THURSDAY, APRIL 9, 1885

## TREDGOLD'S "CARPENTRY"

*Elementary Principles of Carpentry.* By Thomas Tredgold, C.E. Sixth Edition, by E. Wyndham Tarn, M.A., Architect. (London: Crosby Lockwood and Co., 1885.)

MR. TARN has for a good many years enjoyed a high reputation amongst the profession of architects as a writer upon the practical principles of building regarded mathematically. Tredgold's treatise on Carpentry has for a very long time indeed possessed the highest reputation as a much more than elementary book of reference upon that important department of building construction which deals with timber work; it has been republished time after time in the form of the old-fashioned substantial quarto which used to be in vogue before we were encouraged to expect to read as we run. It is quite in accordance with the fitness of things that Tredgold and Mr. Tarn should come together, and the English building world will scarcely require to be told that the result is satisfactory. The new edition before us is in fact a readaptation once more of the excellent material of the old standard treatise to the changing condition of our mechanical knowledge and skill. The author's mode of treating his subject has been retained intact; and we still have the well-known sections upon pressures, resistances, floors, roofs, domes, partitions, centers, bridges, joints, and timber. Whether this particular arrangement is the best, is a question scarcely worth asking, at least on behalf of the less fastidious criticism of those practical designers of carpentry who must here constitute the overwhelming majority of readers; but the editor has certainly not found it to be any bar to the importation of new matter in his own way. In one section he has introduced Prof. Clerk Maxwell's now universally appreciated system of diagrams of pressures, whereby the mere application of a common drawing scale to the component lines of easily constructed geometrical figures saves all further trouble and uncertainty in ascertaining the precise strains which the several members of a truss have to bear. In other sections the accepted formulæ of calculation, given only empirically by Tredgold, are mathematically demonstrated. The familiar tables of strength which supply the values of constants are "corrected" to accord with recent experiments more delicately and adroitly conducted, and several new tables of the kind are added. The consequent revision of Tredgold's "rules" and tables of scantlings has been thoroughly and carefully done; and various modes of more advanced construction are duly developed. That difficult subject, the theoretical thrust of domes—for in practice there ought to be none—is taken in hand mathematically, and a short chapter is added on stone vaulting. The important items of scaffolding, shoring, coffer dams, and so on, have been also introduced. The remarkable timber bridges of America—rough and ready science of the best—have been taken account of as they ought; and certain amendments which are made in respect of the plates serve in a reasonable measure to substitute new trussing for old. Lastly, the description of the nature and properties of timber is largely modified to meet the advanced knowledge of the day. With all this, the Tredgoldian character of the treatise is dutifully preserved; and so we may say it ought to be, for to modernise Tredgold too much would certainly not improve him. One of the prominent merits of the work consists in the unusually large number of illustrative plates, all to a useful scale. If these do not represent many of the more modern designs in timber work, they frequently offer examples to the student which are all the better in one respect—they exemplify that substantiality of construction which it is too much the tendency of scientific precision almost to discourage. It is a good maxim in carpentry as in most other departments of building, to make the structure not only strong but stronger than strong; and Tredgold always leans in that direction. The word *economy* is much employed amongst us; but, whereas its original and proper signification pointed only to skilful administration, its meaning with us is very much like mere parsimony. Waste of material is the bugbear of our builders, and almost still more of our architects. It need not be denied that mathematical science is in a certain way provocative of such parsimony; indeed, lightness of construction is regarded as an academical virtue in both architecture and engineering. But a moment's reflection ought to satisfy alike the most scientific and the least that true science is as much averse to parsimony of substance as common sense is. The strength of building materials can only be determined by extremely delicate experiments upon "breaking" strains, from the results of which the "safe" strains have to be deduced by estimate; and this, no doubt, becomes matter of opinion. The question is, what proportion of the breaking strain shall be recognised—almost arbitrarily—as the safe strain? With the single exception of iron, timber is the material with reference to which this matter of opinion is the most definitively settled. The reason is this:—The breaking strain must be instantaneously applied; this is essential to precision of tabulation. The safe strain is that proportion of this instantaneous breaking strain which the material will bear permanently without any risk of its elasticity being eventually overcome and a commencement made of that disturbance of the structure of the material which, once begun, increases in a geometrical ratio until the end is ruin. It is accepted, therefore, that the proportion of an ascertained instantaneous breaking strain which has to be recognised as the limit of a permanent safe strain is one-third, one-fourth, and so on, according to the character of the material. What does this mean? It means that a greater strain than this proportion would in time, with one accidental circumstance and another, produce a commencement of instability. Perhaps it is to be regretted that this question is still disposed of so empirically as it is; we might at least in these days have express observations made and reduced to what system might appear. Tredgold's rules turn very much upon the manifestations of flexure; and this, of course, is not only another way of dealing with the matter, but one which affords at any rate a basis upon which mathematical formulæ may be arrived at. On the whole, Tredgold is an old-fashioned writer, empirical and practical; but he is none the worse for that, perhaps all the better. Mr. Tarn has accepted the duties and responsibilities of a scientific ally, and we have pleasure in testifying that he does his work well, and that he does not overdo it.

## THE MYRIOPODS OF AUSTRIA

*Die Myriopoden der Oesterreichisch-Ungarnischen Monarchie.* 2te Hälfte, "Die Symphylen, Pauropoden, und Diplopoden." Von Dr. R. Latzel. (Vienna: Hölder, 1884.)

WHEN we say that the second volume of Dr. Latzel's work is in every way equal to the first we are according to it high praise. The first volume, that which dealt with the Chilopoda, has fully proved itself to be indispensable to every student of the Myriopoda, and it seems to us certain that this second volume, dealing with the other orders, must soon be accorded an even more important place in the literature of this subject. Nine years of close attention to the study of the myriopods have enabled Dr. Latzel not merely to complete a monograph of the species inhabiting his native country, but to complete it in such a manner that he has written a book which must be useful to the student of the myriopoda of any country. Not only has Dr. Latzel given minute descriptions of some 170 species, but he has also furnished tables which make it a matter of ease to determine the genus of any myriopod.

There has been unfortunately among those who have specially devoted attention to myriopods a tendency to create numerous new species on very insufficient grounds. By relying solely on characters of importance, Dr. Latzel has in great measure escaped this tendency. It is true that in the volume now under notice he has described a new genus and thirty-five new species. Possibly further observation may reduce this number; but when we remember the extent of area embraced by the Austro-Hungarian Empire, and the little attention which, comparatively speaking, has been paid by naturalists to myriopods anywhere, we must admit that thirty-five is no excessive number of new species; indeed, those who are familiar with the writings of others who have described myriopods must feel thankful that it is so small. A careful synonymy has been given of each species described; this is one of the most useful features of the book, as in this part of his work Dr. Latzel seems to us to have been singularly successful. It can have been no easy task to reduce to order the bulky mass of existing nomenclature; but Dr. Latzel has spared no pains in examining and comparing the types, generally insufficiently described, of his predecessors. It is much to be wished that some capable observer would take in hand to examine the types of the earlier English describers of myriopods, especially with regard to the Chilopoda described by Newport, and compare them with the types of Continental writers, for, so we fancy, the synonymy would be yet further reduced to order. Here we may refer to the only point in nomenclature which we regret in Dr. Latzel's book. He has adopted the specific name *venustus*, Meinert 1868, for an animal which Dr. Latzel evidently suspects to be, and which we have no doubt is, the same as that described by Leach in 1814 as *Julus pulchellus*.

One admirable feature of this work is that, where possible, full descriptions are given of the young stages of each species. As to the details of the work there is not much room for criticism. Dr. Latzel has embodied in his work the results of all recent researches into the minute anatomy of the myriopods. Embryology, indeed, has not received a very large share of attention, but references are given to all writings on the subject. Dr. Latzel differs from some American authorities in looking on Scolopendrella as a true myriopod, and places its order Symphyla as intermediate between the Chilopoda and the Pauropoda. We may here note that Dr. Latzel agrees with Menge in considering those organs which Ryder has described as tracheæ in Scolopendrella, as being merely chitinous supports for muscle-attachment. These are the same organs which Wood-Mason (*Ann. Nat. Hist.* [5] xii. 53) considers are of the nature of segmental organs.

A short notice of fossil myriopods is given, based chiefly on Scudder's researches into the fossil species of America. Scudder's conclusion seems to us to be in many points erroneous, and at any rate to be premature and based on insufficient knowledge, but as no fossil myriopods have yet been found in Austro-Hungary we can only be thankful to Dr. Latzel for dealing with fossil forms at all. The same must be said with regard to the notice of the order Malacopoda. No species of Peripatus has yet been discovered in Europe, but, though we may not agree with him, it is interesting to know that one so qualified to judge as Dr. Latzel, looks on Peripatus as forming an order equivalent to the other orders, the Chilopoda, the Symphyla, and the Diplopoda. A most useful bibliography, brought down to the date of publication, is comprised in the work. The execution of the sixteen plates, showing morphological details, is excellent in every way.

## OUR BOOK SHELF

*Examples in Heat and Electricity.* By H. H. Turner. (London: Macmillan and Co.)

THIS is a Cambridge collection of problems and riders extracted mainly from the Smith's Prize, Tripos, and College papers of the last dozen years. The compiling (for there is nothing to be called authorship) has been, on the whole, judiciously done; and the printing is unusually clear and accurate, considering the complexity of many of the formulæ. The book is designed primarily as a help to candidates for mathematical honours, and will undoubtedly prove useful to them; possibly, perhaps, to a few private students.

But to the natural philosopher the book presents some points of curious interest. For, in these seventy pages alone, may be found (by all who know the subjects) materials for a very complete examination of one important part of the Cambridge system, alike in its present condition and during its recent development. Here and there we detect at a glance the lion-claw of the true physicist, and can, unhesitatingly, write against a question the name of Stokes, Thomson, Clerk-Maxwell, &c., so strongly marked is the individuality of these men:—who *think* in physics, thus propounding nothing unphysical; and who use mathematics as a necessary instrument of expression, neither courting nor shunning mere technical difficulties. Each of their questions stands out like a green oasis in a sandy desert! The rest of the contents (except what is but thinly-veiled "book-work") is mainly the work of *Examining Mathematicians*—the men who use physical facts (or fancies) as mere pegs on which to hang complex catenaries of formulæ; to whom $pt = Rv$ would come quite as naturally and as usefully as the laws of Boyle and Charles; the men who can *explain the result* when the pressure of a gas or the electric resistance of a wire "comes out" negative! To such men the recent introduction of the subjects of heat and electricity by the Board of Mathematical Studies, and the appearance of Thomson's *Electrical Papers*, Maxwell's splendid treatises, and other kindred books, have been happiness indeed. Open any one of these books, at any place, and concoct from it by whatever assumptions (however unphysical) are necessary, a problem which shall lead to an elliptic integral or a Bessel's function, and there you are! This cannot long go on without seriously impairing the progress of physical science in our great mathematical university. Mathematics is, in itself, a right noble and worthy study; but the embryo physicist should, from the first, be taught to regard it as (for him) an indispensable auxiliary only, not a source of natural (?) laws. The whole procedure is thoroughly characteristic of the Cambridge of to-day. It has, among its professors and elsewhere, many of the foremost of living physicists and mathematicians, as well as others destined in time to take similar rank:—but does not utilise them. Even its *one* real test of mathematical merit, real because conducted by such men, the Smith's Prize Examination, has just been abolished! So, it has a magnificent boat at the "head of the river," but *not one member* of that crew is sent to encounter Oxford at Putney! What can be expected, either in the boat-race or in the more arduous toiling over the scientific course, but thorough and most deserved defeat?

*Differential Calculus for Beginners, with a Selection of Easy Examples.* By Alex. Knox, B.A. (London: Macmillan and Co., 1884.)

THIS little book deserves hearty welcome from those who are engaged in leading forward students to the higher mathematics; not so much as a substitute for any other work at present in use, but as presenting a carefully-selected set of illustrations of infinitesimals, limits, and differential coefficients, which a student may profitably work through before entering upon the usual formal treatises on the calculus.

We know of no work in English comparable with the present since De Morgan's "Elementary Illustrations of the Differential and Integral Calculus."

The special symbols of the subject are not introduced into the work before us, attention being directed to the new principles involved in the method of the calculus; indeed, the chief aim of the author throughout is to give the learner a firm grasp of the idea of a differential coefficient—a fundamental notion which, in the minds of beginners, is usually shrouded in a haze. Care is taken to deal one at a time with the difficulties which present themselves in this subject. The book is divided into twenty sections, the latter two or three dealing with successive differentiation, Maclaurin's theorem, and maxima and minima.

But before new principles or processes are introduced, an endeavour is made to insure a precise comprehension of the meaning of terms already employed by the student. And the freshness of treatment, as well as the clearness with which the author brings before the mind the exact meaning of such terms as "point," "line," "superficies," in the first section of this book, will awaken the interest and arrest the attention of even an indifferent learner.

Many of the sections are independent of each other. There is much variety of illustration, the central principle being looked at from different points of view. A distinguishing feature is the great use made of arithmetical calculations, many examples of the method of finite differences occurring.

Besides the usual geometrical treatment based on Newton's "Lemmas," the ideas of time and motion are freely introduced, and illustrations taken from elementary kinematics.

The book closes with a set of examples worked out in full, and a series of one hundred easy exercises, the answers to which are appended. A. R. W.

## 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.*]

### Rock-Pictures in New Guinea

A FEW years ago I mentioned in a paper in *Globus* (lxiii. 94) that Mr. Th. B. Leon had reported the existence of pictures on rocks he had seen in the Ogar and Arguni groups of islands (south part of McCluer inlet), and that the officer in command of H.N.M.S. *Batavia*, who had been charged to make further inquiries, had not been able to find them. At that time Mr. Leon's account had not been published in the regular issue of the *Batav. Genootschap.* Since then, however, explorations by Mr. van Braam Morris, whilst on his voyage in New Guinea in 1883, and by some of the officers of H.N.M.S. *Samarang*, have resulted in the discovery of rock-pictures similar to those spoken of by Mr. Leon. The papers giving an account of these explorations (including Mr. Leon's) have been published in a recent number of the *Tijdschrift voor Indische Land-, Taal-, en Volkenkunde* (xxix. pp. 582-591), and an abstract of their contents may be interesting.

One day Mr. Leon set out from the kampong (village) of Arguni, situated on the island of that name, for the purpose of fishing. In the beginning, on account of the surf, he kept at a great distance, but the third island of the group he was able to approach. He perceived the distinct representation of a human hand, painted in white, and surrounded with red spots, and other drawings in white, which appeared to be meant for letters, though traced in characters unknown to him. Afterwards, on penetrating between two other islands of the group, he saw several hands, all similar to the first, and accompanied by similar drawings. He was not able to land; he estimated the height of the place at which they were drawn on the rock to be from 75 to 150 feet above sea-level, the hands being about three-quarters of the way up, and the other figures about 10 feet higher still. The hands were of all sizes, representing those of children, of full-grown men, of giants, and were in great numbers. He fancied the characters bore some resemblance to the written signs in use amongst the *Orang Kling*, the *Orang Bugis*, and the *Orang Mangkasser*; they were certainly not *Javan* or *Malayan*. He was greatly puzzled as to how they could have come there, since the face of the rock was perfectly perpendicular, and without any projections or caverns, so far as he could perceive. The only explanation he can suggest is that they must have been done at a time when that part of the rock-surface was nearer to the level of the sea, or the outward form of the rock must have been changed on that side by losing ledges or projections by which the native draughtsmen may have approached the place. It will be readily understood that the natives attribute these drawings to *Kasuak*, the prince of evil spirits, who, in their opinion, has his dwelling in one of the small islands, and of whom they are naturally greatly afraid. On another island Mr. Leon discovered a huge stone, which would probably require half a dozen men to lift it, rudely shaped like a bullock, and surrounded with several other stones, evidently arranged on some fixed plan.

Mr. van Braam Morris says:—On September 16, 1883, I came to McCluer inlet, and was told by the native chiefs that the figures I was in search of were to be found on Arguni, or the islands to the west of it. I discovered them on a small island a few hundred yards from the mainland. The shores of both the island and the mainland rose perpendicularly from the water, and in the rocky face of the former, about 5 feet above high-water mark, the surf had eaten out an excavation from 3 to 5 feet wide, thus leaving a narrow platform, on which several small *prahus* were deposited, some of them being 3 feet long. Various figures were drawn on the rock above, especially hands, both of full-grown people and of children. A hand had evidently been sketched in outline from a living model placed against the wall, and coloured to a depth of 6 inches all around it. The native chiefs who accompanied the Resident said that the remains of the Hill-Papuans had formerly been deposited here, but were now interred with Mahommedan rites; there were indications, however, that some *prahus* had been recently lodged on the platform.

Though the most astonishing part of Mr. Leon's report, viz. the difficulty of drawing the figures on the rock at a considerable height above the sea, is not encountered by Mr. van Braam Morris's experience, it is not proved that the latter explored exactly the same place as Mr. Leon. But just this point (the considerable rising of the islands) is most plainly stated with regard to the Ke Islands by Messrs. Alliol, Mol, van Slooten, Meijboom, and Deijl, of H.N.M.S. *Samarang*, which at the time of their visit lay off Tual (5° 37′ 30″ S. lat. 132° 44′ E. lat.), island of Little Ke. These gentlemen were invited by Mr. Langen, the head of the English settlement there, to visit with him the north-western part of the island; after having steamed for three-quarters of an hour they dropped anchor *vis-à-vis* Kalumit, a village at the base of a hill, about 200 metres high. They went to the top to see there some idols situated in a small settlement. I pass over this part of the narrative, and take it up after they had descended from the edge of the rock, where they had found a burial-place belonging to the kampong, which is on the top. A tolerably well-made flight of ironwood steps allowed the visitors to descend easily; after about half an hour's walk they came to the "necropolis."

On the rock near it they discovered representations in red of various figures—human hands, with the fingers spread out; imitations of human heads; a fight between men armed with *klewangs* (= cutlass), and other figures which they took to be representations of the evil spirits, outlines of ships, &c. Though the heads were rudely drawn, the hands, which were fewer in number, were remarkably well done. The place where the drawings are seem to be quite inaccessible to human beings. In the rock are also caverns which are rather difficult to approach. In one of them two gongs and some pieces of bamboo were found; at the entry fragments of broken glass had been spread, probably to prevent visitors from entering. It must be mentioned that the rock, from the base to the top, was covered with sea-shells. Attention is repeatedly drawn in the report to the circumstance that it seems incomprehensible how the pictures could have been drawn on the rock, which overhangs.

The natives connect the rock-pictures with the burial-place on the top of the cliff. Near the edge of the steep descent stand two houses, which serve as mortuaries, one being close to the dwellings of the natives, which are surrounded with a stone wall. These two houses are built of ironwood; on the roofs there are two pieces of wood, the one in the shape of a prow, the other in the shape of a keel. On the latter are two figures, a dog and a bird; a stick bearing a piece of white cloth is stuck into the bird's body. The walls are 4 and 3 metres, and in the shorter, which faces the sea, there are two doors, through which the coffin is carried; inside this hut they saw two coffins with fruits and a bottle of oil which had been left for the spirits.

The natives, who called themselves Hindoos or heathens, a name which of course has no ethnographical significance, but is merely used to distinguish them from their Mahommedan neighbours, said that when a dead body was placed in the hut the spirit was conducted by the bird or the dog on the roof to the caverns where it is to abide. In token of its arrival the animal draws a figure on the rock. The natives who accompanied the explorers durst not set foot within the caves.

It was also said that the bird and the dog were merely symbols. The soul of the deceased, on leaving the body, flies as a bird through the air or runs as a dog over the earth, till it reaches the abodes of the spirits—the caverns—unseen by living men. Every soul that reaches this haven draws a figure on the face of the cliff. In explanation of the contest between human beings and evil spirits in the pictures, they said that the latter try to prevent the souls from reaching the eternal dwellings; but they cannot hinder those who have led good and honest lives, though those who have done wickedly are carried off by the evil spirits.

