible extension of the Coal Measures beneath the south-eastern part of England, read in 1855, his speculations in which as to the western extension of the axis of Artois, all recent deep borings within the Thames Basin have so fully substantiated.

In Dr. Wright we have lost an accomplished palæontologist whose knowledge of the fossil Echinodermata and Ammonitidæ was almost unrivalled.

The Duke of Buccleuch had for fifty years been one of our Fellows, and in 1867 occupied the position of President of the British Association; while Sir Bartle Frere, although an ethnologist and geographer, will probably be better known as an able and energetic public servant and administrator than as a man of science.

In common with the nation at large, we have to deplore the untimely and unexpected decease of another distinguished statesman, the late Postmaster-General, Mr. Fawcett. A man of rare mental powers, the effect upon him of the greatest of all physical deprivations, the loss of sight, was only to make him rise superior to his misfortune. As a student of political economy he attained a high reputation, and he turned his mastery of the subject to good account when he entered into the sphere of public life towards which his natural aspirations led him. His singleness and honesty of purpose, the inborn justice of his well-balanced mind, his devotion to the public good, and his invariable courtesy, endeared him alike to political friends and opponents; while to those who were brought into more immediate contact with him, his truly sympathetic nature, and the marvellous memory which preserved even minute details of former conversations, gave a charm to his intercourse which none who enjoyed it will ever forget.

As I have already observed, our losses on the home list, including one resignation of Fellowship and one removal from our list, are less than in many former years, being altogether 21 in number; we have, on the other hand, elected 16 Fellows, including one Privy Councillor. It would, however, appear that our numbers are gradually attaining to something like a state of equilibrium, and that if our elections continue to be limited as at present, the roll of the Society will remain at its present standard of about 470 Fellows. Looking at the recognised longevity of scientific men and the age at which many now achieve the distinction of being elected into the Society, it seems to me not improbable that our numbers will ere long show a tendency to increase rather than to diminish.

Of the *Philosophical Transactions* three parts, and of the *Proceedings* eleven numbers, have been published; while the number of papers received during the past year was 100, as compared with 103 in the previous year. Of these the most numerous have been in the departments of electricity and magnetism, though physics and mathematics, chemistry, mineralogy, anatomy, and physiology, botany, and morphology have all had their share.

It is hardly within my province to select any papers that we have published as being the most worthy of mention. The mere fact that they have appeared in the *Philosophical Transactions* is a sufficient voucher for their value. I may, however, call attention to the report of Captain Abney and Dr. Schuster, our Bakerian Lecturer for the present year, on the total solar eclipse of May 17, 1882, which is the outcome of an expedition towards which a grant of 350*l.* was made from our Donation Fund. Some of the results were mentioned by Mr. Spottiswoode in his Presidential Address of 1882, but the value of the details with regard to the corona, and the success which attended the efforts of the photographers, can only be estimated from an examination of the paper itself. The detailed results obtained by the photographers who accompanied the American expedition to Caroline Island in the South Pacific in order to observe the solar eclipse of May 5, 1883, have not yet been brought before the Society.

In respect to biological studies, our record of the past year, though it does not contain the announcement of any very startling results, gives evidence of fruitful activity along various lines of research.

In Botany, Mr. Gardiner has continued his observations on the important subject of the continuity of protoplasm in vegetable cells, which was referred to in the President's Address of last year; he has also brought forward some interesting results derived from an examination of the changes in the gland-cells of Dionæa, which serve still further to illustrate the identity of the fundamental physiological processes in plants and animals. Mr. Bower has dealt with the morphology of the leaf in certain plants, in a memoir both valuable in itself, and noteworthy because hitherto the study of abstract vegetable morphology has perhaps not obtained in this country the attention which it deserves, and which has been given to it in other countries, especially in Germany.

In Physiology two important papers have been presented on the difficult subject of the functions of the cerebral convolutions, one by Drs. Ferrier and Yeo, and the other by Prof. Schäfer and Mr. Horsley. Both contain observations which demand careful consideration by all physiologists.

The results of the study of animal forms which is happily being carried on with great activity, I may say, all over the United Kingdom, are for various reasons principally recorded elsewhere than in the pages of the *Transactions* or *Proceedings* of this Society. Nevertheless, this subject has also been fairly represented at our meetings. Our distinguished and unwearied Fellow, Prof. W. Kitchen Parker, is still continuing his elaborate and valuable researches on the vertebrate skull; and during the past session the Society has had the pleasure of receiving several short papers, expounded in person by their author, from a veteran in the study of animal morphology, whose first communication to the Society bears the date of 1832. I need hardly say I mean Sir Richard Owen.

A few words must be said with regard to the acquisitions made by our library and collections. Our gallery of portraits has, through the kind liberality of Dr. Wilson of Florence, received two important additions in the form of half-length original portraits of the distinguished mathematicians and philosophers, Leibnitz and Viviani, both of whom were Foreign Members of this Society. When we remember the warmth of feeling with which the rival claims of Newton and Leibnitz to the invention of Fluxions or the Differential Calculus were for many years discussed, and call to mind that the question occupied the attention of a Committee of this Society in 1712, which reported in favour of Newton's claims, we may rejoice that the heat of the controversy is long since over, and congratulate ourselves that the portraits of these rival intellectual giants now hang peacefully side by side on our walls. The portrait of Viviani, the great geometrician, the pupil of Galileo and the associate of Torricelli, and a contemporary of Newton and Leibnitz, finds also a fitting resting-place in our gallery.

Our portfolio of engraved and lithographic portraits of scientific men has been considerably augmented by liberal donations from the executors of our former President, the late Sir Edward Sabine, through Mr. R. H. Scott.

The Lalande Medal, which had been awarded by the French Academy to Sir Edward in 1826, and which, together with a Royal Gold Medal, was presented to the Scientific Relief Fund, was by the Council redeemed from the Fund, and will be preserved among our other medals as a memorial of one who for so long a period rendered important services to the Society. A bronze medal of our distinguished Fellow, Prof. Sylvester, has been presented to our collection by the Johns Hopkins University, at Baltimore.

The library itself has during the past year received by donations about 380 complete volumes, besides about 240 pamphlets, and more than 2400 parts of serials; 24 charts have also been presented to it.

With regard to our finances, I may venture to say, as your Treasurer, that I consider them to be in a satisfactory condition.

I must now turn to some of the subjects which, during the past year, have occupied the attention of the President and Council, and which in more than one instance have brought them into communication with Her Majesty's Government.

In July of last year a letter from the Treasury was received requesting our opinion as to the desirability of subsidising the Armagh Observatory, the income of which had been materially reduced, owing to recent legislation in Ireland. In reply to this an answer was sent pointing out the good work that had been done in the Observatory, and the exceptional character of the institution, and recommending it to the favourable consideration of the Government. Unfortunately, however, the loss of income applicable to the maintenance of an Observatory has not been made good, though the Treasury, "having regard to the advice of the Royal Society, and to the diminution in the income of the Observatory," has granted a sum of 2,000*l*. in aid of its funds, the annual income derived from which sum is to be applied by trustees to the maintenance and purchase of instruments and apparatus.

Another correspondence with the Treasury as to the bathymetrical survey of the lakes within the British Isles did not lead to any concession in favour of such a necessary complement to the National Ordnance Survey, though the omission in our maps of all details relating to the depth of our lakes and the contour of their beds, cannot be justified on practical, and much less on scientific grounds.

In May last the Astronomer-Royal brought under our notice the position of this country with respect to the International Bureau des Poids et Mesures, an institution established by what is commonly known as the Metric Convention; and it was resolved that in the opinion of the President and Council it was highly desirable that our country should take part in the International Commission of Weights and Measures, and contribute the sum which our adhesion would entail. A deputation was appointed to bring the subject under the notice of the Lords of the Treasury, and, after some correspondence, the Society was authorised to enter into informal negotiations with the officers of the Bureau, with the happy result that Great Britain was invited to join the Metric Convention, and through her Ambassador at Paris has, I believe, now given in her adhesion to it, and is entitled to all the privileges accorded by the Bureau. The appliances at the command of the Bureau for the verification not only of the standards of the metric system, but of other units of measure, far surpass in scientific accuracy anything that is at present available in this country, and we now enjoy the double advantage of being removed from the state of isolation in which for some years we have stood in regard to the other nations of Europe, and of now being affiliated to an establishment in which the verification of standards has been carried to the highest perfection. At the same time, it is distinctly understood that our adhesion to the Bureau in no way commits the Government of this country to any change of opinion favourable to the adoption of the metric system, but that our entire freedom to retain our own system of weights and measures is absolutely preserved. Whatever may be the advantages of the metric system from a scientific point of view, the question whether a scale of weights, money, and measures, which in its lowest denominations follows a duodecimal rather than a decimal system, is not better adapted for the convenience of daily life, is one that by many is regarded as fairly open to discussion.