The officers, judging from the many articles in gold and silver which were found in the caverns, concluded that they must formerly have been used by pirates as places of refuge and for hiding their stores, and that they were then nearer to the level of the water. On this view the drawings on the rocks would answer a double purpose: they would keep the superstitious from approaching the caves, and would also act as a landmark for the pirates themselves when returning from sea, and indicate to them the places where their treasure was hidden.

Without hazarding any opinion upon such incomplete accounts, I wish to state, merely by way of summary—

(1) That Mr. Leon's evidence, combined with that of the officers of the *Samarang*, would seem to indicate that the surfaces of certain islands in McCluer inlet and of the Ke group have been considerably elevated.

(2) That the rise has probably taken place at no distant date, but how long since cannot be determined until (perhaps) after close scientific examination.

(3) That Mr. Morris's explorations, taken in conjunction with the foregoing, suggest that the elevation is not a general one, but, though observed at distant points, is limited to certain islands of different groups, or even to particular sides of them.

Stuttgart, March 18 EMIL METZGER

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### Mr. Lowne on the Morphology of Insects' Eyes

PROF. LANKESTER appears to me to be fighting too much under cover. First he sends his lieutenant into the field, and then he appears himself, in the guise of an independent ally. But inasmuch as he has virtually accused the officers of the Linnean Society of having published a paper unworthy of a place in the *Transactions* of the Society, I feel fully justified in bringing him out into the open.

The anxiety expressed by Prof. Lankester on behalf of the Fellows of the Linnean Society, as to whether my paper was refused by the Royal Society, is manifestly insincere: he knows as well as I do, that the paper was virtually refused by the Royal Society. As Prof. Lankester is taking undue advantage of the secrecy which attaches to the office of referee, I shall state the facts with which I am personally acquainted, and I doubt not these will place the whole matter in a very different light from that which Prof. Lankester has endeavoured to shed upon it.

It is evident Prof. Lankester wishes to make it appear that the rejection of my paper by the Royal Society confirms his strictures and those of his lieutenant, and enables him safely to attack the Linnean Society under cover of the Royal. Now, I believe that every one who was concerned in the publication of my paper knew perfectly well that Prof. Lankester was the first referee to whom it was submitted by the Royal Society. Prof. Lankester wrote to me himself, and stated that the paper had been so referred. Although I then felt sure of its rejection, I should not have had any reason to complain, if the rules of the Royal Society had been carried out, and the paper had been submitted to a second, entirely independent referee. Prof. Huxley, in his opening address to the Royal Society on his election as President, stated that every paper was considered by two entirely independent referees. Now, in my case the second referee was Prof. Schäfer: I do not think it right to refer a paper to two colleagues intimately associated in the same school; and I am sure that no consultation should take place between the referees pending their decision. Yet Prof. Schäfer heard Prof. Lankester's adverse opinions expressed in my presence before he came to any decision himself—at any rate before making any report; and he confessed to me that he had no special knowledge of the literature of the subject on which he was called upon to give an opinion.

Under the circumstances I feel justified in stating that, if the Royal Society had rejected my paper, it would have been a rejection by Prof. Lankester; and I feel sure that an independent referee would have done exactly what was subsequently done on behalf of the Linnean Society.

Prof. Schäfer recommended me to withdraw my paper; I petitioned the Council of the Royal Society to allow me to do so, and the paper was returned to me. If this be a rejection, my paper was rejected.

I then presented it to the Linnean Society, and in so doing I told the Zoological Secretary everything that had happened. The result was that, after some delay, the paper was ordered to be printed in the *Linnean Transactions*.

I could hardly have conceived it possible that any scientific man could have descended to such a device in confirmation of his own views as to pretend that the Royal Society had formed an independent judgment under such circumstances. Prof. Lankester has succeeded admirably in rendering himself impersonal as a representative of the Royal Society—a feat which would have no doubt incited his just indignation if it had been performed by his friend "Sludge," of spiritualistic celebrity.

I cannot help remarking on the coolness of Prof. Lankester's assertion, that my views are "undeniably based upon a mistaken interpretation of defective preparations." Prof. Lankester evidently thinks his opinion final—but he is bold to say it is "undeniable."

My sections have been seen and approved of by a great number of competent histologists and zoologists, and, although some of them are not so pretty as those prepared by the paraffin method which Prof. Lankester extols, they certainly show a great deal more. The paraffin method is well known to me, and I have examined a great number of slides prepared by it. I have possessed a series of sections so made in the Cambridge laboratory by an excellent histologist, and have rejected them as worthless: they show nothing but the connective tissue framework. Nerve fibres and nerve end organs are alike destroyed.

The whole question of the effect of reagents on the tissues is a wide one. The paraffin process destroys much which remains in the cocoa butter process, first devised by Prof. Schäfer. I esteem this process far superior to that now used in the laboratory at Cambridge, and by Prof. Lankester and his assistants. I should not fear to place my specimens side by side with Prof. Lankester's before an unbiassed histologist; and I am content to wait the decision of future observers upon my work. New views are met with little favour by those who are committed to old ones, and, whether I am right or wrong, I expect no justice from a critic who shows such determined bias as Prof. Lankester.

BENJAMIN T. LOWNE

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IF Prof. Lankester imagines that he has any complaint to make against the Council of the Linnean Society for having published Mr. Lowne's paper, I must decline to consider the subject with him in your columns. He is himself a Fellow of the Society, and the anniversary meeting of the Society is due next month. If he then thinks it wise to ask any questions upon the subject, I shall be in my place and most happy to answer them.

GEORGE J. ROMANES, Zool. Sec. L. S.

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## How Thought presents itself among the Phenomena of Nature

IN your issue of the 12th inst. the Duke of Argyll asks, "Is there any difference in this respect between molar and molecular motion?" namely, as regards the persuasion which most men entertain that where there is motion there must be some "thing" to move. The answer to this question appears to be the very direct one that there is the following fundamental difference between molar motions and *some* molecular motions, and that it intimately concerns that belief. *All molar motions are secondary motions*, *i.e.* they consist in the drifting from place to place of underlying motions (and, indeed, in the case of those motions which human beings can perceive even with the utmost aid of the microscope, they consist in the drifting from place to place of vast accumulations of such underlying motions), while, in contrast to this, *there are some molecular motions which are primary—i.e.* which have no other motions underlying them, and which do not consist in the drifting from place to place of more subtile motions.

His Grace correctly expresses the common opinion in the following words—that "an atom[1] is only conceivable as an ultimate particle of matter." Now the term "particle of matter" in this statement needs to be scrutinised. As commonly understood, it means something minute which we should be able to feel or see or perceive by some of our senses were it not for the bluntness of those senses; and this, as science shows, means that *certain specific motions* are present, viz. motions of those particular kinds which are competent, indirectly and through a long chain of intermediate steps, to finally occasion visual, tactual, or some other sensation in our minds. The statement, accordingly, as commonly understood, *really* amounts to this—that no motion can be present unless certain underlying motions are also present!

But to the uninstructed apprehension the statement has quite a different meaning, a much fuller one, and one which lies outside the domain of motion. Before they have made very careful investigation, men do not know that there is no green colour in grass or hardness in a rock. They are unaware that what is really going on in the grass is not a state of greenness, but vast myriads of motions,[1] each of which is repeated about as often every second as there are seconds in thirty millions of years, which motions in the grass occasion undulatory motions around of a like rapidity, some of which occur within our eyes, and, acting upon some compound or compounds in the black pigment which lies behind the retina, produce there an effect (probably a fugitive photographic effect consisting in some chemical change of one or more of three compounds in the pigment). This change, whatever it is, excites the optic nerve to make a stir within the brain, and *it is this last motion* (which we may safely say is utterly unlike the external phenomenon, though uniformly resulting from it through the steps enumerated above), which is what determines the perception of green in our minds. Similarly, when the vast accumulation of molecular motions which is called my finger approaches that other accumulation of motions which is called a rock, these motions act on each other, and my finger is compressed upon certain nerves, exciting them to produce those motions within my brain which, though quite unlike the motions outside, are the motions that are really accompanied by the sensation of hardness. But by uninstructed minds the colour of the grass and the hardness of the rock are confidently believed to be external phenomena, and not even phenomena of motion at all, but absolutely stationary phenomena in external Nature.

Finally, we must never forget that beliefs in the human mind, whether they be pure or mixed up with errors, can neither control nor even exercise any influence whatever upon what is really taking place in external Nature, which is the object of our investigation. What is really going on in Nature is to be ascertained, so far as it can be ascertained at all, not by projecting human beliefs into external existence, but by applying whatever modicum of dry light we can win from the slow but gradually encroaching progress of scientific discovery. And the necessity for this caution is intensified where we find, as in the present instance, that the belief has resulted from the way our brains and the brains of our ancestors have grown, under the influence of an experience of motion which has been so one-sided that it has never extended to primary motions at all, nor even to any but very coarse forms of secondary motion, omitting, along with many others, all those motions, whether primary or secondary, that occasion most of our sense-perceptions; and all this, combined with suppositions about other phenomena in which these phenomena have been quite misunderstood. Scientific scrutiny, so far as it has penetrated, finds motion throughout external Nature—motions everywhere, motions underlying every phenomenon, however different from motions some of them may seem to common apprehension; and no *scientific* investigation has as yet detected anything but motions. This is the positive side of the inquiry; and its negative side is that it would be manifestly illegitimate to draw an inference about what really exists outside us from the habits of thought which have been engendered in most human minds by a narrow and one-sided experience mixed up with palpable errors. *We, therefore, are not in a position to allege that we know of anything existing in the outer world but motions and relations between motions.*

The abstract of my Royal Institution discourse, which you were so good as to publish, only attempted to give a bare statement of the successive steps of the argument with which it deals, and I fear it is too condensed for clearness; but, as I am myself persuaded that the argument is sound, I hope that your correspondent will find that a fuller account of it which I am preparing will put all its essential parts in a sufficiently distinct light.

Dublin, March 20 G. JOHNSTONE STONEY

[1] The Duke of Argyll here employs the word "atom" in its etymological sense; and it is scarcely necessary to point out that the term when so used signifies a different thing from any of the sixty-seven complex bodies known to chemists as chemical atoms, which have intricate internal motions as betrayed to us by the spectroscope, and of which the molecules of compound bodies are known to be made up. The chemical "atom" could not under any view be spoken of as an *ultimate* particle of matter.

I understand the Duke of Argyll to propose these words as a description (not of anything the existence of which has been ascertained by experimental science, but) of that substance, matter, or thing the conception of which he and most other men believe to be the "inseparable concomitant" of the conception of motion, but for the existence of which in external nature no other evidence is forthcoming than this supposed law of human minds.

Now, even if the supposed law were a law from which we could not free ourselves, it might reasonably be maintained that it proves nothing about external existence; but in truth it is not a law, but only a widely prevalent habit of mind, as is *demonstrated* by the fact that the study of nature has extricated some minds from it.

[1] The relations which the parts of motion can have to one another or to other motions are all numerical or space and time relations. Motions may be numerous, few, simultaneous, successive, straight, curved, flat, tortuous, swift, slow, periodic, continuous, linear, or pervading a volume; but they cannot be green motions or hard motions.

### Magnetic Disturbance

There was a considerable disturbance of the magnetograph recorded here on March 15, and had the photographic curves been developed on that day, we should probably have predicted the occurrence of the aurora seen during the evening. The earth-currents, which are necessary concomitants of magnetic disturbances, were probably intense enough to cause the disarrangement of the cable tests referred to by Mr. Willoughby Smith.

G. M. Whipple

Kew Observatory, Richmond, Surrey, April 7

### The Samsams

From a note in last week's Nature it appears that during his recent explorations in the Malay peninsula M. Delouell claims to have discovered the "hitherto unknown" Samsam people. Allow me to state in reply that I have long been aware of the existence of these half-caste Malay and Siamese communities. They will be found duly recorded and described at p. 642 of my ethnological appendix to the "Australasia" of the Stanford Series, published in 1879. They appear to be now mostly Mohammedans, speaking what is called a mixed Siamese and Malay dialect, and otherwise forming an ethnical transition between these two races.

A. H. Keane

University College, Gower Street, April 4

### Meteor

Last evening (April 3) I saw a fine meteor at 8h. 21m. G.M.T. (± 1m.). I was walking along the street at the time and looking at Algol, and so only caught sight of it during the last few moments of its apparition. Its path as observed was from $\alpha$ 80° North $\delta$ 2° to $\alpha$ 76° South $\delta$ 4°, when it disappeared behind houses. It seemed quite twice the brightness of Jupiter, and about 3′ diameter; colour, chrome yellow; duration, three seconds. It left no visible train.

H. Sadler

Clapham, April 4

## *STEEL GUNS*[1]

The whole of this part of the Proceedings of the Naval Institute is occupied by detailed accounts of the steps taken to prepare the way for the establishment of Steel Gun Factories for the United States. We are informed that, while the rest of the world has advanced with the progress of the age, the artillery of the United States has made no step forward. Artillerists and advocates for providing adequate means of defence have laboured under many difficulties during the last twenty years, while regret is expressed that personal interests have entered so largely into the discussion of a question of such magnitude. In the House of Representatives it was declared that the fortifications of that country were in an absolutely worthless condition for all purposes of warfare.

Early in 1882 communications were opened with the owners of the chief foundries and steel works of the United States, but no firm could be found which had ever made steel guns.

At length the President of the United States was authorised and required to select six officers of their army and navy to examine and report respecting the necessary navy-yards and arsenals. Accordingly, the President named six officers (April 2nd, 1883) to form the Board of Gun Foundry, and one of their number, Lieut. W. H. Jaques, U.S.N., was elected secretary to the board. Their report was dated February 16th, 1884. The Board found it necessary to seek information in Europe, and make visits to England, France, and Russia, in order that they might reply satisfactorily to the Act of Congress. There they were well received, and had every facility afforded them in making their inquiries. The aim of Lieut. Jaques, U.S.N., in his communication to the Naval Institute, was to show the necessity of steel gun factories to the United States, to extend the information collected, and to provide a book of easy reference to the details of modern ordnance. He has produced a work which ought to warn and instruct us.

The Board in their Report give an account of the introduction of the coil system of building up guns in England; of the cost of the system to this nation; of the forty-pounder Armstrong, adopted for the navy in 1859, and of the constructing of one hundred of the 110-pounders before any experiments with them had been concluded.

Of four guns under trial, three showed a separation on the outside between the trunnion-ring and the coil behind it. The fourth showed a separation all round, but to less extent. All the guns expanded in the shot chamber and part of the powder chamber, and the *bores were elongated*. Much of these defects, no doubt, arose from excessive friction between the lead-coated projectile and the gun, which caused an unnecessary stress upon the gun.

The first visit paid by the Board was to the Elswick works. They remark: "The establishment at Elswick is thoroughly equipped for heavy work, and has produced the largest guns in the world. . . . The shops are supplied with an abundance of fine tools," page 583. They have a hammer of thirty-five tons. "The advantages of the Whitworth manufacture are also recognised, and a forging press is being introduced."

They next visited the Woolwich Royal Gun Factories, which are stated to have had in 1873-4 a capacity for the production of 6,000 tons of guns of various calibres per year. "The transition state in which the Board found the Woolwich gun factories is due to the change from muzzle-loading to breech-loading, and the substitution of homogeneous metal for the wrought coil" (page 589). The Board give a list of the chief tools in the Arsenal, as boring machines, planing machines, &c. There are four travelling cranes of 60 tons, six of 30, and six of 25 tons capacity. There are also: one steam hammer of 40 tons, one of 12 tons, one of 10 tons, two of 7 tons, besides many smaller ones. The steam power in the Royal Gun Factories is supplied by forty boilers of 40-horse power. "The plant at Woolwich, because of its transition state, contains very little worthy of imitation in planning the erection of gun factories in the United States."

The Board next visited the works of T. Frith & Sons, Sir John Brown & Co., C. Cammell & Co., and Sir H. Bessemer, all of Sheffield, and Lieut. Jaques gives full accounts of the most recent furnaces and methods employed there in working steel, illustrated with many beautiful plates. He also gives an account of the manufacture of compound armour, under the patents of Wilson & Ellis; as well as of the trials of armour plate made at Spezzia, and of granite forts protected by iron plates at Shoeburyness in 1883.

"The new departure in the system of gun construction, described farther on in this report, will demand from the Sheffield steel manufacturers increased effort. Up to the present time the only portion in the construction of the Woolwich gun that required steel was the tube. . . . The new construction requires that steel shall be used throughout, and the castings for the jackets for guns now in hand at Woolwich can hardly be supplied from Sheffield" (page 630).

It is remarked that in one important establishment preparations were being made for the introduction of a large press, to take the place, or supplement, the work of the hammer. The Sheffield steel manufacturers are entirely sceptical as to the advantage or practicability of the compression of steel in the liquid state, and although they concede the efficacy of forging under hydraulic compression, they consider it an objection to the process that a much higher temperature will be required for the press than for the hammer.

Sir Joseph Whitworth's works at Manchester were

[1] *Proceedings* of the United States Naval Institute, vol. x. No. 4, 1884. (The Establishment of Steel Gun Factories in the United States, by Lieut. W. H. Jaques, U.S.N.)

visited, where they enjoyed the privilege of carrying on their investigations within the works. "It may be distinctly asserted that the experiences enjoyed by the Board during its visit amounted to a revelation" (page 633).

"The distinguishing characteristics of the Whitworth fluid-compressed steel are homogeneity, strength, and ductility. It is made of various tempers to suit all purposes, particularly where it is exposed to sudden and violent strains. . . . No other metal possesses the same endurance" (page 633). Sir Joseph Whitworth is said to have remarked that, "Guns of enormous size are now being made at Woolwich at an enormous expenditure. . . . But if monster guns were wanted, they could be made at *far less cost* by means of the Siemens-Martin process and fluid compression. Supposing a hoop was wanted, say, 20 tons weight, the time required for its production would not, commencing with the raw material, he believes, be more than one-tenth the time required by the forging, coiling, and welding processes. . . . The Board witnessed the operations of casting followed by that of liquid compression, the enlarging of hoops, the drawing out of cylinders, and the forging of a solid ingot. The unanimous opinion of the members is that the system of Sir Joseph Whitworth surpasses all other methods of forging, and that it gives better promise than any other of securing that uniformity so indispensable in good gun metal" (page 642).

In France, as in England, the most friendly welcomes were tendered to the Board. The Government has obtained an immense increase of its resources by encouraging private industries. The foundry at Ruelle has become the principal, if not the only, establishment for the manufacture of the larger calibres designed for the navy and coast.

"It contains the most remarkable collection of tools of the age. They are designed for guns of 34 cm. (13·4 in.) and upwards, and have a capacity for handling guns of 160 tons in weight and 60 feet in length" (page 688).

"It seems as if in France the happy mean has been reached by which the Government and the private industries can work harmoniously towards the accomplishment of a national object. In a combined system of this kind, it is very important to be assured that there exist mutual checks which act to prevent one party imposing improper or hard terms on the other" (page 689).

For tubes and hoops for large guns the supply is limited to the works at St. Chamond and at Le Creusot; the former having a steam hammer of 80 tons and the latter, one of 100 tons. At Le Creusot are situated the most important steel-works in France. "At no other place in the world is steel handled in such masses, and it is safe to say that no proposed work can be of such magnitude as to exceed the resources of the establishment" (page 693). There is assembled an array of steam hammers not equalled in the world. They have three cranes capable of sustaining 100 tons, and one 160 tons. For the preparation of metal for cannon and armour-plates Le Creusot is thoroughly equipped.

Little need be said of Germany, as that country depends almost entirely upon Krupp's establishment for the supply of its guns, and the Board were not allowed to examine his works, for they were informed that the works at Essen cannot be seen, as "these are closed to all but those who have special business of inspection of war material on order." Krupp enjoys great advantages in having practising grounds at Meppen 10½ miles long, and at Dälmen of 4½ miles. Near thirty years ago Krupp planned his 50-ton hammer. He is constructing a 121-ton 16-inch gun of 35 calibres length for the Italian Government.

The Russians formerly patronised Krupp, but of late they have begun to manufacture guns at home, with the assistance of private firms. Like many of the great steel-works of Europe, the establishment at Aboukhoff is in a transition state. They possess ten steam hammers, varying from a 1-ton to a 50-ton. The most important improvement which has recently been introduced is Sir J. Whitworth's system of liquid compression.

Certain recommendations are made respecting the production of guns for the United States. As examples of a practical partnership between a Government and a private company, in working towards a national object, the experiences in England and Russia are very instructive, and warn against the adoption of such a system. As an example of depending almost entirely on private works, Germany is a perfect instance. As an example of depending alone on Government works France was a perfect instance before the Franco-German war. "How entirely France has now altered her system is shown in a previous part of this report; her present practice is theoretically perfect, and it has proved to be practically efficient. Her Government establishments are still retained, but as gun factories simply, in which the parts are machined and assembled, but for foundry work she depends upon the private industries of the country" (page 843). But still the Government is careful to secure good advice in controlling these private establishments, for on one occasion it was considered desirable to require the steel to be supplied to be subjected to additional tests. When the steel manufacturers at home resisted this the Government gave the contract to a foreign firm which was willing to comply with their requirements.

An inquiry, instituted in 1882, showed that the cost of steel construction in Europe was then as follows:—Krupp, 51 to 60 cents (26*d.* to 30*d.*) per pound; Whitworth, 38 cents (19*d.*) per pound; Woolwich guns, 30½ cents (15*d.*) per pound; Land service guns (France) 48 cents (24*d.*) per pound; but, it is added, the price of French construction has been greatly reduced (page 852).

From the short extracts we have been able to give from this most important and instructive work it must be apparent that the private firms in Germany and France are much in advance of those in England in respect of the magnitude of the steel-works they are able to execute, but only in consequence of Government encouragement and patronage. There are in those countries steam hammers in operation at least double the weight of any in use in this country. And yet, it must be remarked, these hammers are of English invention, and that the best armour-plates manufactured on the continent are made according to an English patent. The Bessemer process and the Siemens furnace are there much used. But it is equally plain that we have at Manchester and Sheffield several firms capable of successfully competing with the world, if they receive that support which a Government only can give.

After the failure of the 110-pounder B.L. Armstrong gun above noticed, it is remarkable how suddenly the system was abandoned. It was quite plain that the evil arose from the obstruction to the initial motion of the shot, and from the enormous friction all along the bore. But there seems to have been no real effort made to remedy this evil. If the lead coating did not prove satisfactory, why not rifle a condemned gun on the shunt principle and try studded shot? The original B.L. guns seem to have been much better proportioned guns than the M.L. guns which superseded them, for in a lecture delivered before the Royal United Service Institution about 1873, it is remarked that "A long B.L. 40-pounder converted into a M.L. 47-pounder is remarkable for the small amount of resistance it gives, and for its great accuracy of fire. . . . The regularity of the resistance of the air is also very remarkable," *i.e.*, when compared with the shooting of service M.L. guns of the same date. There is no known reason why this gun shot so well, except from its extra length. But the hint was not attended to. And the shortness of the English M.L. guns has been often remarked. Thus at the famous contest at Tegel, in 1868, between a 9-inch 12½-ton M.L. "Woolwich" gun costing

£1,500 and a Krupp 9½-inch B.L. gun of 14½ tons costing £3,453, the length of the former was 125·5 inches and that of the latter 157·6 inches. Great complaints were justly made of the unfairness of the comparative trial, because, while the English gun was strictly confined to service conditions, the German gun was repaired and altered so that every feature of the original combination was changed. After some months' delay Krupp raised the initial velocity of his gun from 1,115·3 f.s. to 1,286 or 1,414 f.s., according to whether a 336 lb. shot or a 275 lb. shell was used. Time has now decided this contest. Here we remark how ready Krupp's party were to notice defects and apply remedies. If the English party were debarred from effecting improvements at Tegel, they were free to improve at home. They had seen that it was possible to construct a 9½-inch B.L. gun, firing lead-coated projectiles, which could compete with an English 9-inch M.L. gun. But we do not hear of any further attempts having been made to render the 110-pounder (about 7 inch) B.L. Armstrong gun an efficient weapon.

Last spring we were informed by authority that the new B.L. gun then about to be constructed would be *double the length* of the old B.L. gun. And quite recently the *Times* intimates a doubt about some newly constructed guns having sufficient strength in front of the trunnions to resist the full charge for which they were constructed. Now some years ago we heard a good deal about the doings of a Committee on Explosives, which carried on experiments for several years, and at last reported. What could be the use of such a committee if it did not furnish rules for *properly proportioning the strength* of guns, and for determining the *proper length* of bore required for the profitable consumption of charges of slow-burning powder? Although Rodman and the pressure gauges and chronoscopes appear to have failed to give reliable results, it would not be difficult to contrive experiments which would give the practical value of every inch in length of the bore, and at the same time show the effect of great length of bore upon the steadiness of the motion of the elongated projectile.

In October, 1883, it was stated in the papers that some comparative trials had been made at Portsmouth before "my lords," between a Krupp and an English 6-inch B.L. gun, "greatly to the advantage of the former." A Krupp gun fired a 64 lb. shot with a 14 lb. charge and the English gun a 100 lb. shot with a 34 lb. charge. That is, the charge of the Krupp gun was two-ninths, and that of the English gun three-ninths of the weight of its shot. This increased charge might be a positive disadvantage to the English gun if it was a short one. This is a case requiring the most careful and candid investigation. Any fine morning a thorough comparison of the performances of these two guns might be carried out in a searching manner, if only known means of doing this were employed. In order to succeed in gun-making it is absolutely necessary for careful experiments to be carried out to clear up anomalies, such as we have mentioned.

This work is illustrated by seventy-eight most carefully executed plates of guns, carriages, large steam hammers, and cranes, furnaces, plans of works, &c., and it concludes with estimates of the expenses of equipping a gun foundry according to modern requirements. F. B.

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## *ON THE FORMATION OF SNOW CRYSTALS FROM FOG ON BEN NEVIS*

IN addition to the actual fall of snow, hail, &c., there is on Ben Nevis a form of solid precipitation scarcely known on lower ground, but of almost daily occurrence here. In ordinary weather the top of the hill is enveloped in drifting fog, and when the temperature of the air and ground is below freezing this fog deposits small crystalline particles of ice on every surface that obstructs its passage. These particles on a wall or large sloping surface, so well described in a recent letter in NATURE (vol. xxxi. p. 216), combine to form long feathery crystals; but on a post or similar small body they take a shape more like fir-cones, with the point to windward. Whether this deposition is from the vapour of the fog directly or from actual particles of frozen water carried along in it is not very clear. The forms and arrangements of the crystals vary according to the form of the surface to which they adhere, but all belong to this feathery or cone type, the branches lying at an angle of 30° with the main axis pointing to windward. They are formed wherever the wind blows past an obstructing body. On a flat board they gather first and most abundantly near its edges, forming a most beautiful border around it; while the centre, which I suppose the wind does not directly reach, remains clear. A round post, on the contrary, has an almost uniform crop of these crystals all over its windward half, and so accurately do they point to windward that it is possible to trace changes in the direction of the wind from the successive layers of crystals lying at different angles. The rate of growth varies with the density of the fog and the speed of the wind, but for the ordinary winds and fogs of this exposed position about half an inch per hour may be taken as a rough average. I have never seen it exceed two inches per hour. If there is a damp feeling in the air, if in fact it is mist that is passing rather than fog, the crystals are icy and hard; but when the temperature is well below freezing and the fog feels comparatively dry, they are looser in texture, seem when first formed to be attached by a mere point to whatever they are on, and are pretty easily knocked off. There is practically no limit to their growth; last winter during a long continuance of strong south-westerly winds and cold weather a post 4 inches square grew into a slab of snow some 5 feet broad and 1 foot thick in less than a week, the crystalline mass then fell off by its own weight and a new set began to form.

The effect of this growth on all the instruments exposed to its action may be easily imagined. Nothing keeps its shape or colour. The louvres of the Stevenson's screen for the thermometers become serrated with rows of teeth which quickly coalesce into a solid mass completely stopping any circulation of air inside the box. The use of exposed radiation thermometers, black bulb *in vacuo*, &c., is rendered well nigh impossible, as these delicate glass instruments would run serious risk of breakage in clearing them of the deposit, while their readings would have little value, being merely the record of the temperature inside a more or less opaque mass of snow. Very often the rain-gauge is coated with these crystals an inch thick on its windward side, while not a particle is to be seen inside. Ordinary anemometers of the type of Dr. Robinson's cup instrument become useless; the cups are no longer hemispheres, but irregular hollow bodies bristling all over with pointed crystals, and the arms carrying them increase to many times their original thickness, thus offering much greater surface for the wind to act on. Under such circumstances the anemometer at the Observatory is usually left to its own devices, and grows into an irregular mass of snow scarcely showing any trace of its original outline, to be cleared again when dry weather or a thaw gives it a chance of working. When the fog comes on while the anemometer is still turning, the crystals form chiefly on the outside of the cups and around their edges, leaving the insides pretty clear. The arms carrying the cups get completely covered, and on the diagonal stays supporting the arms the crystals show a beautiful "twined" structure pointing downwards and outwards on each side.

Occasionally the crystals are smokey-brown in colour instead of white. For example, those found on December 23, 1884, were distinctly brown, but on the 24th these were overlaid by a pure white set. What causes this change of colour and whether it is connected with any special state of the weather I have not yet determined.

*Note.*—Since the above was written, I have made a rough attempt to measure definitely the rate of growth of these crystals. A cylindrical stoneware bottle 3·6 inches high and 2·25 inches diameter was stuck upside down on a post 40 inches high for three hours at a time, the crystals formed on it melted down and the volume of the water measured. Assuming that the cylinder acted like a flat surface placed perpendicularly to the wind whose height and breadth are equal to its height and diameter—an assumption that appears to be very nearly true, at least for small surfaces—I find that with dense fog and strong wind (force 6 to 8 of Beaufort's scale) the rate of growth, as measured above, is about 0·125 inch per hour. That is to say, if the density of the snow be one-tenth that of the water, the crystals were growing at the rate of one and a quarter inch per hour. The crystals were quite loose and feathery, and contained practically no fallen or drifted snow; all had been formed directly out of the fog.

R. T. OMOND

## BIRD ARCHITECTURE

THE way in which a bird builds its nest, seemingly without instruction, thought, or experience, has been repeatedly brought forward as a convincing proof of blind infallible instinct governing it in its task. No more popular proof has been brought forward by the supporters of the blind instinct theory than that of bird-architecture. It is thought a wonderful thing for a bird to build a nest without any instruction, or without ever seeing a nest typical of its species. That birds are capable of such marvellous powers has long ago been denied by Mr. Wallace, and we have not a particle of evidence that such is really the case ("Nat. Selection," and Seebohm's "Brit. B.," ii. Introd.). Indeed the evidence, such as we can glean, goes far to disprove the presence of any such instinctive power. Birds brought up in confinement have been found not to make a nest typical of their species, but generally content themselves with forming a rudimentary structure—heaping a lot of material together without any design, or even laying their eggs on the bare ground with no provision at all! In my opinion, however, the conditions of life are so changed when a bird is kept in confinement that too much weight should not be attached to its actions in captivity, and the experiment has never to my knowledge fairly been tried with wild birds or birds living under normal conditions.

A remarkable instance, however, of a changed mode of nest-building has just been brought to my notice by Mr. W. Burton, the well-known naturalist of Wardour Street. Some time ago his brother (now employed at the museum at Wellington, N.Z.) took out to New Zealand a number of young birds of our common native species, with the object of introducing them to the Antipodes. Amongst them were some young chaffinches (*Fringilla cœlebs*). These were turned out and have thriven well in a wild state, bidding fair to permanently establish this charming little bird in our distant colonies. Some of the birds have built a nest; and to Mr. Burton I am indebted for a photograph of the wonderful structure they have woven. It is evidently built in the fork of a branch, and shows very little of that neatness of fabrication for which this bird is noted in England. The materials with which it is made seem very different, too. The cup of the nest is small, loosely put together, apparently lined with feathers, and the walls of the structure are prolonged for about eighteen inches, and hang loosely down the side of the supporting branch. The whole structure bears some resemblance to the nests of the Hangnests (Icteridæ), with the exception that the cavity containing the eggs is situated on the top. Clearly these New Zealand chaffinches were at a loss for a design when fabricating their nest. They had no standard to work by, no nests of their own kind to copy, no older birds to give them any instruction, and the result is the abnormal structure I have just described. Perhaps these chaffinches imitated in some degree the nest of some New Zealand species; or it may be that the few resemblances this extraordinary structure presents to the typical nest of the Palæarctic chaffinch are the results of memory—the dim remembrance of the nest in which they had been reared, but which had almost been effaced by novel surroundings and changed conditions of life. Any way we have here, at last, a most interesting and convincing proof that birds do not make their nests by blind instinct, but by imitating the nest in which they were reared, aided largely by rudimentary reason and by memory. I have not the least doubt that, had these young chaffinches been *hatched* in an alien nest in this country, and never allowed to see a nest typical of their species, or have any connection with old and experienced birds, the results would have been still more startling and strange. Man has to *learn* the particular art of house-building practised by his own peculiar race —birds have to do the same!

CHARLES DIXON

## THE INSTITUTION OF NAVAL ARCHITECTS

THE Annual Meetings of the Institution of Naval Architects were held during the week preceding Easter at the rooms of the Society of Arts. There were five sittings, at which the necessary routine business was transacted, the presidential address of Lord Ravensworth was delivered, and seventeen papers were read and discussed. On the whole the meetings were successful and the papers of good quality, but far too much work was attempted in the time available. It is to be hoped that the growing importance of the proceedings and the improving financial position of the Institution may lead the Executive to arrange for holding regular autumnal sessions at the principal outports, in addition to the spring sessions in London.

The papers read were chiefly "papers of information," having a strictly practical or descriptive character, only two or three having scientific pretensions. Marine engineering also occupied a far more prominent place than has been usual hitherto, nearly one-half of the papers having relation to the propelling apparatus of steamships. The fact is significant, indicating the remarkable progress which has recently been made in marine engineering, and suggesting the progress which may yet be made. Of the papers coming into this group, that by Mr. Macfarlane Gray, of the Board of Trade, was the only one of a scientific nature. Mr. Gray has on more than one occasion brought his "ether-pressure" theory before the Physical Society, where it has not been well received. His recent paper "On the Theoretical Duty of Heat in the Steam-Engine" was probably understood by only a few of his hearers; and Prof. Cotterill, whose authority on the subject is undoubted, was the only speaker who really contributed any useful criticism. While complimenting Mr. Gray on some of his graphic processes, and expressing admiration for his courage and perseverance, Prof. Cotterill took exception to the generalisations attempted in the paper and to the assumption that the results so far obtained were any real confirmation of the soundness of the theory advanced.

All the other engineering papers were of a practical character. The actual performances of "triple-expansion" engines as compared with the "double-expansion" or ordinary compound marine engines, were discussed at length. Experience appears to be conclusive on the point that, by using steam of 120 to 150 pounds' pressure, and having three successive expansions in separate cylinders, an economy of from 15 to 20 per cent. in coal consumption is to be realised. This economy is of the highest importance, both in mercantile and war ships;

and on long ocean voyages its effects are felt, not merely in the lessened expenditure of coal, but in the gain in cargo-carrying capacity. Twenty-five years ago an expenditure of from 4 to 6 pounds of coal per indicated horse-power per hour was considered good engineering practice. By the introduction of surface-condensers the expenditure was reduced to about 3 to 4 pounds; by the use of the compound engine with higher steam pressures the expenditure fell to about 2 to $2\frac{1}{4}$ pounds; and now with triple expansion it has been brought nearly to $1\frac{1}{2}$ pounds, or less than one-third of the rate common a quarter of a century ago. These are results of which marine engineers may be proud, and which make the extended use of steamships certain. Nor is further progress to be doubted. Much remains to be done in improving the marine border, and Mr. Milton's thoughtful paper on the subject will do good. Attention has been so fixed on the economical use of steam in the engines, that the possible gains by improvements on the generators of the steam have been overlooked to some extend. The employment of "forced draught" in the stokeholes is becoming so common, that it was to be expected that a discussion would arise upon it. Mr. Robinson read a paper describing a method by which steam yachts might have the combustion quickened by driving air under pressure into the furnaces, but not closing in the stokeholes as is done in torpedo boats. This paper was not merely interesting in itself, but served the useful purpose of calling forth some valuable statements of experience gained on larger ships. Forced draughts with closed stoke-holes is now becoming a recognised feature in warship design. By these arrangements, involving very moderate additions of weight and cost, the indicated horse-power can be increased by from 50 to 60 per cent. above that obtained with natural draught, and the "forcing" of the combustion can be carried on for four or five hours. A very considerable gain of speed is thus possible for a moderate time, and under ordinary working conditions with low speed, the economical expenditure of fuel is possible. In special types of merchant ships forced draught would also prove of great value; and even in sea-going steamers something of the kind is likely to be done. Trials are already in progress which promise a great economy in the weight and space required for the steam boilers, while preserving economy in coal consumption. A paper by Mr. Linington, of the Admiralty, on the propelling machinery of high-speed ships, gave a considerable amount of information as to recent Admiralty practice; and another paper by Mr. Joy, described a special arrangement of valve gear adapted for quick-running engines. Upon the efficient working of such gear, and the proper distribution of the steam, very much depends when high piston speeds are accepted, and the weight of machinery reduced.

Mr. Thornycroft's name will always be associated with the introduction of the modern torpedo boat, in which quick running engines of remarkable lightness in proportion to their power are fitted. His paper on a special form of screw propeller suitable for vessels of very shallow draught and relatively high speed naturally attracted great attention. The fundamental principle of this propeller is not a novelty: but Mr. Thornycroft has brought to a practically successful form what has been little more than an experiment in the hands of others. The propeller is one which works with a large amount of "slip," but it is associated with a system of fixed "guide-blades" and casings, by means of which the momentum of the water in the propeller race, which would otherwise be wasted, is made to contribute effectively to the forward thrust of the propeller. The net result of the arrangement is that for a given total weight of propelling apparatus a higher speed can be obtained than is possible with any other propeller yet tried in shallow draught vessels.

Mr. Parker, of Lloyd's, read a paper on the use of thick steel plates for boilers carrying high pressures of steam, with special reference to a case of recent occurrence where a plate fractured badly and in a most unexpected manner. This paper gave rise to one of the most lengthy and interesting discussions at the meetings. Steel makers and users of steel mutually benefit by the joint examination of such problems, which will probably become much rarer than they now are as the manufacture advances. The general opinion expressed in the discussion was distinctly in favour of the generally good behaviour of the new material, whose superior strength, ductility and homogeneity make it so formidable a rival to the best classes of iron.

Two papers on riveted joints were well received: the first giving a *résumé* of recent Admiralty experiments on riveted specimens of steel shipwork; and the other dealing with certain points of importance in the riveting of boiler shells.

Amongst the remaining papers, one, dealing with the stowage of steamships, contained a mass of valuable facts. Another paper dealt with the possibility of making such a disposition of the coal bunkers in steamships that the consumption of the coal might not prejudice the stability or render large quantities of ballast necessary. A third was a scientific attempt to lay down rules for competitive yacht-rocking—a hopeless task we fear.

There still remain to be noticed three of the most important papers in which a distinctly scientific method was followed. Undoubtedly the best of these, from the scientific point of view, was that contributed by Mr. Watts, in which he examined into the remarkable effects which free water may produce in checking the rolling motion of even the largest ships. Mr. R. E. Froude assisted greatly in the investigation, and exhibited a model in which the behaviour and influence of the free water were admirably illustrated. It seems obvious that by this means much greater steadiness at sea may be insured than is possible with bilge keels or other appliances of that kind. But there is a need for scientific treatment in order to secure the best steadying effects in a safe and practicable form.

Another excellent paper was that on "A Mechanical Method of Measuring a Vessel's Stability," by Mr. Heek. Here also a model was used, and by a very ingenious device the movements of the centre of buoyancy of the ship represented by the model were accurately and simply determined for all angles of inclination. It is a method which can be used by comparatively unskilled assistants in a drawing office, although its invention is a proof of thorough knowledge of the principles of stability on the part of the inventor. The plan ought to be widely used, and doubtless will be.