Another event of both scientific and national importance has been the meeting of an International Conference on the subject of a Prime Meridian of Longitude. The desirability of a common starting-point from which to reckon degrees of longitude has long been felt among all civilised nations, especially those of a maritime character, and was discussed at some length during the Congress of the International Geodetic Association at Rome in October 1883. It was not, however, until the end of last year that invitations were issued by the United States Government for different countries to send representatives to an International Conference to be held in the city of Washington for the purpose of discussing, and, if possible, fixing upon a meridian proper to be employed as a common zero of longitude and standard of time-reckoning throughout the globe. The letter of invitation addressed to this country was referred to the President and Council of this Society, with a request to advise the Government whether it was advisable in the interests of science to accept the invitation. In reply, an opinion was expressed as to the high importance, both for the interests of science in general, and of our own country in particular, that our Government should be represented at the Conference, and the Treasury at once sanctioned the expense of sending two delegates to Washington. These were Sir Frederick Evans, the late Hydrographer to the Admiralty, and Prof. J. C. Adams. General Strachey, the Chairman of the Meteorological Committee, was also nominated to represent India, and Mr. Fleming to represent the Dominion of Canada. The delegates assembled at Washington in the month of October last, and proceeded to discuss the questions whether a single prime meridian for all countries should be adopted, and if so, through what point on the earth's surface should that meridian be drawn. After long discussion it was eventually resolved that the meridian of Greenwich should be generally adopted, twenty-two[1] of the nations voting in favour of this measure, and only one, San Domingo, against it. The representatives of France and Brazil abstained from voting. The proposal for the adoption of Greenwich was made by one of the representatives of the United States of America, and was fully discussed. Our own representatives ably supported the proposal, and another of our most distinguished Fellows, Sir William Thomson, who happened to be in America at the time, was courteously invited to attend the meetings of the Conference, and on the request of the President to express his opinions. The arguments adduced in favour of the adoption of Greenwich were such as must commend themselves to all unprejudiced minds. It could hardly be expected that there should be any special spot upon the earth's surface from which longitude would naturally be reckoned, and the whole question, apart from any sentimental or patriotic feelings, is therefore one of the greatest convenience. Were the employment of degrees of longitude as general geographical units entirely unheard-of up to the present time, it would, of course, be a matter of perfect indifference whether the datum was at Greenwich, Paris, the Ferroe Isles, or any other spot. The meridians most in use are those of the two former places, and when we come to consider that, as was pointed out, the shipping tonnage controlled by the Greenwich

[1] The following nations voted in favour of Greenwich:—Austria, Chili, Colombia, Costa Rica, Great Britain, Guatemala, Hawaii, Italy, Japan, Liberia, Mexico, Netherlands, Paraguay, Russia, Salvador, Spain, Sweden, Switzerland, Turkey, United States, and Venezuela.

standard of longitude is about 14,000,000 tons, while that controlled by the longitude of Paris amounts to 1,750,000 tons only, the preponderance of convenience in favour of the former is placed beyond all dispute. The use of nautical charts constructed from the meridian of Greenwich, and also of the Greenwich *Nautical Almanac*, is by no means confined to the British Navy, for numerous other nations have availed themselves of the long-extended labours of our hydrographers, and the computations of our astronomers. At the same time there is no one among us who would for a moment venture to dispute the vast services to science which have been rendered by French astronomers and geographers, nor should we contest the right of French *savants* to regard Paris as the μεσόμφαλος ἑστία of all other branches of science; the question of a common zero of longitude, however, is not only of scientific but of commercial importance, and we may be confident that eventually our friends on the other side of the Channel, whose metric system has been so largely adopted by other countries, will in their turn sacrifice their own meridian, and adopt that which all neighbouring countries have declared to be the most convenient for general use. If some French locality on the meridian of Greenwich, such for instance as Argentan, were nominally the French datum, the results would be the same so far as maps and charts are concerned, and the natural patriotism of the French nation would remain uninjured.

The adoption of a universal day has also been recommended by the Conference. It is to be a mean solar day to begin for all the world at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day and date of that meridian, and is to be counted from zero up to twenty-four hours.

The great volcanic eruption of Krakatoa, in the Straits of Sunda, which took place in August of last year, was followed by remarkable atmospheric and other disturbances, observations on which have been communicated to this and various other learned Societies, and have led to much interesting discussion. The fact, as pointed out by General Strachey and Mr. Scott, that at some barometrical stations the atmospheric wave caused by the eruption was still to be traced until about 122 hours after its origin, and that it must have travelled more than three times round the entire circuit of the earth, shows how vast must have been the initial disturbance causing the wave. The possibility of the remarkable atmospheric appearances which so constantly accompanied the rising and setting of the sun for some months subsequent to the eruption being due to volcanic dust in suspension in the air, offered a farther incentive to investigate the whole history of the eruption. In consequence, the Council in January last nominated a Committee to collect the various accounts of the volcanic eruption at Krakatoa and attendant phenomena, in such form as shall best provide for their preservation and promote their usefulness, and a sum of 100*l*. in all has been granted from the Donation Fund to defray the expenses of the Committee. A Committee of the Royal Meteorological Society, which had already been appointed to study the sunset phenomena of 1883-84, joined forces with our Committee, and their united labours, with Mr. A. Ramsay as secretary, have resulted in the accumulation of a voluminous mass of material. The accounts given in the chief British and foreign scientific serials have been extracted and classified, and the times of the various observations reduced to Greenwich mean time.

The literature on the subject, as Mr. Symons informs me, seems almost inexhaustible, and the Committee, feeling that some limit must be adopted, have now stopped the collection of further data, and are engaged in the discussion of what have already been obtained. The manuscript is classified according to subjects, and each of these is being studied by the members of the Committee most familiar with it. It is to be hoped that in the ensuing session we shall be favoured with some of the results of their labours.

In the Presidential Address of last year mention was made of a series of borings which it was proposed to make across the delta of the Nile in Egypt, and which, with the sanction of the Secretary of State for War, had been intrusted to the officer commanding the Royal Engineers attached to the army of occupation in Egypt. Shortly afterwards a Report from Col. Heriot Maitland, R.E., and Major R. H. Williams, R.E., was received, giving an account of a boring at Kasr-el-Nil, near Cairo, which had been carried to a depth of 45 feet, and of a second boring at Kafr Zaiyat, where a depth of 84 feet was attained. In both cases great difficulties had to be surmounted, but in neither was the solid rock reached beneath the superficial deposits. A second Report from the same officers, dated January 18 last, states that a third boring had been executed at Tantah, this time by the sappers of the Royal Engineers, and not by Arab workmen, though still with but imperfect tools. In this instance a depth of 73 feet was reached, but again without finding the solid rock. Samples of the materials obtained at different depths in these three borings have been forwarded to the Society by the War Department, and Prof. Judd has kindly undertaken their microscopic examination, and will shortly report the results of his labours to the Committee in charge of the subject.

With regard to the continuance of the borings, which seem to promise information of great value and interest, it is to be feared that the attention of the military authorities will for some time to come be attracted to more urgent business, though the Council of this Society has expressed its willingness to grant from the Donation Fund a further sum of 200*l*., with the view of obtaining better apparatus for boring than that which has hitherto been employed.

The publication of the results of the *Challenger* Expedition, with which a Committee of this Society is to some extent concerned, has made considerable progress during the past year. Mr. Murray informs me that 47 Reports, forming 13 large quarto volumes, with 6276 pages of letterpress, 1051 lithographic plates, many woodcuts, charts, and other illustrations, have now been published. Nine other Reports are now being printed, and the eleventh Zoological volume and the first Botanical volume will be issued during the present financial year.

The work connected with the remaining thirty-six memoirs is making satisfactory progress, a large instalment of the manuscript being already prepared, and many of the plates either already printed off or drawn on the stone.

There has been an unavoidable delay in the case of the two volumes containing the narrative of the cruise and a general account of the scientific results of the Expedition, but it is expected that they will be issued within the next three months, and possibly before the end of the current year.

It was estimated that the investigations connected with the collections and observations made during the Expedition would be completed and published in 1887, and Mr. Murray has every reason to believe that the work will be finished within the estimated time.

The tenth Zoological volume which has just been issued, contains important Reports on the Nudibranchiata, Myzostomida, and Cirripedia, by Drs. Rudolph Bergh, L. von Graff, P. P. C. Hoek, as well as on the Cheilostomata, a sub-order of the Polyzoa, by Mr. George Busk. A first instalment of the Anthropological Report is also given by Prof. William Turner, in a detailed examination of the human crania, upwards of 60 in number, brought home by the Expedition. The total number of crania, however, described and tabulated in the memoir is 143, the whole from aboriginal and as yet uncivilised people. The previous Zoological volume is devoted to an exhaustive examination of the Foraminifera, by Mr. H. B. Brady.

The subject of the International Polar Observations, which were carried out during the twelve months ending with August 1883, has been touched on in recent Presidential Addresses, and in that for 1881 the general outline of the whole scheme was indicated. Now, however, the programme then only sketched out has been more than fulfilled, no less than 14 stations for observers, 12 for the Northern and 2 for the Southern Hemisphere, having been organised. Of all the expeditions, one only, that from Holland, failed to reach its destination, Dickson Harbour, at the mouth of the Obi River, as it was beset by ice in the Kara Sea, in the month of September 1882. The ship which carried the members of the expedition sank in the month of July 1883, but they all reached home in safety, having carried out their observations as fully as lay in their power. One of the two expeditions sent out by the Chief Signal Office, Washington, was not so fortunate. The party under Lieutenant Greely, after spending over two years at Lady Franklin Bay, Smith's Sound, was eventually rescued at Cape Sabine, in July last, but not before many of its members had succumbed beneath the fearful hardships of their protracted Arctic sojourn.

The actual points of observation, going eastwards from Behring Straits, and the States which sent out the expeditions, are tabulated below:—

Point Barrow	The United States.
Fort Rae	Great Britain and Canada.

Lady Franklin Bay.........	The United States.
Cumberland Sound.........	Germany.
Godthaab.....................	Denmark.
Jan Mayen	Austria.
Spitzbergen	Sweden.
Bossecop	Norway.
Sodankylä	Finland.
Nova Zemlya	Russia.
Mouth of the Lena.........	Russia.
The Kara Sea	Holland.
In the Southern Hemisphere—	
Cape Horn	France.
South Georgia...............	Germany.

At all of these stations observations were carried on for a year, and at some for even a longer period.

In the month of April last a Conference was held at Vienna, to decide as to the form and mode of discussion and publication of the results, and it may be hoped that these will appear before the end of 1885.