Finally, reference must be made to the only paper contributed by a naval officer, Capt. Noel, in which he attempted to lay down rules of general application for measuring the "fighting efficiencies" of war-ships of all classes and sizes, differentiating their values according to the nature of their speeds, manœuvring powers, armaments, protection, seaworthiness, and other qualities. The task is seemingly a hopeless one, and no general rules can apply. At the same time the paper sets out clearly and succinctly the leading characteristics on which fighting efficiency depends, and in that sense will be of service to the Institution.

W. H. W.

## THE EGGS OF FISHES[1]

CONSIDERABLE advances within comparatively recent times having been made in regard to our knowledge of the spawning of fishes, and the treatment of

[1] Introductory Lecture delivered to the Class of Natural History in the University of St. Andrews, on November 10, by Prof. McIntosh, LL.D., F.R.S.

their eggs after deposition, I have selected this subject for the introductory lecture, since some opportunities have lately been afforded for its investigation in our own waters. These facilities have occurred at sea in connection with the Trawling Commission, and on land at the Marine Laboratory—now, I am glad to say, established, by the aid of the Scotch Fishery Board, within easy reach of the students of Natural History in this University.

The subject, moreover, is one of general interest, for it is but a short time since works devoted to the history of British fishes were devoid of allusion to any other mode of spawning than that by which the eggs of our marine fishes were deposited on the bottom of the sea. Indeed, it was believed by most naturalists that the latter was the normal mode of deposition. As a consequence, some of the text-books at present in use either follow the latter view, or do not specially allude to the question. Under these circumstances, it is not surprising that the majority of those who have spent their lives from boyhood onward at the pursuit of line-fishing should maintain, even at this moment, that the eggs of all marine fishes are deposited at the bottom of the sea—with a tenacity all the more persistent as several apparent corroborations by experiment (which they had, with praiseworthy interest, made, and which I shall allude to by and by) seemed to justify their opinion.

The eggs of all fishes are produced in the ovaries—symmetrical organs which lie beneath the vertebral column, and which at different periods of the year present various appearances according to the degree of development of the eggs. Thus in the quiescent condition of the organs, as in the case of the green cod before you, their size is insignificant, while the fully-developed ovaries occupy a large space and weigh several pounds. At first the eggs are very small, but they gradually increase in size by imbibing nourishment from the ovarian follicles in which they are placed.

A feature not sufficiently insisted on in our country is the fact that only a portion of the ovary in most marine fishes becomes "ripe" at a given time, the matured eggs passing along the oviduct and escaping externally. This provision appears to be admirably suited for the increase of the fishes, a constant succession of embryos being thus liberated, and time afforded for those of one stage to disappear, as we shall afterwards see, from the surface of the ocean before those of the succeeding take their places. In America this condition has been clearly described in the Report on the cod-fisheries of Cape Ann, by Mr. Earll, for the United States Fish Commission in 1880; but the account does not seem to have come under the notice of Mr. Oldham Chambers, who alluded to the subject a year or two afterwards.[1] Mr. Earll observes that the individuals (*i.e.* the cod) do not deposit all their eggs in a single day or week, but probably continue the operation of spawning over fully two months. The result of this arrangement is that the American cod begin to spawn in September, and some continue as late as June. The cod in our own seas do not follow the same habit, though their spawning-period extends on each side of the beginning of April. In the same way the period during which the eggs of the various kinds of skate are deposited is considerably lengthened.

On the other hand, such marine fishes as the lump-sucker and bimaculated sucker, the salmon, trout, and most freshwater fishes seem to deposit their eggs within the limited period of a day or two, and consequently the development of the masses of eggs in the ovaries is more nearly simultaneous.

The importance of this point in the history of the eggs of fishes will be apparent when it is viewed in connection with a close time in legislation; for while nothing could be more simple than the fixing of such a period in the case of the salmon, which spawns in rivers, it would be very different in the case of such as the cod, sole, and turbot, both on account of the lengthened and diverse periods in each case, and the vastness of the field in which it is to be applied.

In general form the eggs of ordinary fishes are circular. On deposition they are usually invested by a single layer (zona radiata), though in some, as in the herring, there is another, viz. the vitelline membrane, which lies outside the former. The great mass of the egg is formed by the oval spherules of the food-yolk, which are separated by protoplasmic bands. Near one of the poles the protoplasm usually forms a lenticular area, the germinal disk or germinal area, and the smaller yolk-spherules in this region differ in character from those of the general mass of the egg. During development the eggs show partial segmentation, this process being chiefly confined to the germinal area.

While the circular form as just described is characteristic of the eggs of most fishes, we have a few marine types which deviate from the general rule, *e.g.* *Myxine* (glutinous hag), with its ovoid and fringed eggs, the goby, with its fusiform ova, the gar-pike, saury pike and flying-fish, which have long filaments attached to their eggs—probably for the purpose of fixing them to floating structures of any kind. Amongst other interesting types are the large eggs of the stickleback and the salmon-tribe, and the almost microscopic eggs of the eel. The large ova of the salmon and trout are surpassed, however, by those of the Siluroid genus *Arius*—found both in the Old World and the New (Ceylon and Guiana)—the eggs being somewhat larger than a pea (5-10 mm.): but this is not the only remarkable feature in these fishes, for, as Drs. Günther and Wyman and Prof. Turner have shown, the large eggs are carried by the male in his mouth and gill-chamber until hatched, the small and almost granular palatine teeth making this possible, without injury to the ova. He thus acts the part of a dry nurse, as also does the male pipe-fish (*Syngnathus*), and the sea-horse (*Hippocampus*), the eggs being borne by the male in a pouch on the under surface. In another Siluroid fish (*Aspredo*) from Guiana the remarkable exception occurs of a female fish interesting itself in the care of its young. The skin on the under surface becomes soft and spongy, and the eggs, which are deposited on the ground, adhere by simple pressure of the body over them—very much after the arrangement in the Surinam toad. Only one other female fish shares with this one the distinction just noted, viz. *Solenostoma*, an Indian Lophobranch, in which the ventral fins (free in the male) coalesce to form with the integuments a pouch for the reception and hatching of the eggs. The entire group of the sharks and rays (Elasmobranchs), again, is characterised by the peculiar condition of their eggs, which are not only distinguished by their great size, but by the fact that they are either deposited in horny capsules, or retained in the oviduct until hatched. The former takes place in the common rays, certain dog-fishes (*Scyllium*), and sharks (*Cestracion*), and in the curious *Chimæra* and *Callorhynchus;* while the latter, that is the production of living young, occurs in the rest of the sharks and in *Torpedo*.

As already indicated, the prevalent notion amongst the older naturalists was that fishes of all kinds deposited their eggs on the bottom of the sea, and that extensive migrations were made by various kinds for this purpose, the general impression being that the majority proceeded shorewards to deposit their eggs in the shallow water. This impression was probably due to the fact that the salmon, and perhaps the herring, followed this habit, the former proceeding up rivers, and the latter selecting certain suitable banks (often near land) covered with seaweeds and zoophytes, or a bottom composed of stones and gravel. Building their notions on these facts, it was

[1] "Fish and Fishes," Prize Essays, International Fisheries Exhibition, Edinburgh, 1883. p. 187.

assumed by the older observers that all marine fishes followed similar habits. Thus it was supposed that the cod, haddock, whiting, ling, hake, and other fishes frequented certain banks for the purpose of depositing their eggs, and that various flat fishes, such as the larger examples of turbot and sole, came from deep water to shallow water for the same end. Such conjectures, however, were found to deviate very considerably from the actual condition.

Amongst the earliest to notice that the eggs of certain marine fishes floated were the cod-fishermen of the Loffoden Islands, off the coast of Norway. These Norwegians had noticed that what they called the "roe" of the cod-fish floated in the water on the great fishing-banks, and often at certain seasons to such an extent as to make the water thick. Prof. G. O. Sars, Inspector of Fisheries in Norway, to whom this remark was made, supposed that the fishermen had mistaken some of the lower marine animals for the eggs of fishes, for such a feature was in direct opposition to anything he knew of the spawning of fishes. The subject, however, was soon set at rest, for he proceeded in 1864 to the fishing-grounds above-mentioned, viz. off the Loffoden Islands, and captured in the tow-net immense numbers of the eggs of the cod floating at the surface of the sea. Next year, indeed, on a calm day, Prof. Sars found the sea covered with a dense layer of floating spawn, so that with a sufficiently large net he could have taken tons of it. This occurred over a celebrated fishing-ground, on which the cod were present in enormous numbers, so as to form what the fishermen called a "fish mountain." Sars also found that the ova of the haddock floated, and amongst the eggs procured from the surface of the sea were some from which young fishes resembling gurnards emerged, and he correctly concluded that the ova of the gurnard followed the same habit as those of the cod and haddock.

The impetus given to such observations by the energetic action of the United States Fish Commission enabled the Americans to corroborate the discovery of the Norwegians in regard to the floating of the ova of the cod, which lately have been artificially hatched on a somewhat extensive scale on their coasts. The labours of the distinguished Prof. Alex. Agassiz in the same country have further added to our knowledge of floating eggs, so that the number of fishes in which this occurs is considerable. Thus the majority of the American flounders, certain kinds of wrasses (*Ctenolabrus*), a species of sparling (*Osmerus*), several species of cottus, cod, haddock, gurnard, shad, mackerel, and Spanish mackerel, a kind of dory (*Zeus*), and the frog-fish are amongst those which have floating eggs. The late Dr. Malm of Gothenburg further increased the list by discovering that the eggs of the plaice were similarly buoyant; and G. Brook has recently added to this category the eggs of the lesser weever. The very great influence which this floating of the tiny eggs exercises on the multiplication of the food fishes will be apparent as we proceed.

On the other hand, most freshwater fishes (except the shad) deposit their eggs on the bottom like the salmon, or on water-plants, like the carp and pike; while other marine species, such as the herring, sprat, lump-sucker, and bimaculated sucker, follow a similar method. The number of marine fishes which are supposed to deposit their eggs on the sea-bed is yearly diminishing, while the ranks of those in which the ripe eggs are found to float correspondingly increases.

To come now to our own shores, and to confine our remarks to what is really the most important group of fishes, viz. the food-fishes, we find that early in spring the surface of the sea over the great fishing-banks, such as Smith Bank, off the north-east of Scotland (Caithness), presents vast numbers of floating eggs of food-fishes, together with multitudes of the very young fishes provided with a yolk-sac exhibiting various degrees of absorption. Some of the ova (*e.g.* those of the haddock and gurnard) are larger than those of the cod, but they are few in number; while a fourth kind are smaller than any yet mentioned. When placed in a vessel of sea-water the eggs persistently float on its surface, descending but a very little when the jar is rudely shaken. Even after a protracted journey only the dead eggs roll on the bottom of the vessel. All the floating eggs are living. Moreover, the eggs were removed from the cod itself, and carried from Smith Bank to the Marine Laboratory at the harbour. On arrival, these floated at the surface of the vessel. On transferring them to a larger jar and turning on a tap of sea-water, a great change occurred. The ova in a few minutes lay on the bottom. Microscopic examination subsequently showed that the edge of the germinal area was disintegrating—free protoplasmic processes and separate cells occurring all round. The cause of this sudden change was doubtless the impurity of the water (for the proper apparatus had not yet been fitted up), the metallic pipe (block-tin) containing an opaque whitish deposit which speedily killed the ova. The addition of methylated spirit in the same way sends all the eggs and embryos to the bottom. Sars, indeed, mentions that if the eggs of the cod are placed in fresh water they sink, and never rise again. They are killed—just as a newly-hatched salmon is killed—though somewhat more slowly, by immersion in sea-water. Sars thinks that even a fall of rain might affect the floating of the ova in the sea, but this is unlikely.

More than once the eggs of the haddock and other fishes have been brought under notice as lying on the bottom of a vessel, and therefore held as proving that the ova did not float. But in every case such eggs were found to be dead or dying, unripe, or not even fertilised. If in removing the eggs from a fish, too much pressure is applied, unripe eggs escape. Such either sink or float ambiguously, according to the stage of development. Unless this fact is borne in mind, disappointment naturally occurs, especially to one who has triumphantly carried such eggs from deep-sea fishing to vindicate statements that have been impugned. No one ever asserted that dead eggs floated. It is the ripe and living eggs that are so buoyant.

In the Marine Laboratory it has happened that some living ova of the cod rolled on the bottom of the vessel, but this was clearly due to the attachment of fine particles of mud and sand which had gained admission from imperfections in the temporary apparatus, and which surely and speedily in every case proved fatal to the embryo.

The ova and embryos brought from the surface of the sea are comparatively hardy, even though kept for ten days without renewal of the sea-water. The lively little cod, about 5 mm. in length, with their characteristic black pigment-patches, swam actively at the surface of the water, darting hither and thither when interfered with, while a stratum of the dead lay at the bottom. The water may even be somewhat milky and the odour characteristic, and yet the embryos survive—until, as Sars also found, the yolk-sac, which supplies them with nourishment, is absorbed.

The difference between the larval cod and the young salmon just hatched is striking. The former (that is, the young cod) is in a very rudimentary condition, not only in size, but in structure. For instance, the heart pulsates, but, as my colleague, Prof. Pettigrew, observed, there is no visible blood and no blood-vessels. Those, therefore, who say that the heart in animals contracts from the stimulus of its living blood, would here find little support. On the other hand, the newly-hatched salmon has attained great complexity; indeed, several days may be spent in delineating its elaborate blood-vessels alone.

(*To be continued.*)

## *NOTES*

WE regret to learn of the death, at the age of eighty years, of the eminent physiologist, Prof. Karl von Siebold, of Munich.

WE have also to announce the death of Mr. Frederick Field, F.R.S. Mr. Field was one of the original members of the Chemical Society. He held for some time the post of Vice-Consul in Caldera, Chili, and was successively Professor of Chemistry at St. Mary's Hospital and the London Institution. He was senior partner of the firm of J. C. and J. Field at the time of his death. Mr. Field contributed numerous papers to various branches of chemistry, especially that relating to the mineralogy and metallurgy of South America.

A COMMUNICATION dated March 7 has been received from Mr. Thorlacius, observer for the Scottish Meteorological Society at Stykkisholm, in which he states that till February the winter in Iceland was not a severe one. In that month, however, the weather was very cold, and ice between six and seven feet thick formed in the harbour, during which of course no temperature observations of the sea could be taken. On March 4 and 5 the ice broke up, and in the open space between the floating ice-blocks the temperature of the sea was found to be 29°·0. Of the Spitzbergen ice it is remarked that nothing had yet been heard of it, but that it could not be far off, as north-easterly winds had been blowing all February. Mr. Thorlacius observed an aurora on January 24, with a triple arch and faint traces of a fourth bow within the other three arches close down on the horizon, being the first time an aurora of this description has been seen by him since he began his regular meteorological observations in 1845.

THE *Monthly Weather Review* of the Dominion of Canada for February, 1885, presents some points of interest. At Victoria, British Columbia, the mean temperature was 9°·0 higher than the average, and 13°·8 higher than February last year; but, on the other hand, to the east of the Rockies, temperature was under the average, the greatest defect from the average, 13°·3, occurring at Port Stanley. At Toronto the mean temperature was only 11°·1, being 11°·1 lower than the average of forty-five years, and with the single exception of February, 1875, when the mean fell to 10°·2, was the coldest month recorded at the observatory during the past forty-five years. Generally the month was remarkable for the cold which prevailed nearly everywhere, and also for the very stormy weather which was experienced over the Lake Region, and in Eastern Canada, between the 8th and 11th. On the 9th temperature fell in Manitoba to −48°·3 at St. Andrew's, and −46°·0 at Stony Mountain; and in Asiniboia to −47°·0 at Pheasant Forks. The proportion of sunshine recorded in each hour of the day during which the sun was above the horizon is given for twelve stations, giving a mean result of 39 per cent. of actual as compared with possible hours of sunshine. It is remarkable that only at one of the twelve stations, viz. Cornwall, was 100 per cent. recorded during any day of the month. The number of predictions or forecasts of weather issued during the month was 523, of which 80 per cent. were fully, and 92 per cent. either fully or partially, verified. As regards the three storms which occurred, thirty-nine warnings were issued and cautionary signals at the various signal stations, each of which was verified in every particular as to the force of the wind; and with respect to the predictions as to the probable changes in the direction of the wind, 90 per cent. were fully and 100 per cent. were either fully or partially verified.

MR. CUTHBERT E. PEEK sends us his First Report of a meteorological observatory established at Rousdon, Devon, in September, 1883. The Report presents some of the features of the meteorology of Rousdon during 1884. Fully half a quarto page is given to a somewhat popular account of the weather of each month. A few illustrations are given, of which the first shows by curves the mean monthly temperature of Greenwich for the forty years ending 1873, and the mean at Rousdon for the months of 1884. Nowhere, however, is there printed in figures a monthly mean either of the pressure or the temperature of the air, the author contenting himself only with the extreme pressures and temperatures of the months. Subsequent reports will, no doubt, make good these omissions, and will continue, it is hoped, the comparison of the weather forecasts of the Meteorological Office, with the weather actually experienced in this district of Eastern Devon.

THE veteran zoologists of Cuba, *Science* states—Prof. Felipe Poey, who is now nearly eighty-six years old, and Dr. Juan Gundlach, who has completed his seventy-fourth year—are still engaged industriously in studying the fauna of that tropical island. Dr. Gundlach has been publishing his contributions to the fauna of Porto Rico in the *Annals* of the Spanish Society of Natural History. The vertebrates (including fishes by Poey) have all appeared, and recently the freshwater marine mollusca have been issued. Gundlach has been publishing every month eight octavo pages in the *Annals* of the Havana Academy of Sciences—a contribution to the mammals, birds, and reptiles of Cuba—and is now at work upon the insects, of which the Lepidoptera are already nearly completed, and occupy already nearly 400 pages. Poey has published the fishes of the island in the *Annals* of the Spanish Society of Natural History, and Arango has discussed the mollusks. It is to be hoped that these still vigorous naturalists will live to see the completion of the work they have undertaken with so much zeal.

THE French Academy of Sciences has appointed a new commission on aërostats consisting of MM. Faye, Fremy, Jamin, Tresca, Cornu, and Perier.

THE French Society of Physics will meet as usual to-day, in the rooms of the Société d'Encouragement, to exhibit all the new apparatus invented during the year.

PROF. TYNDALL will begin a course of five lectures at the Royal Institution on Tuesday next (April 16) on "Natural Forces and Energies."

THE arrangements for the remaining April Popular Science Lectures at the Royal Victoria Hall, Waterloo Road, are as follow:—April 21, P. H. Carpenter, D.Sc., on Greenland. April 28, Dr. J. A. Fleming, "Our Nimble Servant, Electricity, and what we can make it do."

EXHIBITS in the Fish Culture Department of the forthcoming Inventions Exhibition are already being placed in the several spaces allotted to them. They include hatching-boxes showing the manner in which fish eggs are incubated; feeding-boxes in which the fry are inserted after losing their *umbilical sac*, and numerous appliances and apparatus necessary to carrying on the work of fish-culture successfully. There will also be shown various species of fish in different stages of development reared artificially, together with models of fish-farms, oyster-culture establishments, and a number of other exhibits of an interesting nature.

A COMMISSION appointed by the French Government to inspect the forests of Tunis, and to make proposals with regard to afforestation, has recently presented its report. In the districts south of the Medjerda valley the so-called forests are mere brushwood, composed of the callistus, juniper, Aleppo pines, and small oaks. The land is cleared for pasturage and cultivation, and only here and there are seen groups of larger trees, such as Alpine firs and olives Nothing is therefore to be gained by preserving here, and the cost would be very great;

but it is nevertheless recommended that some steps be taken to protect trees and shrubs which exercise a beneficial influence on the *régime des eaux*. The Kroumis mountains to the north are of a totally different character. Magnificent forests of old trees exist in them, which attain as great dimensions as those in the best French forests. They contain magnificent cork trees and white oaks (*Q. Mirbeckii*), with trunks three or four metres in circumference and ten to fifteen metres in height to the first branches. One forest covers 100,000 hectares, and contains also the alder, willow, wild cherry, beech, poplar, holly, bay, and the tamarisk. This and some neighbouring ones should, the report advises, be strictly preserved. The bark and wood of the oak and cork would repay the expense.