Of the serial publication, "Communications from the International Polar Commission," six parts, with an aggregate of 334 pages, have already appeared, and in it will be found all particulars of the undertaking.

The regulations under which the Government Grant of 4000*l*. is administered have during the past year been again under discussion, and have in some respects been slightly modified. It is, of course, needless to repeat that this grant, though nominally made to the Royal Society, in no way adds to its funds, while its administration rests with a Committee of from sixty or seventy members, many of whom are not of necessity Fellows of our Society. As the grant is now made in two instalments, it has been arranged that the meetings of the Committee shall be held twice in each year, viz., in May and December, which it is hoped will amply meet the convenience of applicants for grants.

In looking back upon the grants which have been made during the past year, I think that a tendency may be observed on the part of the Committee to devote considerable sums in aid of extensive researches rather than to fritter away the money at their disposal in a series of small grants. They have, for instance, allotted the sum of 500*l*. towards the exploration of Kilimanjaro and the adjoining mountains of Tropical Africa, and 200*l*. in aid of an expedition for the exploration of the mountain of Roraima in British Guiana. A grant of 200*l*. has also been made towards a report on the Flora of China; while 300*l*. has been allotted towards the extra accommodation and instruments for magnetic observations in the new Observatory of the Royal Cornwall Polytechnic Society. It will be remembered that, in his Address last year, the President called attention to the discovery by Dr. Huggins of a method of photographing the solar corona without an eclipse; and, for the purpose of making further experiments in this direction, and for carrying on other physical observations at some place of high elevation and of easy access, a grant of 250*l*. was placed at the disposal of a Committee. The place of observation selected by the Committee was the Riffel, near Zermatt, in Switzerland, which has an elevation of 8500 feet, and possesses important advantages both of access, and of hotel accommodation. They appointed Mr. C. Ray Woods, who had had experience in photographing the corona during the eclipse of 1882 in Egypt, and again in Caroline Island in 1883, to take charge of the work under the instructions of Dr. Huggins and Capt. Abney.

Mr. Woods arrived at the Riffel in the beginning of July, when he erected the necessary instruments under a tent of "Willesdenised" paper, and continued at work there until September 21. Unfortunately, the present year has been exceptionally unfavourable for work on the corona, in consequence of an unusual want of transparency in the higher regions of the atmosphere. This probably may be owing to the presence there of ice-crystals or of small particles of matter of some kind, such as, personally, I am tempted to think might be due to the Krakatoa eruption. Whatever the cause, the sky as seen from the Riffel was far from being so clear as it has been during former years. Mr. Woods observed that the freer the lower air was from cloud and mist, the more distinctly came out a great aureola around the sun, which he found to have a diameter of about 44°, and to be of a faint red near the outer boundary, and bluish-white within, up to the sun's limb.

These unfavourable conditions of the atmosphere have made it impossible for Dr. Huggins to obtain any photographs of the corona in England. The great advantage at the Riffel of being free from the light scattered from the lower 8000 feet of air has enabled Mr. Woods, notwithstanding the serious drawback of the persistent aureola, to obtain about 150 photographs, of which more than half are sufficiently good to show the general form, and a smaller number the stronger details of that part of the corona which lies within from 8′ to 12′ of the sun's limb. It would be premature to express any opinion as to the information which may eventually come out from the Riffel plates. They are now being drawn preparatory to a full discussion. In the meantime I may congratulate the Society upon the confirmation of the hope expressed by our President at the last anniversary, "that a new and powerful method of investigation has been placed in the hands of students of solar physics."

Another of the grants made by the Committee has also contributed to important scientific results, as it has enabled Mr. Caldwell to make some important observations on the early stages of the Monotreme ovum, a brief account of which was communicated to the meeting of the British Association for the Advancement of Science at Montreal. A fuller account of the observations, such as is necessary for the adequate appreciation of their importance and bearings, will, I hope, be laid before the Society during the ensuing session, when we shall also probably hear the result of similar investigations in like manner rendered possible by the existence of the Government Grant.

Some slight aid has been rendered from the same source towards the reduction of observations carried on at the meteorological station on the summit of Ben Nevis. This Observatory, situated on the highest point within the United Kingdom, has through the past year been under the charge of Mr. R. T. Omond and two assistants. During the summer months the buildings of the Observatory have been enlarged by the addition of new observing-rooms and increased accommodation for the observers and any scientific workers who may desire to carry on those physical researches for which the climate and position of Ben Nevis afford many facilities.

The erection and equipment of the Observatory have cost more than 5000*l*.; and, in connection with the observations carried on at the top of the mountain, others have been daily made near the sea-level at Fort William. A first report on these conjoint high- and low-level observations, which began in 1881, has been prepared by Mr. Buchan ("*Journal* of the Scottish Meteorol. Soc.," 3rd Series, No. 1 (1884), p. 4). The monthly normals for atmospheric pressure and temperature have been approximately determined for the Observatory. Important results have also been obtained relating to the decrement of temperature with height, for different months of the year and hours of the day, the diurnal variations of the wind's velocity, the very large increase in the rainfall on and near the summit, and the altogether unexpected hygrometric conditions of the air in their relation to the cyclones and anticyclones of North-Western Europe.

Another of the funds at our disposal, the Scientific Relief Fund, requires a few words of mention. Its resources have been considerably enriched during the past year by the legacy of 1000*l*. from Sir William Siemens, and nearly 50*l*. from the medals offered by the executors of the late Lady Sabine; and the legacy of 1000*l*. from the late Mr. Bentham will, it is hoped, ere long be received; but even with these munificent additions the income of the fund will amount to only 250*l*. per annum, while last year the calls upon it amounted, I regret to say, to no less than 450*l*. The incalculable value of such a fund to men of science or their families requiring temporary aid must be apparent to all, and looking at the unfortunate necessity for its existence which the calls upon it prove, I venture to commend it to your support. It will, perhaps, not be out of place here to say a few words with regard to the administration of this fund, the existence of which dates from 1859, and is in a great degree due to the exertions of the late Mr. Gassiot. The Council of the Royal Society takes charge of any sums contributed to the fund and invests them, applying the interest in grants for the relief of such scientific men or their families as may from time to time require or deserve assistance. These grants are, however, made only on the recommendation of a committee of seven members who investigate the cases before them, and applications for relief cannot be entertained except on the recommendation of the President of one of the chartered Societies, viz., the Astronomical, Chemical, Geographical, Geological, Linnean, Royal, and Zoological Societies. Since January 1861, when the first grant was made, the total number of grants has been eighty-eight, and the total sum distributed 4340*l*.

Our Donation Fund has also proved of much service, and several of the applications for comparatively small amounts, which were referred by the Government Grant Committee for the consideration of the Council of the Royal Society, were met by grants from this source. This most valuable fund, the annual income of which is now about 400*l.*, has, during the past year, rendered important aid to various scientific objects. From it considerable grants have been made towards obtaining specimens of Hatteria and Apteryx; for expenses incurred on account of the voyage and investigations of the surveying-ship *Triton*; for collection of materials relating to the Krakatoa eruption; towards the borings in the Delta of Egypt; and, lastly, in aid of the Marine Biological Association.

The close connection of the future of our fisheries with the advancement of certain branches of zoological science was commented upon by our President in his last Anniversary Address, and I have now to record the foundation of two establishments devoted to marine research. The first of these is the station established at Granton, near Edinburgh, mainly through the energetic labours of Mr. John Murray of the *Challenger* Expedition. It consists of a floating laboratory where physical and biological investigations are carried on, and it is provided with a steam yacht for taking observations at sea and procuring specimens for examination. Chemical and other laboratories are now being erected on the shore, close to the inclosed piece of water where the floating laboratory is moored. Two naturalists, a chemist and a botanist, are permanently attached to the station, and have an engineer, a fisherman, and three attendants to assist them in conducting regular systematic observations. 2500*l.* have been spent on the equipment of the station, and it has at present an income of 400*l.* a-year, independent of the grants which some of the permanent staff have received from the Government Grant Committee to aid them in their researches. It is well that it should be known that any scientific observer is at liberty to make use of the station free of charge; indeed, during the past year five gentlemen and one lady have availed themselves of this privilege during short periods of time.

But the movement in favour of such stations has not been confined to Scotland, for I have also to chronicle the foundation of the Marine Biological Association, which originated in a meeting held in these rooms on March 31 last, our President being in the chair, and many of our principal naturalists taking part in the proceedings. The formation of such an Association has long been hoped for by many interested in obtaining a correct knowlege of the life and conditions of our sea-coast, who are now principally indebted to Prof. Ray Lankester for the realisation of their hopes. The operations of the Association will in no way clash with those of the station at Granton, but both institutions will work towards a common end. One effect, indeed, of the new Association will probably be to render all the more fruitful the labours on the more northern shores by instituting similar researches at other parts of the coast of our island.