We have received Mr. Morris's Annual Report on the Public Gardens and Plantations of Jamaica, which, as usual, contains various matters of much general and local interest. We have already referred, in noticing a similar report from Queensland, to the immense economical importance of such institutions as this, and we are glad to perceive that such competent authorities as the late Royal Commissioners in the West Indies and Sir Joseph Hooker have publicly recognised the value of Mr. Morris's labours. The former suggest that in all the lesser islands "plant committees" of the residents should at once be formed to correspond with the establishment in Jamaica, while Sir Joseph Hooker, in commenting on this recommendation in his letter to the Colonial Office, stated that there can be no doubt that the future prosperity of the West Indies will be largely affected by the extension to other islands unprovided with any kind of botanical establishment of the kind of the operations so successfully carried out by Mr. Morris in Jamaica. But he thinks that mere committees will not be enough: botanical stations on a cheap basis are an essential condition for doing anything in an effective way. The money value of rain in Jamaica is well shown in a paragraph in the report quoted from Mr. Maxwell Hall's estimate. A comparison has been made between so many inches of rain per annum and so many casks of sugar per acre. Thus there were 1559 casks per acre for 79 inches rainfall and 1441 casks with 56 inches, so that the difference due to a larger or smaller island rainfall is on an average nearly one-tenth of the export sugar crop. This one-tenth export crop, for sugar and rum, represents in value nearly 100,000*l*. But if other produce, which is likewise affected by a greater or less rainfall, such as coffee and pimento, the difference would amount to a very considerable sum. During the year considerable attention was devoted in the herbarium to the medicinal plants of the island, and to forming not only a collection of botanical specimens, but also of the barks, roots, and the portions used for medicine. The value of this herbarium to the commercial interests of the West Indies was shown while working up the botanical classification of the indigenous plants capable of yielding fibre. It was found that the common native *Agave* (aloe) of Jamaica was not, as had been represented in books on Jamaica plants, the *Agave americana*, but an entirely different species, the *Agave keratto* of Salmdyck. The application of this difference, which appears to him only one of botanical nomenclature, to the industrial arts is that, under the belief that this plant was *Agave americana*, and therefore capable of yielding valuable fibre, large sums of money were spent and lost in getting out machinery to clean fibre which was of inferior quality.

At the end of the report on the Jamaica public gardens above referred to, Mr. Morris mentions some curious instances of superstitions among the negroes with regard to plants. The plantation labourers believe that if they take up the horse-plaintain suckers (*i.e.* those with long fingers), and then take up one of the maiden plaintains (with the short fingers) while the gum or juice is still fresh upon their cutlasses, and they use the same cutlass, the maiden plaintains will produce horse-plaintains, and this was said by them to be a matter of common experience. It is believed also to be unlucky to point the finger when speaking of any growing plant in a provision ground, or even to name a plant which has recently been planted. It is stated even by intelligent Europeans that if the seed of the shaddock (*Citrus decumana*) is planted, there is but one in a whole shaddock that will produce good and pleasant fruit, and also that there are fifty-two seeds in a shaddock, only two of which produce the real shaddock, while the others produce a variety of fruits such as the sweet lime, forbidden fruit, grape fruit, chester fruit, and orange!

According to an article in the last number of the *Oesterreichische Monatsschrift für den Orient*, by Herr Friedrich Müller of Vienna, on the palæography of the Philippine Islands, the inhabitants of the archipelago of Malay descent possess a writing which is going more and more out of use and is being supplanted by the Latin writing introduced with Christianity by the Spanish missionaries. The original writing, which is on the whole in the same form among the various tribes, such as the Tagals, Ilocos, Visayas, Pampangas, is connected first with the writings of the people of the Celebes (Bugis, Macassars), and of Sumatra (Battak, Redschang, Lampong), and the forms point to India as the common origin of all. But whether the writing of the Malay peoples came direct from India, or through the intermediary of another writing; from which Indian alphabet it came, *i.e.* from which province; and at what time,—are questions which various competent scholars have answered in various ways, and which may therefore be regarded as still open. To those who desire to pursue the subject two interesting recent studies may be recommended. One, by Prof. Kern, of Leyden, appears in the well-known Dutch magazine, *Bijdragen tot de Taal-, Land- en Volkenkunde van Nederlandsch-Indië*, vol. iv. No. 10 (1885), which is a critical examination of the whole question; the other, in Spanish, by Señor Pardo de Tavera, is published as a pamphlet, and is entitled "A Contribution to the Study of the Ancient Alphabets of the Philippines." The special value of the latter is that it investigates the subject more thoroughly than any of its predecessors with special relation to the Philippines, and illustrates it by much that is original from the old literature of the archipelago. It is accompanied by plates, containing copies of no less than twelve Philippine alphabets. Nos. 11 and 12, however, appear to be identical, with the exception of being produced with different instruments. No. 11 is probably written with a pen on paper, while No. 12 was probably cut by a knife into wood. Even with this deduction there are still eleven distinct alphabets in this archipelago alone.

The stone implements, shell heaps, and other prehistoric remains of Japan have already received some attention at the hands of Profs. Milne and Morse, and of Herr von Siebold, an Austrian *savant* in the diplomatic service in Tokio. Until quite recently, although the Japanese prized stone implements and the like, they appear to have done so on account of their peculiar shapes and as curiosities rather than because of their scientific importance. A Japanese gentleman filling a high official position has, however, just published a volume entitled, "Notes on the Ancient Stone Implements of Japan," for a description of the contents of which we are indebted to the *Japan Mail*. Mr. Kanda enjoys high reputation as an antiquarian. His book contains twenty-four plates, to each of which are appended accurate descriptions of the objects delineated, with their names and other details. The plates are not tinted, so they convey no idea of the colours of the originals, many of which are of black serpentine, jade, jasper, amethyst, agate, calcedony, &c. They give the exact shapes and dimensions of all the objects. Mr. Kanda's object is not to ventilate his own opinions, but to furnish antiquarians abroad with data for comparing the stone implements of Japan with those found elsewhere. In a short treatise of eight pages he describes the beliefs universally current in Japan on the subject of these remains. Dividing stone implements into "chipped" and "polished," he mentions four varieties of the former, which, translating the original Japanese names, he calls arrow-heads, spear-heads, rice-spoons of the mountain gnomes, and pound-stones—the last being really hoe-heads. The three first are known all over Japan, but become more and more numerous as one approaches the north. They are supposed to have been used by the Ainos. Of the "polished" stone implements there are six principal varieties, vulgarly known as thunder-bolts, thunder-clubs, stone daggers, and dagger-heads, *magatama* and *kudatama*, or curve and tube-shaped jewels. The thunder-bolts, so called, are evidently axe-heads; they are found everywhere, but chiefly in the north. The "thunder-clubs" are beautifully ornamented, while their shape and size—occasionally they are found as much as five feet long and five inches in diameter—suggest the idea that they served as insignia of authority rather than as weapons of war. The prehistoric pottery is Kamloka pottery, from the name of the locality in Northern Japan where it was first discovered. Like the stone implements, it occurs with greater frequency the farther north we go. The general conclusion is thus suggested that the aborigines of Japan were gradually pushed northward by invaders from the south, but where the distinction is to be drawn between the races known as Tsuchigamo, Yezzo, and Aino is a question for future determination. No metal implements have ever been found with this pottery, whereas it is constantly associated with all the stone implements enumerated above. In the ancient tombs, which exist everywhere throughout Japan except in Yezzo, there are unearthed several varieties of stone implements, and with them occur metal implements, together with a species of pottery known as *Giogi* ware, after a priest of that name who came to Japan from Corea in the eighth century, and who is supposed to have introduced the potter's wheel. The name is doubtless improperly applied to the ware found in the ancient tombs, for in court relics now preserved and dating back to the eighth century there is ware incomparably superior to this so-called *Giogi* ware, which should therefore probably be referred to a period much more remote. The stone implements found in these tombs are for the most part of an ornamental character, though some may have served for agricultural purposes. The former include the *magatama*, or "curved jewels" which were used as pendants. Some of them are of nephrite and chrysoprase, minerals never yet found in Japan, so that these ornaments must have been brought over from the Asiatic continent. Mr. Kanda thinks that the ancestors of the present Japanese, when they arrived in Japan, brought with them from their old home metal implements which, not being sufficient for all, were appropriated by the privileged few, the majority of the people going back to stone implements. This curious theory would explain the circumstance that many of the thunder-clubs already mentioned are so beautifully ornamented as to indicate, almost with certainty, the use of metal chisels; but archæologists will probably prefer leaving this circumstance unexplained to adopting so violent an explanation.

We have received the *Proceedings* of the Windsor and Eton Scientific Society for 1884, with the Society's diary and the presidential addresses since its formation in 1881. One naturally looks in the *Proceedings* of this and similar societies to the local work—the papers with some of the *locus in quo* in them—rather than to the more general papers read and lectures delivered. We find more than one instructive communication on the subject of the old Roman town of Silchester, near Reading; a paper on the trees of Windsor Forest, by Dr. Gee; whilst amongst the papers read during the four years, but not printed, we notice one on some bronze implements found in the Thames near Windsor, on carnivorous plants found in the same neighbourhood, and on recent explorations of a tumulus at Taplow. The Society, which does all its interesting work on a subscription of five shillings from each member, is affiliated with the Albert Institute of Windsor, and was formed in consequence of the success of an exhibition of microscopes and other scientific objects which formed one of the fortnightly entertainments provided by this institute.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr. F. J. Edmonds; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; two Great Kangaroos (*Macropus giganteus* ♂ ♀), eight Silky Bower-birds (*Ptilonorhynchus violaceus*) from New South Wales; two Red Kangaroos (*Macropus rufus* ♂ ♀) from Australia; two Bennett's Wallaby (*Halmaturus bennetti* ♂ ♀) from Tasmania; a Roan Kangaroo (*Macropus erubescens*), two —— Wombats (*Phascolomys* ——) from South Australia, received in exchange; two Sumatran Rhinoceros (*Rhinoceros sumatrensis* ♂ ♀); a Rufous-tailed Pheasant (*Euplocamus erythrophthalmus* ♀) from Malacca; a Bar-tailed Pheasant (*Phasianus reevisi* ♀) from North China; two Peacock Pheasants (*Polyplectron chinquis*) from British Burmah; a Silver Pheasant (*Euplocamus nycthemerus* ♀) from China, a Cocoi Heron (*Ardea cocoi*) from America, purchased; a Bonnet Monkey (*Macacus sinicus*), a Black Lemur (*Lemur macaco*), born in the Gardens.

## *OUR ASTRONOMICAL COLUMN*

Ancient Occultations of Aldebaran.—In Nature, vol. xxxi. p. 182, reference was made to an occultation of Aldebaran which Bullialdus found recorded in a Greek manuscript, and which it had been supposed was observed at Athens on March 11, A.D. 509. The extract from the manuscript is given at p. 172 of the well-known work of Bullialdus, "Astronomia Philolaica." The observation is perhaps mentioned in somewhat undecided terms, inasmuch as it is rather implied that after twilight had ended the moon seemed to have occulted the star; nevertheless we have its position described as close to the moon at the time of observation; and further: "Stella quippe apposita erat parti, per quam bisecatur limbus Lunæ illuminatus." If we remember rightly, Street, amongst others, has pointed out that the occultation itself could not have been seen at Athens, but must have been observed at some more eastern station. The following are results of a recent computation in which the moon's place has been determined on the same elements which closely represent the occultations observed in China B.C. 69, February 14, and A.D. 361, March 20, referring to the planets Mars and Venus respectively, as well as other phenomena recorded previous to the fourth century.

A.D. 509, March 11, at 2h. 30m. Paris mean time.

| | ° | ′ | ″ |
|---|---|---|---|
| Moon's right ascension ... ... ... | 48 | 11 | 23 |
| ,, declination ... ... ... ... | +12 | 55 | 46 |
| Hourly motion in R.A. ... ... ... | | 30 | 15 |
| ,, ,, Decl. ... ... ... | | +7 | 12 |

The position of Aldebaran was in R.A. 48° 10′ 16″, Decl. +12° 29′ 29″. The sidereal time at mean noon at Athens was 23h. 22m. 11s. Hence, calculating for Athens, we find the star disappeared at 3h. 7m., and re-appeared at 4h. 37m. local mean time; the sun set at 6h. 6m., so that the occultation occurred in broad daylight, and "post accensas lucernas" there would be a considerable distance between the moon and the star, as seen at Athens.

By way of testing the moon's place here employed, we may examine the circumstances of another occultation of Aldebaran, which Gaubil extracted from the Chinese historical works, and thus describes:—"In the ninth year (period *Yung-ming*), third moon, day *ping-chin*, the moon eclipsed Aldebaran;" this occurs in the records of the "Dynastie des *Tsi* du sud, la cour à Nanking." Gaubil gives the date March 29, A.D. 491. Proceeding as before we have for

A.D. 491, March 29, at 1h. 30m. Paris mean time

| | ° | ′ | ″ |
|---|---|---|---|
| Moon's right ascension... ... ... ... ... | 48 | 35 | 53 |
| ,, declination ... ... ... ... ... | +12 | 53 | 1 |
| Hourly motion in R.A. ... ... ... | | 29·44 | |
| ,, in Decl. ... ... ... | | +7·39 | |

The position of Aldebaran was in R.A. 47° 50′ 44″, Decl. +12° 10′ 15″. The sidereal time at mean noon at Nankin was 0h. 29m. 36s., and, calculating for that place, we find the star disappeared at 9h. 2m. local mean time, and would set at 9h. 14m., so that its altitude at disappearance was only 2°·3. Whence, assuming the accuracy of these computations, it is clear that the occultation could not have been seen as recorded at Nankin, if the moon's place about the epoch to which they refer were sensibly behind that deduced, so as to render possible an observation in twilight at Athens of the occultation of March 11, 509.

This result for the circumstances of disappearance of Aldebaran at Nankin in 491 reminds us of a similar observation made in London on the occultation of the same star, September 14, 1717, probably from the roof of the Royal Society's house in Crane Court, Fleet Street, whence, we are told, on the occasion of the total solar eclipse in 1715 there was a free horizon. "On the 14th of September, in the evening, for the first time the moon returned after a long interval to hide *Palilicium*; and the sky was extraordinarily clear at London, so that the moon and the star were seen to rise in the horizon at the same time; the immersion of *Palilicium* was at 9h. 6m. 20s., the moon not being 3° high, in the very middle, as it were, of the eastern limb, over against the northern part of that small *macula* which Hevelius called *Stagnum Mœridis*, and Ricciolus by his own name . . ."

BARNARD'S COMET.—A new computation of the orbit of this comet, by Mr. Egbert, of the Dudley Observatory, Albany, U.S., confirms that of Dr. Berberich, as regards the close approach which the comet makes to the orbit of Mars. At a true anomaly of 37° 35′, corresponding to heliocentric longitude 343° 52′ (equinox of 1884), the distance is within 0·008, the earth's mean distance from the sun being taken as unity, and a very close approach of the two bodies may have taken place, as before remarked, at the end of the year 1873. Dr. Berberich's period of revolution is 1958·9 days, that of Mr. Egbert 1970·3 days, an increase of only ten days on the latter period would suffice to have brought the comet and planet together in December 1873. The latest observation made by M. Perrotui, at Nice, in November, 1884, has not yet been brought to bear upon the direct calculation of the orbit, though Dr. Berberich's comparison of his elements therewith shows but small difference between calculation and observation. Barnard's comet does not quite attain to the orbit of Jupiter, the distance at aphelion being 0·555.

## *ASTRONOMICAL PHENOMENA FOR THE WEEK*, 1885, *APRIL* 12–18

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

*At Greenwich on April* 12

Sun rises, 5h. 12m.; souths, 12h. 0m. 41·7s.; sets, 18h. 51m.; decl. on meridian, 8° 51′ N.: Sidereal Time at Sunset, 8h. 15m.

Moon (New on April 15) rises, 4h. 2m.; souths, 9h. 47m.; sets, 15h. 43m.; decl. on meridian, 3° 38′ S.

| Planet | Rises h. m. | Souths h. m. | Sets h. m. | Decl. on meridian ° ′ |
|---|---|---|---|---|
| Mercury ... | 5 27 | ... 13 7 | ... 20 47 | ... 18 0 N. |
| Venus ... | 5 10 | ... 11 41 | ... 18 12 | ... 5 26 N. |
| Mars ... | 4 55 | ... 11 15 | ... 17 35 | ... 3 13 N. |
| Jupiter ... | 13 13 | ... 20 30 | ... 3 47* | ... 14 1 N. |
| Saturn ... | 7 46 | ... 15 52 | ... 23 58 | ... 21 59 N. |

* Indicates that the setting is that of the following day.

*Phenomena of Jupiter's Satellites*

| April | h. m. | | April | h. m. | |
|---|---|---|---|---|---|
| 12 ... | 2 1 | I. occ. disap. | 14 ... | 22 43 | III. occ. disap. |
| | 23 22 | I. tr. ing. | 15 ... | 2 22 | III. occ. reap. |
| 13 ... | 1 41 | I. tr. egr. | | 3 13 | III. ecl. disap. |
| | 20 29 | I. occ. disap. | 16 ... | 0 0 | II. occ. disap. |
| | 23 50 | I. ecl. reap. | 17 ... | 21 2 | II. tr. egr. |
| 14 ... | 20 9 | I. tr. egr. | 18 ... | 23 36 | IV. tr. egr. |

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

| April | h. | |
|---|---|---|
| 14 ... | 6 ... | Mars in conjunction with and 0° 12′ south of the Moon. |
| 14 ... | 20 ... | Venus in conjunction with and 0° 6′ north of the Moon. |
| 16 ... | 7 ... | Mercury in conjunction with and 6° 21 north of the Moon. |
| 17 ... | 20 ... | Mercury stationary. |

## *GEOGRAPHICAL NOTES*

THE Pescadores, which have recently been bombarded and occupied by Admiral Courbet, are a small group of islands lying in the Formosa Channel, about twenty-five miles off the west coast of Formosa. They are attached for administrative purposes to that island, and form one of the six districts into which it is divided. The islands are known to the Chinese as the Panghu-ting, or district of Panghu, and in Chinese geographical works more than thirty distinct islands are mentioned, but no distinction is made between the inhabited and uninhabited, large and small islands, nor between islands and mere rocks and shoals. The largest of the group is called Panghu, and from it the archipelago has doubtless derived its name. The main island is forty-eight miles in circumference, and the next in size, called Fisher's or West Island, is seventeen. According to the late Admiral Collinson, who surveyed it in 1845, the want of trees, which the Chinese officers accounted for by the violence of the wind and the absence of sheltered valleys, give the islands a barren appearance. Millet is extensively cultivated, and between its rows the ground-nut is planted. In sheltered spots the sweet potato and a few vegetables are grown, but the inhabitants depend mainly on Formosa for vegetables and fruits. Bullocks and poultry were abundant. The population of the two larger islands was stated then to be 5000, and of the whole of the islands 8000. The archipelago contains actually twenty-one inhabited islands, besides several rocks. They extend from 23° 13′ to 23° 48′ N. lat., and from 19° 16′ to 119° 37′ E. long. Their general appearance is flat, the summits of many of the islands being nearly level, and no part of the group being 300 feet above the sea-level. The two larger islands are situated near the centre of the archipelago, forming an extensive and excellent harbour between them. The capital of the whole—Makung or Macon—is situated on the north side of an inlet on the main island. The islands offer shelter in all states of the weather in the dangerous Formosa Channel. The archipelago was seized by the Dutch in 1622, and some remains of their fortifications are still to be seen; but in 1624 they left for Formosa, where they remained till finally driven out by the Chinese pirate Koxinga.