The work of the Association is as yet in the inceptive stage, but a site well adapted for a marine observatory will, through the liberal endeavours of the Mayor and Corporation of Plymouth, probably be secured in that town, some citizens of which have also promised a noble donation of 1000*l.* towards its erection. The Clothworkers' Company has contributed 500*l.* and the Mercers' Company 250 guineas, while the Council of this Society has also shown its sympathy with the movement by a grant of 250*l.*, and the British Association by one of 150*l.* Handsome donations have also been made by private individuals, and the number of members of the Association is gradually increasing. When once the station is completed and at work, and its aims and operations become better known, I make little doubt that it will receive a much larger share of public support. But before the station can be erected and at work, it is calculated that an outlay of 10,000*l.* is necessary for its building and equipment, of which as yet not quite half is forthcoming, and I venture to take this opportunity of enforcing the claims of the Association upon all who are interested in "the improvement of natural knowledge." As has already been pointed out in the memorandum issued by the Association, "great scientific and practical results have been obtained in other countries, notably in the United States of America, in Germany, France, and Italy, by studies carried on through such laboratories as the Marine Biological Association proposes to erect in this country," and I may add as is already at work at Granton. When we consider the enormous importance of our fisheries, and how large may be the amount of material benefit derived from a scientific investigation of the causes of their increase and diminution, it will, I think, be evident that the work to be carried on at these stations is not only for such a purpose as the development of abstract biological science, important as that may be, but for the advancement of our national resources. It is, therefore, to be hoped that, in addition to the private support which they will receive, they may in some manner be recognised by the nation at large as centres for carrying out systematic investigations into the circumstances determining marine life, from which a portion of our food-supply is drawn, and a much larger portion might probably be derived. The importance of our sea fisheries, which it will be one of the principal objects of the Association to promote, has of late years been more fully recognised, and the recent International Fisheries Exhibition has done much to popularise the subject; while the official appointment of our President also proves that in the opinion of our Government the scientific aspects of our fisheries are not to be neglected.

In the last Presidential Address reference was made to the great desirability of carrying out, on the part of this country, investigations into the nature of cholera in continuation and extension of those so zealously and bravely initiated by the distinguished German inquirer Koch. Although the Society has had no very direct influence in the matter, the Fellows will, I venture to think, regard it as a subject for congratulation that the wish then expressed from this chair has been fulfilled, and that the distinguished expert in such questions—our Fellow, Dr. Klein—is at present engaged in India in the investigation of cholera at the instance of the Indian Government. It is sad to think how much nearer our own shores such investigations might have been conducted; may it be long ere they can be instituted on this side of the Channel.

These remarks have already extended to such a length that I can now only briefly refer to a few of the events of scientific interest which have during the past year occupied the attention of the Society or of a large number of its Fellows. In the month of April last the University of Edinburgh celebrated its Tercentenary with great pomp and no less hospitality, upwards of 120 delegates from various universities and other learned bodies being invited as guests. On this occasion Lord Rayleigh kindly consented to be our representative, and was among those on whom the University conferred the honorary degree of LL.D. The same distinguished Fellow occupied the Presidential chair at the meeting of the British Association for the Advancement of Science at Montreal, on which occasion many of our body took the opportunity of crossing the Atlantic. Owing to the munificent liberality and ungrudging hospitality of our brethren in the Dominion of Canada, the somewhat bold experiment of holding a meeting of the Association beyond the limits of the British Isles has proved a great success, though, perhaps, it is an experiment which would require exceptional conditions to be successfully repeated.

The Society was represented by delegates at the meeting of the American Association for the Advancement of Science at Philadelphia in September last. The Electrical Exhibition at the same place resulted in the formation of a Memorial Library in connection with the Franklin Institute, to which separate copies of the papers relating to electricity that have appeared in the *Philosophical Transactions* have been granted by the Council. An Electrical Congress at Paris, and an Ornithological one at Vienna have also been among the events of the year.

Subscribers to the Darwin Memorial Fund will be pleased to hear that a fine block of marble has been secured for the statue to be erected in the Natural History Museum at South Kensington, and I am glad to learn from Mr. Boehm that his work will probably be completed by the end of this year. When the total cost of the statue has been ascertained, it will be necessary to hold a meeting of the Committee in charge of the Memorial Fund to determine the manner in which the balance is to be applied.

It now only remains for me to thank the Fellows and others conversant with the subjects on which I have touched, for information kindly afforded me; to thank you for the attention with which you have listened to me, and to express a hope that it may not again for many years occur that the Anniversary Address from this Presidential chair shall have to be delivered by deputy.

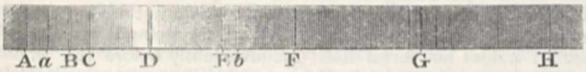
After the Address the awards of the medals and the election of the Council for the ensuing year were proceeded with; these we have already referred to. A gloom was cast over the meeting by the announcement of the sudden death of Prof. Kolbe, the distinguished recipient of the Davy Medal.

The Annual Dinner subsequently took place at Willis's Rooms, the Treasurer being supported by the Lord Chancellor, the Marquess of Salisbury, the Lord Mayor, and others.

THE WAVE THEORY OF LIGHT[1]

II.

TO continue our study of visible light, that is, undulations extending from red to violet in the spectrum (which I am going to show you presently), I would first point out on this chart that in the section from letter "A" to letter "D" we have visual effect and heating effect only; but no ordinary chemical or photographic effect. Photographers can leave their usual sensitive chemically prepared plates exposed to yellow light and red light without experiencing any sensible effect; but when you get



The Solar Spectrum.

toward the blue end of the spectrum the photographic effect begins to tell, more and more as you get towards the violet end. When you get beyond the violet, there is the invisible light known chiefly by its chemical action. From yellow to violet we have visual effect, heating effect, and chemical effect, all three; above the violet only chemical and heating effects, and so little of the heating effect that it is scarcely perceptible.

The prismatic spectrum is Newton's discovery of the composition of white light. White light consists of every variety of colour from red to violet. Here, now, we have Newton's prismatic spectrum produced by a prism. I will illustrate a little in regard to the nature of colour by putting something before the light which is like coloured glass; it is coloured gelatine. I will put in a plate of red gelatine which is carefully prepared of chemical materials, and see what that will do. Of all the light passing to it from violet to red it only lets through the red and orange, giving a mixed reddish colour.

Here is another plate of green gelatine. The green absorbs all the red, giving only green. Here is another plate absorbing something from each portion of the spectrum, taking away a great deal of the violet and giving a yellow or orange appearance to the light. Here is another absorbing out the green, leaving red, orange, and a very little faint green, and absorbing out all the violet.

When the spectrum is very carefully produced, far more perfectly than Newton knew how to show it, we have a homogeneous spectrum. It must be noticed that Newton did not understand what we call a homogeneous spectrum; he did not produce it, and does not point out in his writings the conditions for producing it. With an exceedingly fine line of light we can bring it out as in sunlight, like this upper picture, red, orange, yellow, green, blue, indigo, and violet, according to Newton's nomenclature. Newton never used a narrow beam of light, and so could not have had a homogeneous spectrum.

This is a diagram painted on glass and showing the colours as we know them. It would take two or three hours if I were to explain the subject of spectrum analysis to-night. We must tear ourselves away from it. I will just read out to you the wave lengths corresponding to the different positions in the sun's spectrum of certain dark lines commonly called "Fraunhofer's lines." I will take as a unit the one-hundred-thousandth of a centimetre. A centimetre is ·4 of an inch; it is a rather small half an inch. I take the thousandth of a centimetre and the hundredth of that as a unit. At the red end of the spectrum the light in the neighbourhood of that black line "*A*" has for its wave length 7·6; "*B*" has 6·87; "*D*" has 5·89; the "frequency" for "*A*" is 3·9 times 100 million million; the frequency of "*D*" light is 5·1 times 100 million million per second.

Now what force is concerned in those vibrations as compared with sound at the rate of 400 vibrations per second; suppose for a moment the same matter was to move to and fro through the same range, but 400 million million times per second. The force required is as the square of the number expressing the frequency. Double frequency would require quadruple force for the vibration of the same body. Suppose I vibrate my hand again, as I did before. If I move it once per second a moderate force is required; for it to vibrate ten times per second 100 times as much force is required; for 400 vibrations per second 160,000 times as much force.

If I move my hand once per second through a space of a quarter of an inch a very small force is required; it would require very considerable force to move it ten times a second, even through so small a range; but think of the force required to move a tuning fork 400 times a second; compare that with the force required for a motion of 400 million million times a second. If the mass moved is the same, and the range of motion is the same, then the force would be one million million million million times as great as the force required to move the prongs of the tuning fork. It is as easy to understand that number as any number like 2, 3, or 4.

Consider gravely what that number means and what we are to infer from it. What force is there in space between my eye and that light? What forces are there in space between our eyes and the sun, and our eyes and the remotest visible star? There is matter and there is motion, but what magnitude of force may there be?

I move through this "luminiferous ether" as if it were nothing. But were there vibrations with such frequency in a medium of steel or brass, they would be measured by millions and millions and millions of tons action on a square inch of matter. There are no such forces in our air. Comets make a disturbance in the air, and perhaps the luminiferous ether is split up by the motion of a comet through it. So when we explain the nature of electricity, we explain it by a motion of the luminiferous ether. We cannot say that it is electricity. What can this luminiferous ether be? It is something that the planets move through with the greatest ease. It permeates our air; it is nearly in the same condition, so far as our means of judging are concerned, in our air and in the inter-planetary space. The air disturbs it but little; you may reduce air by air-pumps to the hundred-thousandth of its density, and you make little effect in the transmission of light through it. The luminiferous ether is an elastic solid. The nearest analogy I can give you is this jelly which you see.[1] The nearest analogy to the waves of light is the motion, which you can imagine, of this elastic jelly, with a ball of wood floating in the middle of it. Look there, when with my hand I vibrate the little red ball up and down, or when I turn it quickly round the vertical diameter, alternately in opposite directions;—that is the nearest representation I can give you of the vibrations of luminiferous ether.

Another illustration is Scottish shoemaker's wax or Burgundy pitch, but I know Scottish shoemaker's wax better. It is heavier than water, and absolutely answers my purpose. I take a large slab of the wax, place it in a glass jar filled with water, place a number of corks on the lower side and bullets on the upper side. It is brittle like the Trinidad pitch or Burgundy pitch which I have in my hand. You can see how hard it is, but if left to itself it flows like a fluid. The shoemaker's wax breaks with a brittle fracture, but it is viscous and gradually yields.