PORT HAMILTON, the English Naval Station in the North Pacific, acquired during the past week, is the name commonly applied to the large Corean island of Quelpart, situated about sixty miles due south of the extreme point of the Corean peninsula, and situated between 33° and 34° N. lat. and 126° and 127° E. long. It has been described at great length by Hamel, the "secretary" of a Dutch vessel wrecked there on its way to Nagasaki in the seventeenth century. Hamel and his companions were kept captive in Corea for thirty-five years, when some of them succeeded in escaping. Hamel's story will be found in Pinkerton and other collections of voyages. During the present century it has also been visited occasionally in search of the crews of shipwrecked vessels. A glance at the map shows its position relatively to Japan, North China, Corea, and the Sea of Japan, and its value as a naval station better than any words could do. It is 150 miles distant from Shanghai, about 100 miles from Nagasaki, and lies in the mouth of the only exit to the south from the Sea of Japan. It is described by Mr. Griffis, a recent historian of Corea, as an oval, rock-bound island covered with innumerable conical mountains, tipped in many instances by extinct volcanic craters, the highest of all being Mount Auckland, or Haura, which is about 6500 feet high. On the top are three extinct craters, within each of which is a lake of pure water, and Corean children are still taught to believe that the three first-created men of the world still dwell on these lofty heights. The whole island is well cultivated; there are a number of towns, three walled cities, but no good harbours. It has long been used as a place of banishment for criminals. The chief industry is the manufacture of straw hats, those from Quelpart being the best in Corea, which is a country of large straw hats. It has been known from very ancient times, when it formed an independent kingdom. The origin of the great peak of Mount Auckland, which renders the island so conspicuous, is thus given by the inhabitants (we quote from Mr. Griffis): "Clouds and fogs covered the sea, and the earth trembled with a noise of thunder for seven days and seven nights. Finally, the waves opened, and there emerged a mountain more than 1000 feet high, and forty *ri* in circumference. It had neither plants nor trees upon it, and clouds of smoke, widely spread out, covered its summit, which appeared to be composed chiefly of sulphur." The fullest recent account which we possess is one published by a gentleman who visited the place with the French Consul in Shanghai in 1851, to seek for the crew of a vessel, the *Narwhal*, believed to have been wrecked there. The story of the visit was published at the time in an English journal printed in China. The inhabitants are Coreans of the ordinary type; iron appears to abound on the southern coast, and there were ample evidences of much comfort and even wealth among the islanders. Christianity is said to have reached Quelpart through a Corean, who made his way through North China to Hongkong, where he was taught by the missionaries, and who then made his way back to the island.

THE geographical subject proposed this year by the French Academy of Inscriptions for the Prix Bordin is "A Critical Examination of the Geography of Strabo." According to the terms laid down by the Academy, competitors are (1) to give the history of the text of the work; (2) to characterise the language of Strabo with reference to that of contemporary Greek writers, such as Diodorus Siculus and Dionysius of Halicarnassus; (3) to distinguish the information collected by direct observation of places and that drawn by him from his predecessors; (4) to express definite conclusions on his critical method in using various documents. The papers should be in the hands of the Secretary of the Institute not later than December 31, 1886.

THE Hungarian Society of Geography is engaged just now in organising a Magyar expedition for the exploration of the regions about the Urals, and principally of the Baskir country, where the Uralo-Altaic peoples are disappearing. The Society regards it as essential to study tribes which will soon be only a more or less confused recollection. The exploration is to be anthropological, ethnographical, and archæological.

THE Director of the Museum of Ethnography in Paris has just received from the Minister of Public Instruction a fragment of the planking of the canoe in which MM. Crévaux, Bellet, and Ringel were ascending the river when they were murdered on the Tejo-Picolmayo by the Tobas Indians. The Minister sent at the same time a collection of ethnographical water-colour drawings made by Ringel and annotated by Crévaux. These were recovered by M. Bueno, and sent to the French Legation at Rio de Janeiro.

IN the *Bollettino* of the Italian Geographical Society for March an attempt is made to determine the limits of the new "Kingdom of the Congo," as recognised by the late Berlin Conference, and modified by the treaty concluded between the African International Association, and Portugal on February 14. The territory as thus determined would be limited on the west by the Atlantic seaboard from Banana to Yabé (5° 45′ S. lat.), then by the parallel of Yabé to the meridian of Ponta da Lenha; then by this meridian northward to the Chiloango; then by the left bank of this river to its source, and beyond that point by a curved line to the Ntombo-Macata Falls on the Congo, leaving to the French the station of Mboco, but reserving Mucumbi and Manianga; lastly, from the Ntombo-Macata Falls the Congo itself to its confluence with the Bumba beyond the equator, where the boundary running north-west remains still to be determined. The southern frontier follows the Congo from Banana to a point a little above Nokki, the north bank remaining to the Association, the south to Portugal; then from near Nokki the parallel of this place as far as the river Kwango; then this river to about 9° S. lat., and thence a diagonal line across the continent to Lake Bangweolo. Eastwards the boundary coincides with the west coasts of Lakes Bangweolo, Tanganyika, Muta Nzighé, and Albert Nyanza. On the north the frontier will follow the line of water-parting to be hereafter determined between the Congo, Nile, Shari, and Benué (Niger) river basins. Within these limits the new State will have an approximate area of about 1,000,000 square miles and a population of probably 40,000,000, mostly of Bantu speech and Negro or Negroid stock.

THE same number of the *Bollettino* publishes a letter from Count Giacomo di Brazza, dated Brazzaville, October 22, 1884, in which the writer complains that his efforts to complete the triangulation of Stanley Pool were frustrated by the officer of the African Association, a certain Captain S., in charge of the left bank of the pool. To complete the work it was necessary to cross over to that side of the Congo; but the permission to do so was refused by the official in consequence of instructions issued by Colonel de Winton, "that all were to remain on their own side."

## *ON THE SALINITY OF THE WATER IN THE FIRTH OF FORTH*[1]

IT is the purpose of this paper to state the methods employed for examining the salinity and alkalinity of estuary water at the Scottish Marine Station at Granton, and to describe and record six months' observations of the water of the River and Firth of Forth up to December 31, 1884.

(1) *Collection of Water Samples.*—To collect a sample of surface-water from a small boat it is sufficient to wash out the bottle with the water, and then hold it a few inches under the surface until it fills. The temperature of the water is taken by means of an ordinary thermometer in a copper case. On board a larger vessel the same thing may be done, the bottle being attached to a sounding-line and lowered over the side, or, without stopping the vessel, by means of a clean bucket, care being taken to draw the sample forward of the ejection-pipe of the condenser. When brought on board a thermometer is immersed for a minute, and the temperature noted. The water is then bottled, tied down, and labelled.

The water-bottle employed for obtaining samples from any depth beneath the surface consists of a brass basal disk supporting three radiating sheets of brass surmounted by a brass dome, on the top of which there is a ring for the line. The basal plate has an india-rubber ring fixed upon it, and its under surface has two rings for attaching the lead, and a stopcock for running off the water. There is also a brass cylinder, the edge of which rests upon the india-rubber ring when the instrument is closed.

On board the *Medusa*, the steam-yacht of the Marine Station, the water-bottle is attached to the sounding-line, which is wound on a drum worked by a small deck-engine. It has a 7-lb. lead attached to it, the stopcock is closed and a little plug screwed in to prevent the entrance of mud should it strike the bottom. It is then lowered, the slip-cylinder being held in the hand. When the desired depth is reached the slip is let go; it crashes down on the frame and is guided by the brass strips on to the india-rubber ring, on which it presses, and so firmly incloses a sample of water. It has been found necessary to let down one or two cylindrical weights, slipping on the line, after the slip has struck the body, in order to press it firmly down. Repeated trial and continuous use have shown this manner of water-collecting to be satisfactory.

The bottles used for preserving the samples are glass-stoppered, blue glass half-Winchesters, which hold about 1·5 litres. They are packed in boxes, fifteen in each, so as to be carried easily and safely. Each bottle is labelled as it is put aside, with particulars of the date, hour, and temperature.

The temperature below the surface is ascertained by means of the Negretti and Zambra thermometer in the Scottish frame, which was described to this Society in July, 1884 (*Proceedings*, vol. xii, p. 927).

When each sample of water is taken, the following observations are made and recorded:—Date; hour; position by bearings; depth of water;[2] depth from which sample was taken; temperature of the water at that depth; temperature of the air; nature of the weather, wind, and state of sea; state of tide; colour and transparency of the water.[2]

The colour of the water is observed by sinking a disk of iron, painted white, to the depth of a few feet or fathoms, according to circumstances, and noting its colour. The transparency may be very roughly measured by observing the distance to which the disk remains visible.

It is important that the actual notes of all observations be

[1] Abstract of a paper read at the meeting of the Royal Society of Edinburgh, January 5, 1885, by Hugh Robert Mill, B.Sc., F.C.S., Chemist to the Scottish Marine Station, Granton, Edinburgh.

[2] These are sometimes omitted in the case of surface samples.

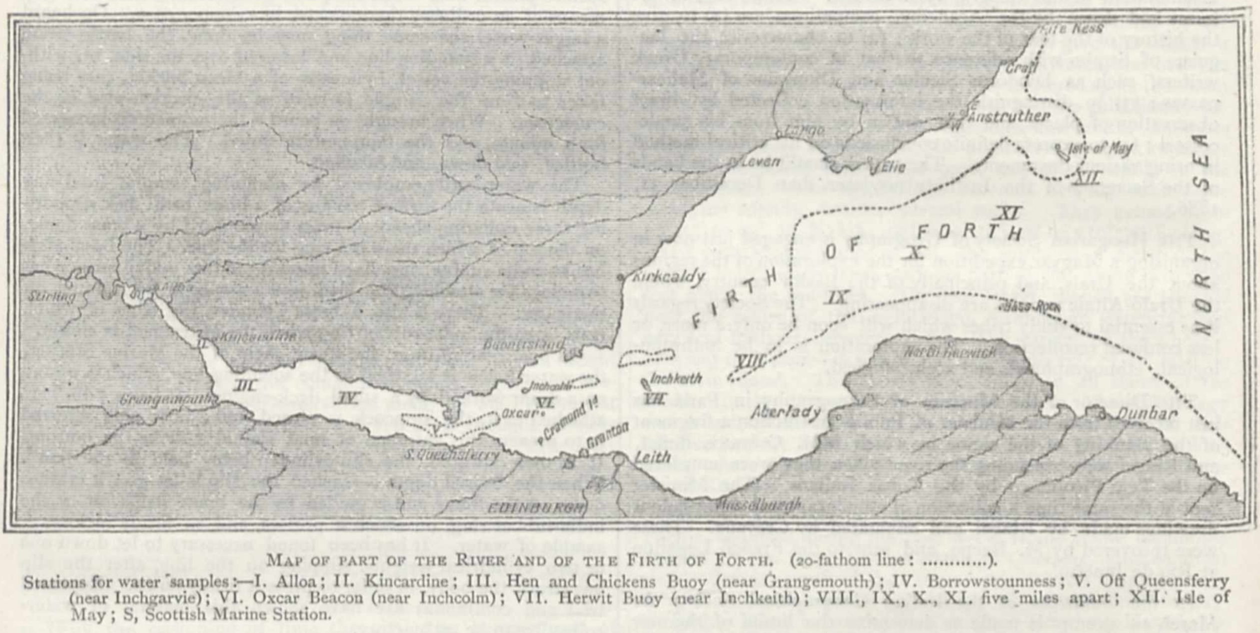
preserved for future reference should uncertainty arise regarding them. There are difficulties in doing this, for it is not easy on a small vessel, when there is any sea on, to keep an ordinary note-book from getting wet. It is most convenient to use cards with memoranda of the observations to be made printed on them, which are kept in a small leather case, and when each card is used, it may be slipped beneath the others, as is done in a date-case. The cards can be conveniently kept in boxes, and may be readily and rapidly referred to at any time.

2. *Determination of the density.*—The density of the samples of water collected in the Firth is determined by means of a very delicate hydrometer of the form used on board the *Challenger*. The hydrometer is made of glass, the tubes for body and stem having been very carefully selected to ensure uniformity of diameter. The instrument has a body of about 5 cm. diameter and 12 cm. long; the stem is nearly the same length, and has a diameter of 3 mm. The process of making and calibrating the hydrometer has been described in great detail by Mr. Buchanan in his *Challenger* report on the specific gravity of ocean water ("*Challenger* Rep. Phys. Chem.," vol. i. pt. ii. pp. 1-4.)

The hydrometer which has been used at the Marine Station is provided with seven movable weights, which can be attached to the top of the instrument, and so increase the weight of the hydrometer from 150·1478 grms. to 155·8390 grms. through thirty-six gradations. The volume of the body and bulb of the instrument is 150·2070 cc. at 0°·3, and its coefficient of expansion is known; the volume of the 100 mm. into which the stem is divided is 0·85 cc., and as it is assumed to be uniform, the volume of each millimetre of the stem is taken as 0·0085.

The density of each water-sample was taken twice, by first using a weight that did not immerse more than the lower third of the stem, then adding another to immerse at least two-thirds. A table giving the volume of the hydrometer at every tenth of a degree Centigrade from 0° to 25° has been drawn up, and from this table the volume of the body at the observed temperature is taken; the volume of the stem immersed is got from another table, which gives the value for each half millimetre from 0 to 100. These added together give the total immersed volume, and, the weight being taken from another table and divided by this volume, gives the density *at the observed temperature.* The mean of the two densities is taken, and reduced from the mean of the two corrected observed temperatures to 15°·56 C. by means of Dittmar's table ("*Chall.* Rep. Phys. Chem.," vol. i. part 1, p. 70).

Advantage was taken of the double determination of each density and of a number of separate experiments to form an idea of the probable error of an individual determination. The result showed that the probable uncertainty is not more than




MAP OF PART OF THE RIVER AND OF THE FIRTH OF FORTH. (20-fathom line: ............).
Stations for water samples:—I. Alloa; II. Kincardine; III. Hen and Chickens Buoy (near Grangemouth); IV. Borrowstounness; V. Off Queensferry (near Inchgarvie); VI. Oxcar Beacon (near Inchcolm); VII. Herwit Buoy (near Inchkeith); VIII., IX., X., XI. five miles apart; XII. Isle of May; S, Scottish Marine Station.

0·00005, taking pure water as 1·00000, and that consequently, in considering the relative densities of the water in the Firth, the fourth decimal place is certain.

The amount of total halogen was determined by Mohr's volumetric method, but, as the probable error was so great as to render the second decimal place in the per milleage uncertain, no reliance can be placed on the results. The largeness of the uncertainty is due, in part at least, to the disadvantageous position in which the determinations were made—a floating laboratory where the atmosphere was always more or less laden with saline particles.

The alkalinity was determined by Tornoe's method with standard solutions of hydrochloric acid and of potash.

The quantity represented by an alkalinity is very small, although the number used to express it is large. An alkalinity of 50 means that in a litre—say 1026 grammes—there is 0·05 gramme of carbonic acid as calcium carbonate; that is, a percentage of 0·00487, which, from the inaccuracy of the determinations, might vary from 0·00498 to 0·00476.

### *Notes of Previous Work on Estuary Water*

In 1816 Dr. John Murray read a paper to this Society on the composition of sea-water, the samples which he analysed being taken from the Firth of Forth near Leith. The paper (*Trans.* R.S.E. for 1816) contains results of great theoretical value, which were instrumental in modifying the theory of the existence of salts of different bases and acids in solution, and which altogether changed the mode of analysis of sea and mineral waters. Attention was given more particularly to the solid constituents, and no observations seem to have been made by Dr. Murray on the variations in salinity at different parts of the Firth.

Dr. John Davy published a paper (*Ed. New Phil. Journ.* xxxvi. p. 1) in 1843, on "The Temperature and Specific Gravity of the Water of the Firth of Forth." He examined the temperature and density of the water at the end of Leith pier on eight occasions at intervals of about a month. It was Davy's intention to continue the monthly observations for a number of years, but, as he had to leave Edinburgh, they were stopped. Since no particulars as to how the densities were determined were given, it is impossible to compare them with others observed at a later date.

Dr. Stevenson Macadam investigated the salinity of the Firth of Clyde in 1855 (Brit. Assoc. *Reports*, 1855, ii. 64). He observed the specific gravity at more than fifty places, and determined the total solids and chlorine in each. In subsequent investigations he examined the Firths of Cromarty and Inverness. The results are recorded in the *Proceedings* of this Society for 1866 (*Proc.* Roy. Soc. Ed., p. 5).

Prof. Kyle, of Buenos Ayres, made some observations in

1874 on the River Plate, in the same way as Dr. Macadam on the Clyde. Mr. F. Newman has kindly supplied a translation of Kyle's Spanish pamphlet ("Algunos Datos sobre la Composicion de las Aguas del Rio de la Plata"), and a chart of the Plate, with the water-sampling stations. The results brought out by Prof. Kyle are interesting, but, like the other observers cited above, he neglects to mention whether his specific gravities are reduced to 0°, to 4°, or to 15°·56, or whether water at 0°, 4°, or 15°·56 was taken as unity. It is therefore impossible to consider the results except as purely relative to the estuary in question, and no comparison between the different investigators can be made.

The Cattegat, Skagerrack, Baltic, and north-eastern parts of the North Sea have been made the subject of very careful and prolonged examination by various Danish and German scientific workers. Water-samples have been taken regularly for a number of years at various points along the coast, and from lighthouses and light-ships at considerable distances from land. The results of the examination of these samples from 1872 to 1881 are tabulated in conjunction with the meteorological conditions, especially with respect to rainfall, in a recently issued paper by the Commission in Kiel for the scientific investigation of the German seas.[1] The general low densities of these waters, and the variations to which they are subject, make the conditions which obtain there not unlike those in an estuary.

While it is fully realised that it will take years of consecutive observations to thoroughly settle the relations of the fresh and salt water in an estuary, and that many conditions, such as the currents, law of the tides, and rainfall over the area drained by the principal river and its tributaries must be taken into account; it is considered expedient to state the results observed in the six months, from June to December, 1884, on the Firth of Forth. These results are purely preliminary; but as little attention has been given such matters hitherto, they may prove of interest, and may lead to suggestions for improvements in carrying on the work.

*The Firth of Forth.*—The River Forth rises in the valley between Ben Lomond and Ben Venue, is joined near Stirling by the Teith, and gradually merges into the Firth of Forth, the precise point where the river ends and the Firth begins being a matter which permits of difference of opinion. Probably the best plan is to view the river as ending at Queensferry, but for convenience the term "Firth of Forth" may be applied as describing the river and Firth proper from Alloa to the Isle of May, a distance of fifty-five miles. According to Keith Johnstone the area drained by the Forth is 500 square miles. Few large rivers flow into the Firth. Those of any importance are: on the north side, the *Black Devon*, at Clackmannan; and the *Leven*, at Leven: on the south side there are the *Carron*, at Grangemouth; the *Avon*, a few miles further east; the *Almond*, at Cramond; the *Water of Leith*, at Leith; the *Esk*, at Musselburgh; and the *Tyne*, near Dunbar.

From Alloa to within three miles of Queensferry the depth of the water is under 10 fathoms; there it increases, at first gradually, then at the Bamer Beacon abruptly, to over 30 fathoms, and close to Inchgarvie, to over 40 fathoms. This is the deepest part of the Firth, and the narrowest. The Forth Bridge is in process of construction at this point. A very strong tide runs in the channels on each side of Inchgarvie, and the deep water is confined to a very small area. The 10-fathom stream runs along the northern shore, until off Kirkcaldy, where it widens out in a funnel shape, and approaches the shore on each side. There is a short tract over 10 fathoms to the south of Inchkeith, known as the *Narrow Deep*. Several small depressions of more than 20 fathoms occur between Queensferry and Inchkeith, and a little to the east of that island the 20-fathom area begins as a narrow stream trending northward, and spreading out off Largo. The Isle of May is connected to the mainland of Fife by a submerged plateau rising to less than 20 fathoms from the surface; and, about four miles east of the May, depths beyond 30 fathoms commence.

A line drawn from Aberlady Bay to Largo divides the Firth into two very different halves. To the west of it the slope of the bed is extremely gradual, and the depth slight; to the east of it the shore slopes down abruptly, and the bed of the Firth is, with one or two insignificant exceptions, uniformly over 20 fathoms in depth.

[1] *Vierter Bericht—für die Jahre* 1877 *bis* 1881. Berlin, 1884: "Periodische Schwankungen des Salzgehaltes im Oberflächenwasser in der Ostsee und Nordsee."