What we know of the luminiferous ether is that it has the rigidity of a solid and gradually yields. Whether or not it is brittle and cracks we cannot yet tell, but I believe the discoveries in electricity, and the motions of comets, and the marvellous spurts of light from them, tend to show cracks in the luminiferous ether—show a correspondence between the electric flash and the aurora borealis and cracks in the luminiferous ether. Do not take this as an assertion, it is hardly more than a vague scientific dream: but you may regard the existence of the luminiferous ether as a reality of science, that is, we have an all-pervading medium, an elastic solid, with a great degree of rigidity; its rigidity is so prodigious in proportion to its density that the vibrations of light in it have the frequencies I have mentioned, with the wave lengths I have mentioned.

The fundamental question as to whether or not luminiferous ether has gravity has not been answered. We have no knowledge that the luminiferous ether is attracted by gravity; it is sometimes called imponderable because some people vainly imagine that it has no weight. I call it matter with the same kind of rigidity that this elastic jelly has.

[1] A Lecture delivered at the Academy of Music, Philadelphia, under the auspices of the Franklin Institute, September 29, 1884, by Sir William Thomson, F.R.S., LL.D. (Continued from p. 94).

[1] Exhibiting a large bowl of clear jelly with a small red wooden bal embedded in the surface near the centre.

Here are two tourmalines; if you look through them toward the light, you see the white light all round, *i.e.* they are transparent. If I turn round one of these tourmalines the light is extinguished, it is absolutely black, as though the tourmalines were opaque. This is an illustration of what is called polarisation of light. I cannot speak to you about qualities of light without speaking of the polarisation of light. I want to show you a most beautiful effect of polarising light, before illlustrating a little further by means of this large mechanical illustration which you have in the bowl of jelly. Now I put in the lantern another instrument called a "Nicol prism." What you saw first were two plates of the crystal tourmaline which came from Brazil, I believe, having the property of letting light pass when both plates are placed in one particular direction as regards their axes of crystallisation, and extinguishing it when it passes through the first plate held in another direction. We have now an instrument which also gives rays of polarised light. A Nicol prism is a piece of Iceland spar, cut in two and turned, one part relatively to the other, in a very ingenious way, and put together again and cemented into one by Canada balsam. The Nicol prism takes advantage of the property which the spar has of double refraction, and produces the phenomenon which I now show you.

I turn one prism round in a certain direction and you get light, a maximum of light. I turn it through a right angle and you get blackness. I turn it one quarter round again and get maximum light; one quarter more, maximum blackness; one quarter more and bright light. We rarely have such a grand specimen of a Nicol prism as this.

There is another way of producing polarised light. I stand before that light and look at its reflection in a plate of glass on the table through one of the Nicol prisms, which I turn round, so. Now I must incline that piece of glass at a particular angle, rather more than 45°; I find a particular angle in which, if I look at it and then turn the prism round in the hand, the effect is absolutely to extinguish the light in one position and to give it maximum brightness in another position. I use the term "absolute" somewhat rashly. It is only a reduction to a very small quantity of light, not an absolute annulment as we have in the case of the two Nicol prisms used conjointly. Those of you who have never heard of this before would not know what I am talking about. As to the mechanics of the thing it could only be explained to you by a course of lectures in physical optics. The thing is this, vibrations of light must be in a definite direction relatively to the line in which the light travels.

Look at this diagram, the light goes from left to right; we have vibrations perpendicular to the line of transmission. There is a line up and down which is the line of vibration. Imagine here a source of light, violet light, and here in front of it is the line of propagation. Sound vibrations are to and fro; this is transverse to the line of propagation. Here is another, perpendicular to the diagram, still following the law of transverse vibration; here is another circular vibration. Imagine a long rope, you whirl one end of it and you send a screw-like motion running along; you can get the circular motion in one direction or in the opposite.

Plane polarised light is light with the vibrations all in a single plane, perpendicular to the plane through the ray which is technically called the "plane of polarisation." Circular polarised light consists of undulations of luminiferous ether having a circular motion. Elliptically polarised light is something between the two, not in a straight line, and not in a circular line; the course of vibration is an ellipse. Polarised light is light that performs its motions continually in one mode or direction. If in a straight line it is plane polarised light; if in a circular direction it is circularly polarised light; when elliptical it is elliptically polarised light.

With Iceland spar, one unpolarised ray of light divides on entering it into two rays of polarised light, by reason of its power of double refraction, and the vibrations are perpendicular to one another in the two emerging rays. Light is always polarised when it is reflected from a plate of unsilvered glass, or water, at a certain definite angle of 56° degrees for glass, or 52° for water, the angle being reckoned in each case from a perpendicular to the surface. The angle for water is the angle whose tangent is 1·4. I wish you to look at the polarisation with your own eyes. Light from glass at 56° and from water at 52° goes away vibrating perpendicularly to the plane of incidence and plane of reflection.

We can distinguish it without the aid of an instrument. There is a phenomenon well known in physical optics as "Haidinger's Brushes." The discoverer is well known in Philadelphia as a mineralogist, and the phenomenon I speak of goes by his name. Look at the sky in a direction of 90° from the sun, and you will see a yellow and blue cross, with the yellow toward the sun, and from the sun, spreading out like two fox's tails with blue between, and then two red brushes in the space at right angles to the blue. If you do not see it, it is because your eyes are not sensitive enough, but a little training will give them the needed sensitiveness.

If you cannot see it in this way try another method. Look into a pail of water with a black bottom; or take a clear glass dish of water, rest it on a black cloth and look down at the surface of the water on a day with a white cloudy sky (if there is such a thing ever to be seen in Philadelphia). You will see the white sky reflected in the basin of water at an angle of about 50°. Look at it with the head tipped to one side and then again with the head tipped to the other side, keeping your eyes on the water, and you will see Haidinger's brushes. Do not do it fast or you will make yourself giddy. The explanation of this is the refreshing of the sensibility of the retina. The Haidinger's brush is always there, but you do not see it because your eye is not sensitive enough. After once seeing it you always see it; it does not thrust itself inconveniently before you when you do not want to see it. You can readily see it in a piece of glass with dark cloth below it, or in a basin of water.

I am going to conclude by telling you how we know the wave lengths of light and how we know the frequency of the vibrations. We shall actually make a measurement of the wave length of the yellow light. I am going to show you the diffraction spectrum.

You see on the screen,[1] on each side of a central white bar of light, a set of bars of light variegated colours, the first one, on each side, showing blue or indigo colour about four inches from the central white bar and red about four inches farther, with vivid green between the blue and the red. That effect is produced by a grating with 400 lines to the centimetre, engraved on glass, which I now hold in my hand. The next grating has 3000 lines on a Paris inch. You see the central space and on each side a large number of spectra, blue at one end and red at the other. The fact that, in the first spectrum red is about twice as far from the centre as the blue, proves that a wave length of red light is double that of blue light.

I will now show you the operation of measuring the length of a wave of sodium light, that is a light like that marked "*D*" on the spectrum, a light produced by a spirit lamp with salt in it. The sodium vapour is heated up to several thousand degrees, when it becomes self luminous and gives such a light as we get by throwing salt upon a spirit lamp in the game of snap-dragon.

I hold in my hand a beautiful grating of glass silvered by Liebig's process with metallic silver, a grating with 6480 lines to the inch, belonging to my friend Prof. Barker, which he has kindly brought here for us this evening. You will see the brilliancy of colour as I turn the light reflected from the grating toward you, and pass the beam round the room. You have now seen directly with your own eyes these brilliant colours reflected from the grating, and you have also seen them thrown upon the screen from a grating placed in the lantern. With a grating of 17,000 lines—a much greater number of lines per inch than the other—you will see how much further from the central bright space the first spectrum is; how much more this grating changes the direction or diffraction of the beam of light. Here is the centre of the grating, and there is the first spectrum You will note that the violet light is least diffracted and the red light is most diffracted. This diffraction of light first proved to us definitely the reality of the undulatory theory of light.

You ask why does not light go round a corner as sound does. Light does go round a corner in these diffraction spectra; it is shown going round a corner, it passes through these bars and is turned round an angle of 30°. Light going round a corner by instruments adapted to show the result, and to measure the angles at which it is turned, is called the diffraction of light.

I can show you an instrument which will measure the wave lengths of light. Without proving the formula, let me tell it to you. A spirit lamp with salt sprinkled on the wick gives very nearly homogeneous light, that is to say, light all of one wave length, or all of the same period. I have a little grating which I take in my hand. I look through this grating and see that

[1] Showing the chromatic bands thrown upon the screen from a diffraction grating.

candle before me. Close behind it you see a blackened slip of wood with two white marks on it ten inches asunder. The line on which they are marked is placed perpendicular to the line at which I shall go from it. When I look at this salted spirit lamp I see a series of spectra of yellow light. As I am somewhat short-sighted I am making my eye see with this eyeglass and the natural lenses of the eye what a long-sighted person would make out without an eyeglass. On that screen you saw a succession of spectra. I now look direct at the candle and what do I see? I see a succession of five or six brilliantly coloured spectra on each side of the candle. But when I look at the salted spirit lamp, now I see ten spectra on one side and ten on the other, each of which is a monochromatic band of light.

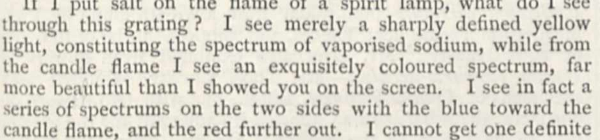
I will measure the wave lengths of light thus. I walk away to a considerable distance and look at the candle and marks. I see a set of spectra. The first white line is exactly behind the candle. I want the first spectrum to the right of that white line to fall exactly on the other white line, which is ten inches from the first. As I walk away from it I see it is now very near it; it is now on it. Now the distance from my eye is to be measured, and the problem is again to reduce feet to inches. The distance from the spectrum of the flame to my eye is thirty-four feet nine inches. Mr. President, how many inches is that? 417 inches, in round numbers 420 inches. Then we have the proportion, as 420 is to 10 so is the length from bar to bar of the grating to the wave length of sodium light. That is to say, as forty-two is to one. The distance from bar to bar is the four-hundredth of a centimetre: therefore the forty-second part of the four-hundredth of a centimetre is the required wave length, or the 16,800th of a centimetre is the wave length according to our simple, and easy, and hasty experiment. The true wave length of sodium light, according to the most accurate measurement, is about a 17,000th of a centimetre, which differs by scarcely more than 1 per cent. from our result!

The only apparatus you see is this little grating; it is a piece of glass with four-tenths of an inch ruled with 400 fine lines. Any of you who will take the trouble to buy one may measure the wave lengths of a candle flame himself. I hope some of you will be induced to make the experiment for yourselves.

If I put salt on the flame of a spirit lamp, what do I see through this grating? I see merely a sharply defined yellow light, constituting the spectrum of vaporised sodium, while from the candle flame I see an exquisitely coloured spectrum, far more beautiful than I showed you on the screen. I see in fact a series of spectrums on the two sides with the blue toward the candle flame, and the red further out. I cannot get one definite thing to measure from in the spectrum from the candle flame as I can with the flame of a spirit lamp with the salt thrown on it, which gives, as I have said, a simple yellow light. The highest blue light I see in the candle flame is now exactly on the line. Now measure to my eye, it is forty-four feet four inches, or 532 inches. The length of this wave then is the 532nd part of the four-hundredth of a centimetre, which would be the 21,280th of a centimetre, say the 21,000th of a centimetre. Then measure for the red, and you would find something like the 11,000th for the lowest of the red light.

Lastly, how do we know the frequency of vibration?

Why, by the velocity of light. How do we know that? We know it in a number of different ways, which I cannot explain now, because time forbids. Take the velocity of light. It is 187,000 British statute miles per second. But it is much better to take a kilometre for the unit. That is about six-tenths of a mile. The velocity is very accurately 300,000 kilometres per second; that is, 30,000,000,000 centimetres per second. Take the wave length as the 17,000th of a centimetre, and you find the frequency of the sodium light to be 510 million million per second. There, then, you find a calculation of the frequency from a simple observation which you can all make for yourselves.



Vibrating spherule embedded in an elastic solid.

Lastly, I must tell you about the colour of the blue sky which was illustrated by the spherule embedded in an elastic solid. I want to explain to you in two minutes the mode of vibrations. Take the simplest plane polarised light. Here is a spherule which is producing it in an elastic solid. Imagine the solid to extend miles horizontally and miles down, and imagine this spherule to vibrate up and down. It is quite clear that it will make transverse vibrations similarly in all horizontal directions. The plane of polarisation is defined as a plane perpendicular to the line of vibration. Thus, light produced by a molecule vibrating up and down, as this red globe in the jelly before you, is polarised in a horizontal plane, because the vibrations are vertical.

Here is another mode of vibrations. Let me twist this spherule in the jelly as I am doing it, and that will produce vibrations, also spreading out equally in all horizontal directions. When I twist this globe round, it draws the jelly round with it; twist it rapidly back, and the jelly flies back. By the inertia of the jelly the vibrations spread in all directions, and the lines of vibration are horizontal all through the jelly. Everywhere, miles away, that solid is placed in vibration. You do not see it, but you must understand that they are there. If it flies back it makes vibration, and we have waves of horizontal vibrations travelling out in all directions from the exciting molecule.

I am now causing the red globe to vibrate to and fro horizontally. That will cause vibrations to be produced which will be parallel to the line of motion at all places of the plane perpendicular to the range of the exciting molecule. What makes the blue sky? These are exactly the motions that make the blue light of the sky, which is due to spherules in the luminiferous ether, but little modified by the air. Think of the sun near the horizon; think of the light of the sun streaming through and giving you the azure blue and violet overhead. Think first of any one particle of the sun, and think of it moving in such a way as to give horizontal and vertical vibrations and what not of circular and elliptic vibrations.

You see the blue sky in high-pressure steam blown into the air; you see it in the experiment of Tyndall's blue sky, in which a delicate condensation of vapour gives rise to exactly the azure blue of the sky.

Now the motion of the luminiferous ether relatively to the spherule gives rise to the same effect as would an opposite motion impressed upon the spherule quite independently by an independent force. So you may think of the blue colour coming from the sky as being produced by to-and-fro vibrations of matter in the air, which vibrates much as this little globe vibrates embedded in the jelly.

The result in a general way is this: The light coming from the blue sky is polarised in a plane through the sun, but the blue light of the sky is complicated by a great number of circumstances, and one of them is this, that the air is illuminated not only by the sun but by the earth. If we could get the earth covered by a black cloth, then we could study the polarised light of the sky with simplicity, which we cannot do now. There are, in Nature, reflections from seas and rocks and hills and waters in an indefinitely complicated manner.

Let observers observe the blue sky not only in winter when the earth is covered with snow, but in summer when it is covered with dark green foliage. This will help to unravel the complicated phenomena in question. But the azure blue of the sky is light produced by the reaction on the vibrating ether of little spherules of water, of perhaps a fifty-thousandth or a hundred-thousandth of a centimetre diameter, or perhaps little motes, or lumps, or crystals of common salt, or particles of dust, or germs of vegetable or animal species wafted about in the air. Now what is the luminiferous ether? It is matter prodigiously less dense than air—millions and millions and millions of times less dense than air. We can form some sort of idea of its limitations. We believe it is a real thing, with great rigidity in comparison with its density, and it may be made to vibrate 400 million million times per second and yet with such rigidity as not to produce the slightest resistance to any body going through it.

Going back to the illustration of the shoemaker's wax: if a cork will in the course of a year push its way up through a plate of that wax when placed under water, and if a lead bullet will penetrate downwards to the bottom, what is the law of the resistance? It clearly depends on time. The cork slowly in the course of a year works its way up through two inches of that substance; give it one or two thousand years to do it and the resistance will be enormously less; thus the motion of a cork or bullet, at the rate of one inch in 2000 years, may be compared with that of the earth, moving at the rate of six times ninety-three million miles a year, or nineteen miles per second, through the luminiferous ether; but when we have a thing elastic like jelly and yielding like pitch, surely we have a large and solid ground for our faith in the speculative hypothesis of an elastic luminiferous ether, which constitutes the wave theory of light.

SCIENTIFIC SERIALS

Bulletin de la Société de Géographie, Paris, 3 Trimestre, 1884.—The principal portion of this number is occupied by papers of M. Huber, who spent the years 1878 to 1882 in Arabia on a scientific mission on behalf of the Department of Public Instruction. In the first he introduces 145 inscriptions which he found in various parts of Central Arabia on rocks. The second article is the first instalment (accompanied by a map) of an account of his numerous and extensive journeys in the same region, from Palmyra and Bagdad in the north, to Kheiber in the south. A glance at the route map shows that he has explored the greater part of this region during his prolonged stay there.—M. Petitin, in his account of his journey in Indo-China, gives a lengthy description of the difficulties and dangers which the traveller encounters in this peninsula. He was selected by Admiral de la Grandière when Governor of Saigon to make a geological investigation of Cochin-China, Siam, Hainan, and Formosa, but the death of the governor and the appointment of another whose views were different cut M. Petitin's explorations short. He saw enough, however, to give a brief account of the geology of Cochin-China, and to give the intending traveller much advice as to his arrangements and preparations. He also urges his countrymen to extend their dominion in the Indo-Chinese peninsula, especially in Tonquin, where the Red River affords them an opening into the heart of China.—M. la Mesllé's paper on the eastern provinces of Australia is little more than a lively account of a journey in Queensland, while the object of M. Simonin's article on the ports of Great Britain—especially London, Liverpool, and Glasgow—is not quite apparent, unless it be to urge his countrymen to go and do likewise with their ports.

Verhandlungen der Gesellschaft für Erdkunde zu Berlin, Band xi., Nos. 6 and 7.—Herr Müller-Beeck, in the trade of Further India deals largely with trade routes into the Shan States and China. The Songkoi route into Yunnan he regards as one of great difficulty on account of the rapids. The delta also is constantly extending. Hanoi is now 110 miles from the sea; in the seventeenth century it was only half that distance. For half the year the upper part of the river is only navigable for boats of four tons, and when Manhao is reached, there is still a difficult land journey to Yunnan. The population also, he thinks, will form a grave obstacle to any regular trade by this channel.—Herr Buchta, in the Soudan and the Mahdi, deals purely with the political side of the Soudan question.—Prof. Seelstrang gives much interesting geographical and statistical information about the province of Santa Fé, in the Argentine Republic.—The usual notices of other societies and of new books conclude the number.