*Observations on the Surface Salinity in the Firth.*—It is assumed that the amount of total salts may be deduced from the density, as if estuary water were ocean water diluted with pure water. This cannot be exactly the case, as the salts carried down by rivers are in quite different proportion to those found in the sea, and before the processes occurring there have had time to produce uniformity of composition—that is, where river-water predominates—the proportion of salts among themselves must vary. Consequently, until exact experiments can be made on this point, the interpretation of estuary densities by ocean-water tables must be taken with reservation, and it is better to view the densities as such, without reducing them to amounts of total salts. To get a preliminary view of the rate of freshening, it was determined in September 1884 to make a monthly trip for collecting water samples from the entire Firth; and on September 18 the *Medusa* proceeded from Inchkeith to Grangemouth for that purpose. Surface samples were taken every five miles, and bottom samples at each alternate station. Observations were made both in going and in returning. The intention to make the complete tour of the Firth in one day had to be relinquished, and the Inchkeith to May section was completed on the 25th. This double trip showed that the densities of the water samples decreased steadily, gradually, and uniformly from the May to Inchkeith, but that the change then became more rapid, the curve resembling a portion of a rectangular hyperbola. The second water sampling trip was on October 7 and 8; the water, beautifully clear and transparent, and of a deep green-blue colour at the May, became light green and less transparent about Inchkeith, and from Inchgarvie onwards it was yellow and very muddy. The results were similar to those of September. The November trip took place on the 10th and 11th; the weather was fine, almost summer-like, and, in consequence of previous heavy rains, all the rivers were in flood. The effect was a marked lowering of the density of the surface water, greatest in the upper reaches of the Firth, but quite perceptible at the Isle of May, which is almost in the open sea. The effect of this "spate" was to reduce the density at Inchgarvie from its mean of 1·02382 to 1·02029; that at the Oxcar Beacon from the mean of 1·02438 to 1·02022; that at Inchkeith from 1·02472 to 1·02403; and those at Stations VIII. and IX. from 1·02505 and 1·02518 to 1·02458 and 1·02508 respectively. The December trip did not take place till the 25th, when my friend Mr. Ritchie was good enough to take charge of the eastern excursion. The day was fine, with a north-easterly breeze and a slight swell. On the 27th the yacht started for Alloa, but the morning, which was hazy, gave place to a day of fog, and it was impossible to proceed beyond Inchgarvie. The 29th and 30th were also misty, and this portion of the trip had very reluctantly to be dispensed with.

The effect of the tide obscures the changes of salinity to a certain extent in these monthly cruises, but, although the data are so few, they are sufficient to show that between Inchkeith and the Isle of May—that is, in the wide and open part of the Firth—the tidal effect is relatively slight and the variations in density very gradual, though perceptible; while from Inchkeith to Alloa the tidal effect increases with every mile, and the rate of change becomes more and more rapid. The following tables (I. and II.) give the figures observed in these consecutive trips:—

TABLE I.—*Density at* 15°·56

| 1884 | I. | II. | III. | IV. | V. | VI. |
|---|---|---|---|---|---|---|
| Sept. | — | — | 1·02082 | 1·02285 | 1·02444 | 1·02470 |
| Oct. | 1·00160 | 1·01088 | 1·01911 | 1·02272 | 1·02332 | 1·02443 |
| Nov. | 0·99923 | 1·00272 | 1·01419 | 1·01704 | 1·01946 | 1·02022 |
| Dec. | — | — | — | — | 1·02351 | 1·02353 |

| 1884 | VII. | VIII. | IX. | X. | XI. | XII. |
|---|---|---|---|---|---|---|
| Sept. | 1·02499 | 1·02533 | 1·02531 | 1·02537 | 1·02549 | 1·02555 |
| Oct. | 1·02505 | 1·02512 | 1·02547 | 1·02525 | 1·02555 | 1·02558 |
| Nov. | 1·02403 | 1·02458 | 1·02501 | 1·02529 | — | — |
| Dec. | 1·02464 | 1·02511 | 1·02508 | 1·02545 | 1·02554 | — |

TABLE II.—*Alkalinity*

| 1884 | I. | II. | III. | IV. | V. | VI. |
|---|---|---|---|---|---|---|
| Sept. | — | — | — | — | 49·1 | 50·4 |
| Oct. | — | — | — | — | — | — |
| Nov. | 1·2 | 11·6 | 31·4 | 39·2 | 44·3 | 45·2 |
| Dec. | — | — | — | — | 48·6 | 49·6 |

| 1884 | VII. | VIII. | IX. | X. | XI. | XII. |
|---|---|---|---|---|---|---|
| Sept. | 49·6 | — | — | — | — | — |
| Oct. | — | — | — | — | — | — |
| Nov. | 48·3 | 48·6 | 50·5 | 49·7 | — | — |
| Dec. | 51·2 | 52·3 | 51·4 | 51·7 | 53·9 | — |

The mean of the density, &c., at the stations going and returning is given here.

The maximum, minimum, and mean of all the density observations at each station, together with the number of cases which give the mean, are tabulated (Table III.). The temperature observations made on the monthly trips have not been alluded to here; they are intended to form a separate paper.

TABLE III.—*Variations in Density*

| Station | Maximum | Minimum | Mean | No. of Obs. |
|---|---|---|---|---|
| I. Alloa | 1·00160 | 0·99923 | 1·00042 | 4 |
| II. Kincardine | 1·01521 | 1·00070 | 1·00680 | 4 |
| III. Hen & Chickens buoy | 1·02169 | 1·01084 | 1·01898 | 11 |
| IV. Blackness | 1·02414 | 1·01650 | 1·02087 | 6 |
| V. Inchgarvie | 1·02461 | 1·01863 | 1·02303* | 11 |
| VI. Oxcar | 1·02492 | 1·01953 | 1·02355† | 10 |
| VII. Inchkeith | 1·02526 | 1·02380 | 1·02472 | 13 |
| III. | 1·02544 | 1·02450 | 1·02505 | 7 |
| IX. | 1·02551 | 1·02495 | 1·02518 | 8 |
| X. | 1·02557 | 1·02417 | 1·02530 | 9 |
| XI. Off Fiddra | 1·02566 | 1·02526 | 1·02547 | 6 |
| II. May Island | 1·02570 | 1·02443 | 1·02511 | 5 |

* Omitting the day of high flood in the river, mean = 1·02382
† " " " " = 1·02438

Differences between mean densities:—

| I. | II. | III. | IV. | V. | VI. | VII. | VIII. | IX. | X. | XI. | XII. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 638 | 1218 | 189 | 216 | 52 | 113 | 33 | 13 | 12 | 17 | −36 | |

*Note.*—All the densities given are at 15°·56 C.

The change of temperature produces a corresponding change of the density of the water *in situ*, which has important bearings on convection currents, and which must also influence the rate of mixture of sea and river water, especially as the temperature of the river water is in winter usually below that of its maximum density.

An examination of Table III. shows that for maximum and minimum, as well as for mean observed densities, the increase is perfectly continuous until the last station is reached, when the maximum density is only probably greater than that at Station XI., the minimum is certainly less than that at Station VIII., and the mean is less than that at Station IX. It is not easy to find an explanation of this fact, for there is no river nearer than the Tyne at Dunbar, and there are no springs on the Isle of May, the lighthouse keeper being compelled to get all his fresh water carried from Crail. The proximity of the Firth of Tay may possibly account for the observation.

The difference between the density of the surface-water at high and at low tide is by far the greatest in the upper reaches of the Firth, and decreases more and more gradually. Beyond Inchkeith the difference is little noticed, in fact the water is found to be sometimes denser at a lower state of tide. This effect may be due to currents which are not taken account of in this preliminary investigation. The rate of change of density with the tide decreases very rapidly at first. At Kincardine the difference between high and low water is 1 in the second place of decimals, or, calling the density of pure water 10,000, it is 100; at Inchgarvie it is about 15, at Inchkeith 4, and beyond Inchkeith about 1; that is 1 in the fourth decimal place by ordinary notation.

The density of the surface-water was determined almost daily from August to December at the Scottish Marine Station, Granton, but the results were so variable, that dependence cannot be placed upon them as representative of the water in the Firth at that point. The density was always found to be greater at low water, and after some trouble the cause was ascertained. From the station westward for a distance of a mile and a half the shore dries at low water for from quarter to half a mile, and Cramond Island becomes a peninsula, on the west or further side of which the River Almond discharges itself. At high water there is from half to one fathom of water between Cramond Island and the coast, and the river, taking the shorter course, is carried by the ebb tide along the shore, and so reduces the den-ity of the water in the neighbourhood.

As there was considerable time lost in devising and testing a suitable means of collecting samples of bottom water, the number of reliable cases for consideration is small.

It may be generally stated that the part of the Firth east of Inchkeith is the region where the difference between the density of surface and bottom water is least, and that the difference decreases steadily towards the May. Towards Alloa, on the other hand, the differences in the density between surface and bottom water are great, but they are greatly influenced by the tide. Table IV. gives details of nineteen comparisons between bottom and surface water.

At the Hen and Chickens Buoy, near Grangemouth, the depth is only $5\frac{1}{2}$ fathoms, but the salinity is very much greater at the bottom than at the surface. The difference is least observed at low water, but as the flood tide sets in, it appears to increase, and then to fall off again as the ebb commences. The only divergence from this rule noticed was on November 11, when the rivers were all much flooded and the current very rapid. It would appear that these observations confirm the theory that sea water ascends rivers along the bottom under the opposite current of fresh water.

TABLE IV.—*Bottom Water at Hen and Chickens, near Grangemouth* (III.)

| Date. 1884 | Sample | Tide | Depth, fms. | Density B. | Density S. | Density Dif. | Alkalinity B. | Alkalinity S. | Alkalinity Dif. |
|---|---|---|---|---|---|---|---|---|---|
| June 19 | 20 & 21 | l.w. | 2 | 1·01876 | 1·01850 | 26 | — | — | — |
| Oct. 8 | 183 & 184 | 2h. fld. | 4 | 1·02041 | 1·01693 | 348 | — | — | — |
| Nov. 11 | 206 & 208 | 1h. ebb | $5\frac{1}{2}$ | 1·02158 | 1·01755 | 403* | 44·7 | 34·3 | 10·4 |
| " | 207 & 209 | 5h. ebb | $5\frac{1}{2}$ | 1·02040 | 1·01084 | 956* | 47·4 | 28·5 | 16·9 |
| | | | *At Inchgarvie* (V.) | | | | | | |
| June 19 | 22 & 24 | 1h. fld. | 25 | 1·02478 | 1·02424 | 54 | — | — | — |
| July 31 | 41 & 43 | 5h. ebb | 31 | 1·02455 | 1·02324 | 131 | — | — | — |
| Sept. 18 | 129 & 133 | ½ ebb | 35 | 1·02448 | 1·02425 | 23 | 56·9 | 47·9 | 9·0 |
| Oct. 8 | 178 & 179 | l.w. | 40 | 1·02437 | 1·02241 | 196 | — | — | — |
| Nov. 11 | 200 & 202 | h.w. | 32 | 1·02508 | 1·02029 | 479* | 51·8 | 46·5 | 5·3 |
| " | 201 & 203 | l.w. | 35 | 1·02476 | 1·01863 | 613* | 45·0 | 42·1 | 2·9 |
| Dec. 27 | 259 & 260 | h.w | $38\frac{1}{2}$ | 1·02509 | 1·02351 | 158 | 53·9 | 48·6 | 5·3 |
| | | | *At Inchkeith* (VII.) | | | | | | |
| Sept. 18 | 119 & 123 | ¾ ebb | $15\frac{1}{2}$ | 1·02491 | 1·02481 | 10 | 50·4 | 48·2 | 2·2 |
| Oct. 7 | 160 & 161 | l.w. | $13\frac{1}{2}$ | 1·02517 | 1·02519 | −2 | — | — | — |
| Oct. 8 | 174 & 175 | ¾ ebb | 10 | 1·02501 | 1·02494 | 7 | — | — | — |
| Dec. 25 | 247 & 248 | 2h. ebb | 17 | 1·02531 | 1·02470 | 61 | 48·6 | 48·6 | 0 |
| | | | *At Station* IX. | | | | | | |
| June 11 | 13 & 15 | 5h. ebb | 22 | 1·02424 | 1·02417 | 7 | | | |
| | | | *At Station* XI. | | | | | | |
| June 4 | 1 & 3 | ½ ebb | 23 | 1·02542 | 1·02528 | 1 | | | |
| | | | *At May Island* (XII.) | | | | | | |
| June 11 | 16 & 17 | 2h. fld. | 7 | 1·02532 | 1·02443 | 89 | | | |
| Oct. 7 | 167 & 168 | ¾ fld. | 9 | 1·02562 | 1·02547 | 15 | | | |

* Rivers in flood.

Speaking roughly, it appears that waters having an alkalinity under 40 (that is, in which there is less than 0·04 grammes of carbonic acid as carbonate of lime per litre) have a density under 1·0200, alkalinities under 25 correspond to densities under 1·0100. The only strikingly anomalous case is that of sample 189, a bottom water from off Alloa, when the river was low and very dirty. The density was 1·00146, the alkalinity 47·9, which usually corresponds to a density of 1·024. The presence of sewage in the river might account for this observation to some extent, but more probably it was due to the presence of particles of calcium carbonate. With an alkalinity between 40 and 50 water has a density between 1·024 and 1·025 as a general rule, and when the alkalinity is over 50 the density is almost invariably over 1·025.

On account of the absence of data for deducing the total salts of estuary water from the density, we cannot reduce the alkalinity to percentage of total salts, and, consequently, it is impossible to form a correct idea of the difference between bottom and surface alkalinities, as this difference may be entirely due to the different salinity of the water.

Arrangements have been made for continuing and greatly extending observations on the salinity of the Firth of Forth. Samples of water will be taken by trustworthy observers at high and low water at different points on the Firth, and water-sampling trips, both from Alloa to the May and across the Firth from north to south at various places, will be carried on regularly.

Throughout this paper the density of the water is given as reduced to 15°·56 C. (60° F.). It is *specific gravity* at 15°·56 referred to pure water at 4° C. as unity.

The water-sampling stations and the principal contour lines of depth are shown in the chart of the Firth of Forth (Fig. 1).

## THE PEARL FISHERIES OF TAHITI

A RECENT issue of the *Journal Officiel* contains a lengthy report by M. Bouchon-Brandely, Secretary of the College of France, who was sent by the Ministry of Marine and the Colonies on a mission to Tahiti to study questions relating to oyster-culture there. The principal product of what M. Brandely, with "the summer isles of Eden" fresh in his mind, calls "*notre belle et si poëtique colonie de Taïti*," is mother-of-pearl. All its trade is due solely to this article, which for a century has regularly attracted vessels to the islands which compose the archipelagoes of Tuamotu, Gambier, and Tubuai. The mother of-pearl which is employed in industry, and especially in French industry, is furnished by various kinds of shells, the most estimated, variegated, and beautiful of which are those of the pearl oyster. There are two kinds of pearl oysters—one, known under the name of pintadine (*Meleagrina margaretifera*), is found in China, India, the Red Sea, the Comoro islands, North-Eastern Australia, the Gulf of Mexico, and especially in the Tuamotu and Gambier archipelagoes; the other, more commonly called the pearl oyster (*Meleagrina radiata*), comes from India, the China seas, the Antilles, the Red Sea, and Northern Australia. The shell of the former is harder, more tinted, more transparent, and reaches greater dimensions than the latter. Some have been found which have measured thirty centimetres in diameter and weighed more than ten kilogrammes, while the *Meleagrina radiata* rarely exceeds ten centimetres at the most, and never weighs as much as 150 grammes. Both varieties supply pearls, those of one kind being at one time more favoured, at another time those of the other. This depends on fashion; but, on the whole, those found in the great pintadine are more beautiful, and the colour more transparent, than those of its congener. The amount of the trade from Tahiti in pearls cannot be stated with accuracy, as there is much clandestine traffic, but M. Brandely puts it down approximately at 300,000 francs, England, Germany, and the United States being the chief markets for the fine pearls. The great pintadine is found in great abundance in the Tuamotu and Gambier islands. The situation there is very favourable to them; in the clear and limpid waters of the lagoons they have full freedom for development, and are undisturbed by storms. Mother-of-pearl is found in almost every one of the eighty islands which form the archipelagoes Tuamotu and Gambier. These belong to France, having been annexed at the same time as Tahiti and Moorea, and have a population of about 5000 people, all belonging to the Maori race. M. Brandely gives an interesting description of these little-known islands and people. The latter appear to hover always on the brink of starvation, as the islands, which are composed mainly of coral-sand, produce hardly anything of a vegetable nature. While the neighbouring Society islanders have everything without labour and in abundance, the unfortunate inhabitant of Tuamotu is forced to support existence with cocoa-nuts, almost the only fruit-trees which will grow on the sandy beach, with fish and shell-fish which are poisonous for several months of the year, and often they have to kill their dogs for want of other animal food. There are no birds, except the usual sea-birds; no quadrupeds, except those brought by man; no food resources necessary to European life, except what is brought by ships. Although the people are gentle and hospitable, they practise cannibalism, and M. Brandely suggests that it is pitiless hunger alone which has driven them into this horrible custom. These miserable people are the chief pearl-divers of the Pacific; indeed it is their only industry, and women and even children take part in it. There is at Anaa, says the writer, a woman who will go down twenty-five fathoms, and remain under water for three minutes. Nor was she an exception. The dangers of the work are great, for the depths of the lagoons are infested by sharks, against which the divers, being unable to escape, are forced to wage battle, in which life is the stake. No year passes without some disaster from sharks, and when one happens all the divers are seized with terror, and the fishing is stopped for a time. But gradually the imperious wants of life drive them back to the sea again, for mother-of-pearl is the current coin of the Tuamotu. With it he buys the rags which cover him, the little bread and flour which complete his food, and alcohol, "that fatal present of civilisation," for which he exhibits a pronounced passion. Twenty or thirty years ago the trade in mother-of-pearl in the Tuamotu archipelago was very profitable for those engaged in it. For a valueless piece of cloth, a few handfuls of flour, or some rum, the trader got half a ton of mother-of-pearl worth one or two thousand francs, or even fine pearls of which the natives did not know the value. The archipelagoes were frequented by vessels of all nationalities; mother-of-pearl was abundant, and pearls were less rare than they are now. The number of trading-ships increased; there was competition amongst them, and consequently a higher price to the natives, who fished to meet the new demand with improvident ardour. The consequence is that the lagoons are less productive, and that even the most fertile give manifest signs of exhaustion. The prospect of having the inhabitants of Tuamotu thrown on its hands in a state of helpless destitution, as well as of the disappearance of the principal article of the trade of Tahiti, and an important source of revenue to the colony, alarmed the Colonial administration, and the Ministry of Marine and the Colonies in Paris. Accordingly, M. Brandely was selected to study the whole subject on the spot. The points to which he was instructed to direct especial attention were these: (1) The actual state of the lagoons which produce oysters; are they beginning to be impoverished, and if so what is the cause, and what the remedy? (2) Would it be possible to create at Tuamotu, Gambier, Tahiti, and Moorea, for the cultivation of mother-of-pearl, an industry analogous to that existing in France for edible oysters? Would it be possible by this means to supply the natives of Tuamotu with continuous, fixed, remunerative labour which would render them independent, and remove them from the shameless cupidity of the traders? Could they not be spared the hardships and dangers resulting from the continued practice of diving, and be turned to more fixed sedentary modes of life, by which they might be raised gradually in the social scale? (3) Should the pearl fishing in the archipelagoes be regulated, and, if so, what should be the bases of such regulations? It was on the mixed economical and philanthropic mission here indicated that M. Brandely went to Tahiti in February last. The statistics did not show any decline in the production of mother-of-pearl, but a careful study on the spot showed that this was due to the great amount of the clandestine traffic, and that the lagoons were growing less productive day by day, that beautiful mother-of-pearl was becoming rarer, and in order now a-days to get oysters of a marketable size, the divers are forced to go to ever greater depths. M. Brandely recommends prompt and vigorous measures be taken at once, as the lagoons of Tuamotu will soon be ruined for ever. The partial steps already adopted have been useless. The total prohibition of fishing in some of the islands for several years has failed, because it has been found that the pintadine is hermaphrodite, and not, as formerly was believed, unisexual. The cause of the impoverishment of the lagoons is excessive fishing, and nothing else. He thinks that it is possible to create in Tuamotu, Gambier, Tahiti, and Moorea a rational and methodical cultivation of mother-of-pearl oysters, analogous to that existing with regard to edible oysters on the French coasts, and to constitute for the profit of the colony an industrial monopoly which no other country can dispute, for nowhere else can such favourable conditions be met with.