SOCIETIES AND ACADEMIES

London

Linnean Society, November 20.—Prof. P. Martin Duncan, F.R.S., Vice-President, in the chair.—Mr. A. Roope Hunt was elected a Fellow.—Mr. F. B. Forbes drew attention to specimens of pods and seeds used by the Chinese in place of soap. He stated that for ordinary detergent purposes an impure earthy soda and a lye made from ashes are employed. The leaves of *Hibiscus syriacus* and *Ginko biloba* are occasionally used for cleansing the head. The most favourite substance, however, is the fruit of certain Leguminosæ (Fei-tsao-tow). The late Daniel Hanbury figures these seeds as a species of *Dialium*. Dr. Porter Smith says they are the product of the *Acacia concinna* (*Mimosa saponaria*, Roxb.). Dr. Breitschneider asserts, on the contrary, that they belong to *Gymnocladus chinensis*, originally described by Baillon from pods only. Specimens at Kew lately figured in the "Icones Plantarum," are young leaves, fruit, and flowers from Foochow; those now exhibited (by Mr. Forbes) are, however, much finer examples from Ningpo and Wahu. The pods are roasted and kneaded into small balls used for washing clothes, and the head in bathing, but, on account of their unpleasant smell, they are prohibited in the public baths. The pods of *Gleditschia sinensis*, Lamk. (Tsao-chio) are used for the same purposes as *Gymnocladus*, those shown at the meeting being from Pekin and Shanghai district. One appears to answer to Dr. Hance's new *G. xylocarpa*. Bentham refers a South China tree to *G. sinensis*. Lamarck founded his species on a tree growing in the Jardin des Plantes, raised from seeds sent by Père Incarville 200 years ago from Pekin. It is doubtful if the northern and southern plants are identical. The pods are broken into small bits soaked in boiling water until an oily substance is floated, when they are ready for use. Another saponaceous substance is derived from *Sapindus makarosi* (the *S. chinensis* or *Kolreuteria paniculata*, Lam.), specimens of which were shown from Ningpo.—Messrs. H. and J. Groves exhibited specimens of (1) *Chara connivens*, collected at Slapton, South Devon, the only known British station, for no trace of the plant is now to be found at Stokes Bay; (2) *Chara canescens*, obtained from a pool between Helston and the Lizard, West Cornwall, by Messrs. Guardia and Groves, and also at Little Sea, Studland, Dorset, by Mr. Mansell Pleydell.—Mr. Geo. Murray showed dried and moistened examples of an Algæ, *Glœocapsa*, found by Mr. Pryer in birds'-nest caves in North Borneo.—Mr. J. G. Baker read the following letter from Mr. W. Brockhurst, of Didsbury, dated November 17, 1884:—"On April 2 I had the pleasure of exhibiting to the Society a number of prepared specimens of the daffodil, which appeared to prove that double daffodil flowers might produce seeds, and I advanced some arguments, based upon the observations I had made, to show that they were spread over wide areas in a wild state of seeding. The specimens showed the seed-vessels filled with ovules, but this did not fully prove that ripe seeds capable of germination would be matured. I therefore carefully observed a number of flowers of double daffodils (*Narcissus telamoneus-plenus*), and marked them as they went out of bloom, to prevent any mistakes. One of these produced a capsule containing nine shining black seeds, which were gathered on June 24, and at once sowed in a pot, and covered with a sheet of glass. Of these seeds four have already germinated, and show grass-like growths an inch above the soil. This therefore completes the proof."—Mr. W. T. Thiselton Dyer pointed out and made remarks on some sterile runners of *Mentha piperita*, and the remains of flowers of *Epilobium hirsutum*, both taken from a wreath found by Prof. Maspero in a tomb near Thebes, and supposed to be of the 20th or 26th dynasty; Mr. Dyer also exhibited fresh flowers of *Ipomea purpureo-cærulea*.—Mr. Thos. Christy exhibited two specimens of *Lycaste Skinneri*, Lindl., one with two flowers on one stem, the other with an aborted lip adherent for the greater part of its length to the column. He also drew attention to samples of the tea (probably a species of *Ilex*) used largely in Bogota, but which is said to be deficient in flavour.—Mr. E. C. Stanford thereafter showed some of the products from seaweed, viz.:—Algin, the insoluble form of which (alginic acid) can be made into shirt-studs resembling horn, &c.; the soluble algin (or alginate of soda), which diminishes the brittleness of shellac, besides other uses.—A paper was read by Mr. E. M. Holmes on *Cinchona Ledgeriana* as a species. The author expressed the opinion that under the name of *C. Ledgeriana*, a number of varieties or forms, and probably some hybrids of *Cinchona Calisaya*, are now under cultivation in the British colonies. He believed that, if more attention were paid to the characters afforded by the bark of trees, taken in conjunction with the other botanical characters of flower and fruit, these varieties and hybrids would be more easily defined and recognised. He considers that the plant published under the name of *C. Ledgeriana* by Dr. Trimen was probably referable to Weddell's *Cinchona Calisaya*, var. *pallida*, as a horticultural form, for which the author proposed the name "*Trimeniana*."—A paper was read, notes on the habits of some Australian Hymenopterous Aculeata, by H. L. Roth. He states that the wasps of the genus *Pelopæus* (*P. lætus*) build their nests on the walls, ceilings, legs of chairs, under the table, in cupboards, vases, between pictures and the walls, on curtains, in all sorts of crevices in the house, and on the roof. No place is safe from their intrusion. When a cell is completed, the wasp goes in search of spiders, and, seizing these, packs their half-dead bodies in the cell, lays an egg, and closes the cell-top; thereafter rows of cells are added to the primary one and dealt with in the same fashion, generally finishing with a streaked coating of mud, thus to deceive as to the real contents beneath. These wasps are infested with Dipterous parasites. Of the Australian ants, *Formica rufinigro* is numerous, bold, and destructive. They destroy the web of certain caterpillars and wriggle them out, when they fall a prey to a host of attendant warrior ants.—Mr. E. T. Druery read a paper on a singular mode of reproduction in *Athyrium filix-fœmina*, var. *clarissima*. In a previous paper the author had shown that prothallia-bearing antheridia and archegonia were developed on the apex of pear-shaped bodies with the larger end downwards, in the place usually occupied by sori. In the present paper he brought forward evidence to show that these pear-shaped bodies were not developed from sporangia, but from a previous formation of thread-like bodies, a few of which became thickened, and developed into the pear-shaped bodies previously mentioned, the others remaining starved and undeveloped.

Zoological Society, November 18.—Prof. W. H. Flower, F.R.S., President, in the chair.—A communication was read from Mr. J. G. F. Riedel, C.M.Z.S., containing comments on certain passages in Mr. H. O. Forbes's paper on Timor-Laut birds, read before the Society on June 17.—A communication was read from Mr. H. Pryer, C.M.Z.S., giving an account of a recent visit to the edible-birds'-nest caves of British North Borneo. In illustration of this paper, Mr. Pryer sent specimens of the swift (*Collocalia fuciphaga*), of its nest and eggs, of the *Alga* on which the bird was supposed to feed, and of the bat which inhabited the same caves.—Mr. Sclater read an account of some skins of mammals from Somali-land, which belonged apparently to five species. Amongst these was an apparently new form of wild ass, which was proposed to be called *Equus asinus somalicus*.—Mr. F. E. Beddard read a paper on the anatomy of the Umbrette (*Scopus umbretta*). The author observed that, as regards its exact systematic position, which had been hitherto a matter of doubt, he was inclined to place this peculiar form as a type of a separate family, between the herons (Ardeidæ) and the storks (Ciconiidæ).—A second paper by Mr. Beddard contained the results of some recent investigations into the structure of *Echidna*, and related to the presence of a persistent umbilical vein in that animal.—Captain Shelley read a paper on some new or little-known species of East African birds. Three of these were described under the names *Muscicapa johnstoni*, *Pratincola axillaris*, and *Nectarinia kilimensis*. The collection, which contained altogether ninety-four specimens, referable to thirty-eight species, was the first-fruits of Mr. H. H. Johnston's expedition to Kilimanjaro.—A communication was read from Mr. J. H. Gurney, F.Z.S., on the geographical distribution of *Huhua nipalensis*, with remarks on this and other allied species of owls.

Chemical Society, November 20.—Dr. Perkin, F.R.S., in the chair.—The following gentlemen were elected Fellows:—F. Broughton, F. J. Down, L. Ehrmann, F. G. Holmes, J. Hulme, C. Thompson, W. F. Wigley.—The following papers were read:—On some new paraffins, by Khan B. B. Sobrabji. The author has prepared cetane boiling at 278°, dicetyl melting at 70°, ethylcetyl and diheptyl.—On additive and condensation compounds of diketones with ketones, by F. R. Japp and N. H. J. Miller. The authors have studied the action of potash of various strengths on mixtures of phenanthraquinone and acetone. Additive compounds were obtained containing one molecule of the first substance to two of acetone, and another containing two molecules of phenanthraquinone to one of acetone. Condensation compounds were formed from the above additive compounds by the abstraction of the elements of water. The authors have also studied the action of potash upon mixtures of benzil with acetone and with acetophenone respectively, and have obtained acetobenzil and acetophenonebenzil.—On the vapour-pressure of acetic acid, and on a new method of determining the vapour-pressures of liquids, by W. Ramsay and Sydney Young. The authors have used a species of still into which a thermometer dips, the bulb of which is covered with cotton-wool moistened with the liquid. On heating, the liquid evaporates from the cotton-wool without ebullition. Results obtained agree with those obtained in the ordinary way. Perfectly concordant and regular results have been obtained with acetic acid.—On the action of the halogens on the salts of trimethylsulphine, by L. Dobbin and Orme Masson. The authors conclude that all the haloid salts of trimethylsulphine combine directly with chlorine, bromine, iodine, and iodine monochloride. In no case is one halogen replaced by the other. The authors have partly investigated the action of the halogens on trimethylsulphine sulphate.—Note on the heats of dissolution of the sulphates of potassium and lithium, by S. U. Pickering. The salts do not seem to form isomeric modifications such as exist in the case of sodium sulphate.—On the application of iron sulphate in agriculture and its value as a plant food, by A. B. Griffiths. The author finds that half a hundredweight of sulphate of iron per acre increased the yield of beans from 28 bushels to 44 bushels, of turnips from 13 tons to 16½ tons, but little effect was produced on cereals.—Notes on the chemical alterations in green fodder during its conversion into ensilage, by C. Richardson. The author confirms the results obtained by Kinch and Kellner, that a considerable increase in the non-albuminoid nitrogen takes place in the conversion: no such change occurs during the ordinary drying of fodder. The author used maize in his experiments.—On the decomposition of silver fulminate by hydrochloric acid, by E. Divers and Michitada Kawakita. The authors have studied the action of dilute and strong hydrochloric acid on this salt. With dilute acid the principal products are hydroxyammonium chloride and formic acid; if the acid is strong, much ammonium chloride is produced. A small quantity of hydrocyanic acid is always formed. They could not obtain any oxalic acid by decomposing mercury fulminate with hydrogen sulphide in ether. They have also studied the action of hydrochloric acid on fulminurates.

PARIS

Academy of Sciences, November 24.—M. Rolland, President, in the chair.—Experiments with the chlorhydrate of cocaïne (continued), by M. Vulpian. Further experiments made on snails (*Helix pomatia*) and fresh-water prawns (*Astacus fluviatilis*, F.) show that this anæsthetic is less efficacious in the case of invertebrate than vertebrate animals.—Note on the algebraic relations between hyperelliptic functions of the n order, by M. Brioschi.—On some reactions of the sulphuret of carbon, and on the solubility of this substance in water, by MM. G. Chancel and F. Parmentier.—Remarks by M. Daubrée on M. Nordenskjöld's "Voyage Round Europe and Asia," in connection with the French translation of that work presented to the Academy.—Note on the action of heat on electric piles, and on the law of Kopp and Wœstyne, by M. G. Lippmann.—Statistical note on cholera in the Paris hospitals since the outbreak of the epidemic on November 4 till the present time, by M. Emile Rivière. During this period 971 patients (579 men, 392 women) were treated in the various hospitals. Of these, 511 succumbed (302 men, 209 women), and 239 (129 men, 110 women) have so far been completely cured. The mortality has thus been 52·33 and 53·31 for men and women respectively. The working classes—rag-gatherers, seamstresses, washerwomen, masons, bricklayers, and shoemakers—have supplied the largest relative number of victims. These have almost invariably been persons of feeble constitution, subject to chronic disorders, exhausted by previous excesses, exposed to extreme physical destitution, or dwelling in the lowest slums of the French capital and its suburbs.—Remarks on the second instalment of the new map of Tunis prepared in the War Office on a scale of 1 : 200,000, by Col. Perrier. This instalment comprises six sheets, embracing the districts of Kef, Kairwan, Mahedia, Feriana, El Jem, and Sfax, based on surveys executed on the spot.—Presentation of the "Annals of the Ouro-Preto School of Mines," by the Emperor Dom Pedro II., with remarks by M. Daubrée.—On the condensation of the solar nebula on the hypothesis of Laplace, by M. Maurice Fouché.—Remarks on the nature of the curve known as Poinsot's erpolodie, by M. de Sparre.—On the involution of superior dimensions, by MM. J. S. and M. N. Vanecek.—Dynamo-electric machines: experimental confirmations of the two reactions, on the effective values of the inner resistance and of the inductor magnetism, by M. G. Cabanellas.—Action of water on the double salts, by M. F. M. Raoult.—On the composition of the gaseous products resulting from the combustion of pyrite, by M. Scheurer-Kestner.—New experiments on the rotation of crops in connection with the cultivation of beetroot, by M. P. P. Dehérain.—On the appearance and spread in France of the parasite of the beetroot known as *Heteredora Schachtii*, by M. Aimé Girard. To this parasite, the author thinks, is largely due the partial failure of this year's crop, which showed a deficit of 20 per cent. in the weight of the roots, besides a decrease in the yield of saccharine, which in some of the northern districts amounted to 12 or 14 per cent.—On the formation of vegetable acids in combination with potassa and lime bases, on the nitric substances and the nitrate of potassa developed in the saccharine plants, beetroot and maize, by M. H. Leplay.—On the characteristic smell and toxic effects of the products of fermentation produced by the comma-bacillus of cholera, by MM. W. Nicati and M. Rietsch.—On cholera and cholemia, by M. W. Nicati. From the experiments recently made in the chemical laboratory of the Faculty of Sciences at Marseilles it seems established that biliary acids are relatively more abundant in the blood of the victims of cholera than in others. But the author is unable yet to decide whether in their case death is to be attributed to cholemia.—Note on infectious and parasitic pneumonic affections, by M. Germain Sée.—Experiments on the efficacy of disinfecting agents in the case of chicken cholera, by M. Colin.—On the virulence of the bubo accompanying soft chancre, by M. I. Straus.—On the luminous intensity of the spectral colours; influence of the state of the retina in determining light effects, by M. H. Parinaud.—On the appendices to the jaw of grinding insects, by M. Joannes Chatin.—On the floral polymorphism and the fertilisation of *Lychnis dioica*, L., by M. L. Crié.—Remarks on Dr. Ladislas Szajnocha's memoir on the Cephalopods of the Elobi Islands, West Coast of Africa, by M. Daubrée.

BERLIN

Meteorological Society, November 4.—Dr. Hellmann, following up an account of the most recent works in the department of meteorological literature, which he concluded with a full discussion of Mr. Blanford's rain-map of India, communicated his own observations regarding the rain conditions prevailing in Heligoland. The measurements there obtained had given an annual rainfall of 72·50 inches, an amount far surpassing that which had been observed at any of the neighbouring stations on the west coast of Schleswig and at the mouth of the Elbe. The speaker, having last summer made a tour of inspection, and convinced himself, from the instruments in use and their situation, of the accuracy of the registrations above referred to, explained the excessive rainfall in Heligoland by the circumstance that the steep coast, shooting up almost perpendicularly to about 164 feet above the level of the sea, forced the moist sea winds suddenly aloft, and so caused them to cool and condense both very rapidly and to a great extent. For the sake of testing the correctness of this explanation he had got another rain-gauge set up on the dunes at about 16 feet above sea-level, the registrations of which would next year be compared with those at the higher level. A second point in which the rain conditions of Heligoland deviated from those observed at the neighbouring stations on the coast respected the annual course of the rainfall. It was found that in North-West Germany the rainfall indicated a minimum in the middle of April and a maximum in August. In Heligoland, on the other hand, though indeed the minimum of rainfall occurred likewise in the middle of April, the maximum was attained in November. Dr. Hellmann sought an explanation of the postponement of the rain maximum in this latter case in the circumstance that in the yearly course of the temperature of the water and the atmosphere the difference between the two was greatest in November, the water at that time showing a temperature as much as 3°·6 F. warmer than that of the air.—Prof. Spörer gave a brief sketch of the present period of sun-spots. The spot periods being counted from minimum to minimum, the commencement of the present spot period was to be referred to 1878·8. So far as had been hitherto observed the present was distinguished from the two last spot periods by two peculiarities; first, that the maximum in the present period appeared to have occurred 0·4 of a year later than in the previous periods, and, second, that during the maximum the distribution of the solar eruptions showed an essentially different character from that usually obtaining. In the former periods it was observed during the maximum that the greatest concourse of spots surrounded with faculæ occurred in the median latitudes of the sun, that they were completely wanting towards the poles, became less numerous also towards the equator, and only at the equator itself did they again become somewhat more crowded. In the rotation of the sun those eruptions showed a heliographic displacement towards the equator, in contrast to the spots free from faculæ which, in the course of rotation, wandered towards the poles. During the minima of the spot periods the maximum of the eruptions was generally found in the neighbourhood of the equator. In the present period, again, the greatest concourse of eruptions surrounded with faculæ was found towards the equator during the maximum as well, a phenomenon usually occurring at the time of the minimum. The present, on the other hand, resembled former periods in the circumstance that it was only on rare occasions that the concourse of spots was alike on both hemispheres of the sun. In the majority of cases either the northern hemisphere presented a more copious display of spots than the southern, or the southern mustered them in larger numbers than the northern.

STOCKHOLM

Academy of Sciences, November 12.—Prof. Gyldén communicated the results of the Meridian Conference in Washington, according to the report of the Swedish delegate Count Lewenhaupt, and gave an account of his own paper "On the origin of comets."—Prof. Lindström exhibited a fossil scorpion recently found near Wisby in the Silurian formation of Gotland, and remarkable as the most ancient air-breathing land-animal at present discovered.—Prof. Retzius presented the last volume of his great work "Das Gehörorgan der Wirbelthiere," and made some remarks on its contents.—Prof. Nordenskjöld communicated a "Catalogue of the Meteorites in the Swedish Museum of Natural History," by Herr G. Lindström, Assistant Mineral Department.—Prof. Wittrock gave an account (1) of a paper by Dr. Johansson, of Upsala, "On Fungi from Iceland," and (2) of another paper by Dr. Alb. Nilsson "On the mechanical function of the sheaths of *Dianthus banaticus*, Heuff."—The Secretary presented the following papers:—On a quantity of the electrical potential, by Prof. Dahlander.—Sur la sommation des puissances semblables des *n* premiers nombres entiers, by Dr. C. O. Boije, of Gennäs.—On some recently-published mathematical papers from the seventeenth century by Bierens de Haan, by Dr. G. Eneström.—On a proposition from the theory of the elliptic functions, by E. Phragmén.—On substituted cyanamides and melanins, by Dr. P. Claësson.—On *Mergus anatarius*, Eimbeck, found in Sweden, by G. Kolthoff.—On a new Isopod from the coast of Sweden, by Dr. C. Bowallius.—On minerals occurring at Vestra Silfberg, by Dr. Mats Weibull.—A catalogue of the phænogamous plants and ferns of Jemtland, by Dr. P. Olsson.

VIENNA

Imperial Academy of Sciences, October 23.—Report on his journeys in the Balkan Peninsula, by F. Toula.—The geological exploration of the Central Balkans and adjacent regions, by the same.

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