## SOCIETIES AND ACADEMIES

### LONDON

**Royal Society**, March 26.—"On the Peculiar Behaviour of Glow Lamps when raised to High Incandescence." By W. H. Preece, F.R.S.

The experiments described had for their object the investigation of a phenomenon observed by Mr. Edison, who brought it to the author's notice last autumn. Between the limbs of an incandescent filament of a glow-lamp a thin, narrow platinum plate being fixed with an independent wire connection, and a sensitive galvanometer being placed in circuit between the filament and the platinum, a derived current is observed to pass through the galvanometer and through the rarefied space at the bottom of the limb when the main current is increased to a certain strength and the filament reaches a certain degree of incandescence, the strength of the derived current increasing with the increased brilliancy of the glowing filament. In the author's investigations Mr. Edison had made other lamps, in which the centre conducting plate was of copper, iron, and carbon respectively; but the general effects were practically the same as when platinum was used. The currents (from Faure-Sellon-Volckmar cells) were increased gradually, the effects of each increase being carefully noted. The nature and resistance of the rarified space in the shunt-circuit had to be ascertained. Certain increments in the current were followed by a diffused blue effect in the globe, more or less intense, accompanied in each instance by a marked fall in the resistance of the shunt—pointing to an intimate connection between the two phenomena. The strength of the shunt-current when the faint blue tinge appeared was: with carbon, 3·42; with iron, 3·85; and with copper, 3·80 milliamperes. No perceptible difference in the results was observable with lamps in which the centre plate was a fine wire or a very broad surface, nor when the plates were doubled. That the effect was due primarily to the "Crooke's bombardment," or the projection of molecules in right lines from the carbon filament on to the metal plate was confirmed by the following experiments:—Lamps were constructed varying the position of the plate. In one the plate, was fixed at the end of a tube having a portion of the filament exposed to the plate; in this case, with an E.M.F. of 108 volts in the main circuit, the blue effect entered the tube. In another lamp the tube was so constructed that no portion of the filament was opposed by right lines to the metal plate; with 112 volts the blue in the globe became very marked; with 120 volts the bulb was hot, the tube cool. Another lamp was constructed with three branches at right angles to each other, and each metal plate taken in succession; no result was obtained, no current being evident in either section. All the experiments went to show that, when once the blue effect appeared, destruction was only a question of time. Hence this blue effect is an indication of the advent of disintegration, and a very useful warning of danger ahead. Whenever the incandescence of the filament is raised beyond a certain limit, the interior of the glass envelope is blackened by a layer of carbon which has been deposited by a Crooke's bombardment effect.

It was evident from the observations that the Edison effect is due to the formation of an arc between the carbon filament and the metal plate fixed in the vacuous bulb, and that this arc is due to the projection of the carbon particle in right lines across the vacuous space. Its presence is detrimental to the life of the lamp, and as its appearance is contemporaneous with the blue effect, the latter is a warning of the approach of a critical point and a sure indication that the E.M.F. is dangerously high. It is also clear that, as the Edison effect is only evident when we are "among the breakers," it is not available for practically regulating the conditions of electric light currents as its ingenious discoverer originally proposed.

**Mathematical Society**, April 2.—J. W. L. Glaisher, F.R.S., President, in the chair.—Dr. R. Stawell Ball, F.R.S., Astronomer Royal, Ireland, and Baboo Basu, of Bhowanipore, were elected Members.—The following communications were made:—New relations between bipartite functions and determinants, with a proof of Cayley's theorem in matrices, by Dr. T. Muir.—On eliminants, and associated roots, by E. B. Elliott.—On five properties of certain solutions of a differential equation of the second order, by Dr. Routh, F.R.S.—On the arguments of points on a surface, by R. A. Roberts.—On congruences of the third order and class, by Dr. Hirst, F.R.S.

**Geological Society**, March 11.—Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., President, in the chair.—William Lester and Thomas Stewart were elected Fellows of the Society.—The following communications were read:—The granitic and schistose rocks of Donegal and some other parts of Ireland, by C. Callaway, D.Sc., F.G.S. The author first recalled attention to the current theories on the nature of the Donegal granitic rock, one which described it as a highly metamorphosed portion of a sedimentary series, another which regarded it as a mass of Laurentian gneiss. In his view, however, it was a true igneous granite, posterior in age to the associated schists. In six districts examined it was intrusive and sent out veins. The apparent interstratification with bedded rocks was explained as a series of comparatively regular intrusions. Where the granite was seen in contact with limestone, the latter contained garnets and other accessory minerals. No gradation could be discovered between the granite and any other rock, the junctions (even in the case of small fragments of schist immersed in granite) being well marked. The granite was distinctly foliated. In some localities there was merely a linear arrangement of the mica; but near the western margin of the granite promontory there was a striping of light and dark bands, the colour of the latter being due to the abundance of black mica. The gneissic structure was attributed to lateral pressure, the existence of which in the associated strata was seen in the conversion of grits into schist-like rocks, in the production of cleavage in beds of coarse materials, in the crushed condition of some masses, in the overthrow of folds, and in the production of planes of thrust. The direction of the pressure was perpendicular to the planes of foliation in the granite. The schistose rocks of the region were divided into two groups. The *Lough Foyle series* consisted of quartzites, quartzose grits with a mineralised matrix, slaty-looking schists, fine-grained satiny schists, black phyllites, and crystalline limestones and dolomites. The semicrystalline condition of most of these rocks was characteristic. This series was well seen at Londonderry and on Lough Foyle, and formed a broad band striking to the south-west. These rocks were compared with similar types in the Hill of Howth (north of Dublin), near Aughrim (Co. Wicklow), and south of Wexford. The Leinster semicrystalline masses were quite unlike the Wicklow Cambrians, and bore a strong resemblance to the slaty series of Anglesey. They were lithologically intermediate between the Donegal and Anglesey groups, and from a comparison of all these areas the author referred the Lough Foyle series, with some confidence, to the Pebidian system. The prolongation of the Lough Foyle rocks into the Grampian region was well known, and Ireland thus served to connect some parts of the Scottish highlands with South Britain. The author was not prepared to correlate this Donegal series with any American group, but the lithological affinities were rather with the Taconian that with the Huronian. The *Kilmacrenan series*, in which the granite is intrusive, was described as crystalline, and older than the Lough Foyle group. It was mainly made up of micaceous, quartzose, hornblendic, and hydromagnesian schists, quartzites, and crystalline limestones. There were no indications in these rocks of a metamorphism progressive in the direction of the granite. This series was lithologically similar to the Montalban system. Fifty-five microscopic slides of Donegal and Leinster rocks had been examined by Prof. Bonney, whose observations confirmed those of the author both as regards the nature and relations of the granite and the general characters and state of crystallisation of the two schistose groups.—On hollow spherulites and their occurrence in ancient British lavas, by Grenville A. J. Cole, F.G.S.

EDINBURGH

**Royal Society**, March 2.—Robert Grey, Vice-President, in the chair.—At the request of the Society's Council, Dr. A. Geikie, Director-General of the Geological Survey, gave an address on the recent progress of the Survey. He indicated what would be the future work of the Survey.

March 16.—Thomas Stevenson, M.I.C.E., President, in the chair.—Prof. Tait called attention to anticipations of the kinetic theory, and of synchronism, which occur in a tract, "De Potentiâ Restitutivâ," published by Hooke in 1678.—Prof. Crum Brown read a paper on the hexagonal system in crystallography. The forms of the uniaxial systems may be regarded as derived from forms or parts of forms or combinations of the regular system by uniform expansion or contraction in a direction parallel to the axis of the uniaxial system, *i.e.* normal to a face of the cube for the tetragonal, and normal to a face of the octahedron for the hexagonal system. Faces, therefore, which are, in the regular form or combination, at right angles to or parallel to such axis, retain their relative angular position unchanged in the uniaxial form or combination, and can be represented by means of indices referring to the rectangular axes of the regular system, whatever be the amount of the deformation (expansion or contraction). These faces are prism faces, parallel to the axis, and basal faces at right angles to it. All other faces have their angular position affected by the deformation. These other faces are pyramid faces. Each pyramid face lies between, and in the same zone with, a prism face and a basal face. It may, therefore, be represented by the symbol $as + \frac{1}{\rho}bt$, where $s$ and $t$ are the symbols of the prism face and the basal face respectively, $a$ and $b$ are small whole numbers, and $\rho$ is the ratio of the length of a line parallel to the axis after, to the length of the line before deformation. We may put $\frac{b}{a} = n$, when this becomes, for the tetragonal system $(h k 0) + \frac{1}{\rho} n (001)$, which is $\left(h k \frac{n}{\rho}\right)$ the Miller symbol for a pyramid face in this system, with the ratio of the parameter of $z$ to that of $x$ or $y$, expressed by $\rho$. In the hexagonal system the symbol $s + \frac{1}{\rho} n t$ takes the form $(h k l) + \frac{1}{\rho} n (111)$, where $h + k + l = 0$. We may leave $\rho$ understood, as it is constant for the same substance and same temperature, and write this in the contracted forms $(h k l, n)$. This gives $h + \frac{n}{\rho}$, $k + \frac{n}{\rho}$, $l + \frac{n}{\rho}$, as the coefficients of $x$, $y$, and $z$ in the equation of the face referred to the rectangular axes of the regular system. These axes are, of course, not crystallographic axes of the hexagonal system, but some advantages arise from their use. They are rectangular, and therefore the ordinary formulæ of solid geometry can be used; the symbol of the general form $(h k l, n)$, where $h$ $k$ and $l$ are free to change places and change sign together, and $n$ changes sign independently, gives a clear oversight of all the faces of the holohedral form, and enables us to derive from the symbol the various kinds of hemihedry.—In a note on the effect of temperature on the compressibility of water, Prof. Tait showed that the minimum compressibility temperature of water appears to rise with increase of pressure.—Dr. A. B. Griffiths' paper on chemico-physiological investigations on the cephalopod liver and its identity as a true pancreas, was read by Mr. Hoyle.

PARIS

**Academy of Sciences**, March 30.—M. Bouley, President, in the chair.—Experiments connected with the phenomena occurring within the sphere of organic life during epileptic fits, by M. Vulpian. The effects of epileptic attacks artificially produced on the dog were found to agree substantially with those observed in human patients subject to ordinary affections of this class.—A reply to the remarks of M. Troost on the objections advanced against his experiments with the hydrate of chloral, by M. Friedel.—Provisional elements of Borrelly's new planet 246, determined at Toulouse from observations taken at Marseilles and Berlin, by M. Andoyer.—Observations of the same planet made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—Latitudinal distribution of the solar phenomena (spots, faculæ, eruptions, and protuberances) observed during the year 1884, by M. P. Tacchini. From the observations here tabulated the author concludes that last year the phenomena were more numerous in the southern hemisphere of the sun, where protuberances occurred frequently even near the pole. The spots, faculæ, and eruptions were numerous, especially in a wide zone stretching north and south of the equator, whereas in preceding years a notable diminution had been observed close to the equator itself.—A geometrical presentation of the three constants relative to the great mirror M of the sextant, by M. Gruey.—A method of measuring the double stars by means of the spectroscope, by M. Ch. V. Zenger.—On an apparatus intended to regulate the curvature of the surfaces and the refraction of lenses (four illustrations), by M. L. Laurent. This apparatus is described as a focometer of great precision, generally applicable to all curved surfaces, in ordinary cases showing at a glance and without preparation the *quality* of any optical system.—Remarks on the actinometric observations made during the year 1884 at the Observatory of the Montpellier School of Agriculture, by M. A. Crova.—Heat of combustion of the Ronchamp coal, by M. Scheurer-Kestner.—On the formation of the hydrocarbonate of magnesia (hydromagnesite), by M. R. Engel. In this paper the author gives the results of experiments made for the purpose of determining the causes of the formation of hydromagnesite in the precipitation of a soluble salt of magnesia by alkaline carbonates.—Experiments on the reduction of mannite $(C_6H_8(OH)_6)$ by means of formic acid, by M. C. Friedel.—On the formation of the kreatines and kreatinines: a new kreatinine, α-ethylamidopropionocyamidine, by M. E. Duvillier.—On the simultaneous contractions of antagonistic muscles, by M. Beaunis.—On the pelagic fauna of the Baltic Sea and Gulf of Finland, by MM. G. Pouchet and J. de Guerne. From specimens of crustaceans (*Cyclops quadricornis*, *Daphnella brachyura*, *Daphnia quadrangula*, &c.) fished up last year in the Gulf of Finland, the authors conclude that the pelagic fauna of that slightly brackish sea resembles that of the great European lakes, while the central basin of the Baltic offers well-marked transitional forms between fresh-water and marine animals.—On the existence of limestone at Fusulines in the Morvan geological area, by M. Stan. Meunier.—On some crystals of celestine (sulphate of strontian) discovered near Grauchet (Tarn), by M. A. Caraven-Cachin.

BERLIN

**Physiological Society**, February 27.—Prof. Busch laid before the Society two preparations illustrative of his investigations into the laws of ossification. The one preparation was of the inferior maxilla of a dog, in which, when the animal was from three to four months old, two pairs of precisely similar grains of shot were inserted, as fixed marks, into holes bored by a gimlet of the same diameter. In order that such marks might be really fixed points from which the process of growth could be studied, it was necessary that the pieces of metal inserted into the osseous tissue should not project beyond the surface of the bone, nor, on the other hand, should they touch on other organs by the growth of which they would be liable to be displaced. In the inferior maxilla of a dog Prof. Busch had made four marks, two on each side, at distances of several centimetres, and then, with an exact pair of calipers, he measured the distances of the four grains of shot from each other. The wounds soon healed, the dog did not seem to suffer the least inconvenience, and after 112 days was killed. The examination of the lower jaw now showed that of the four grains there were only three still remaining, the fourth not being discoverable. The two placed on one side of the lower jaw, in front and behind, showed exactly the same distance from each other as at the beginning of the experiment. The distance of one grain on one side from the corresponding grain on the other had on the other hand grown greater, while the length of the whole lower jaw from the posterior angle to the anterior end had throughout the period in question undergone an increase of about five centimetres. From these results Prof. Busch inferred that the increase in length of the lower maxilla was not due to interstitial growth but to apposition. The second preparation had for its object to ascertain facts regarding the growth of the epiphyses of the long bones whether it proceeded from the terminal line between epiphysis and diaphysis, from the epiphysal line, or from the articular cartilage. For this purpose steel pins, 1 centimetre long, were inserted into previously bored holes, one pin close under the epiphysal line of the tibia, a second in the epiphysis of the tibia, a third in the epiphysis of the femur, and a fourth close above the epiphysal line of the femur. The point of the gimlet was broken off during the operation, and served as a fifth mark. The question as to the mode by which the epiphyses grew was to be decided by the eventual change in the distance between mark 2 and mark 3. The experiment in this case likewise was carried out on a big dog of three months old, which was killed 119 days after the operation. The examination of the marks then showed that mark 1 was removed several centimetres lower down, lying horizontally under the periosteum. Mark 2 lay apparently unchanged at its original spot; mark 3 was shifted a large piece upwards, and lay horizontally under the periosteum of the diaphysis. As a result of the operation, therefore, instead of under the epiphysal line, it was inserted above that line into the diaphysis; mark 4 was not to be found; mark 5, the broken-off gimlet-point, lay far up on the posterior edge of the diaphysis. As to the growth of the epiphysis, the experiment had therefore no significance, seeing that mark 3 was not inserted into the epiphysis of the femur. It showed, however, indisputably that the diaphyses grow by apposition from the epiphysal line, and that in proportion as the parts retired from this line, they became from resorption thinner and slenderer. In the discussion on this communication, Prof. Wolff stated that he had performed a great number of experiments on the lower jaws of quite young rabbits, which, contrary to the results obtained by Prof. Busch, clearly demonstrated the interstitial growth of the bone in question. After he had quite concluded these experiments, he would lay the results before the Society.—Prof. Ehrlich made a communication on physiologically important results he had obtained from his investigations into the susceptibility of the different tissues to colouring matters. If colouring solutions—in particular methylic blue—were injected into living animals and then, with the utmost expedition, particular tissues were examined, interesting reactions of the living tissue under the colouring materials would be perceived, which, in spite of their rapid evanescence, revealed important facts which by other methods were in part wholly unascertainable, in part to be ascertained only with difficulty.

After the injection of methylic blue, Prof. Ehrlich found in the submucous tissue of the tongue very numerous fibres and fibrous reticula coloured intensely blue which sent processes to the epithelial formations, and it was easy to determine that these fibres were the axis cylinders of the sensory nerves. These blue-tinged axis cylinders were found very numerously in the gustatory cuplets, at the basis of which they formed a quite narrow reticula network, whence, then, single fibres ending in knots proceeded anteriorly to the ciliated cells. Network of blue fibres were found very copiously and closely in the cornea. The iris likewise showed blue plexuses, particularly on the anterior side; on the posterior side only long cancellated reticula were observed. In the muscles, on the other hand, were found only detached blue fibres, the ending of which in the muscle fibre could not be established. The axis cylinders of the motory nerves were, according to this experiment, not coloured by methylic blue during life; it was only the sensory nerves which reacted to the colouring matter. The vessels, arteries, capillaries, and veins were surrounded by blue plexuses. It could not, however, be decided whether the blue fibres proceeded to the smooth muscle cells. In the retina the nervous layer showed no blue colouring. In the ganglion layer, on the other hand, cells richly charged with blue, and having numerous branching processes, were found, which, too, were in communication with the processes of neighbouring cells. In the mixed nerve stems and in the roots of the nerves no blue fibres were found. The central ends, on the other hand, showed a decided methylic blue reaction, as did also the peripherical ends of the sensory nerves. In the brain blue fibres were found only rarely, but were very abundant in the medulla oblongata, while they were wanting, again, in the spinal marrow, and from these results it appears that the colouring of living organs with methylic blue was a very important means towards observing the endings of sensory nerves in them. It must, however, be borne in mind, that the examination had to be prosecuted very rapidly after the colouring process, because, in living tissue, the colouring material got very quickly—in the course of a few minutes—lost by diffusion, and the colouring of the axis cylinders disappeared.—Dr. Benda laid before the Society several preparations sent by Prof. Adamkiewicz, of Cracau, and gave an explanation of them. After colouring with saffranine, Prof. Adamkiewicz found, in transverse sections of nerve fibres and cords of the spinal marrow within Schwann's sheaths, yellow to brown coloured crescents, which were sections of peculiar fusiform cells, and in the opinion of Prof. Adamkiewicz represented hitherto unknown parietal cells, lying within the nerve fibres, distinguished by their saffranine reaction.

**Meteorological Society**, March 3.—Dr. Hellmann spoke on the rainfall of Germany. After a short reference to the rain-maps of Germany, hitherto published, which had been in some degree prepared from insufficient material and according to inadequate methods, he set forth the points of view which had determined the arrangement of sixty new rain-stations. By grouping and comparing the new annual observations with those of neighbouring stations, which ranged over a long series of years, he was now in a position to draw a number of important conclusions. He was able to establish, for example, that the eastern part of North Germany, and, in particular, the right bank of the Oder, was not, as had hitherto been supposed, a dry district, at least not over its whole area, seeing that there were several stations within that section showing moderate amounts of rain. It was further ascertained that the views formerly prevalent respecting the rainfall in mountainous regions were not correct, each mountain chain not having been considered separately when inductions were made from the data hitherto accumulated, in which other essential factors came to be mixed up with that of the elevation and vitiated the result. In regard to the yearly distribution of rain, Dr. Hellmann's investigations showed that the great North German plain was embraced within the region of the summer rains; that the curve of rain-quantity and rain-frequency sank from January to April, reaching its minimum in that period, whence it rapidly rose to its maximum, which was attained in the summer months, and then sank slowly to its winter values. The maximum of rainfall in the furthest east occurred in June; immediately to the west in July; still more to the west in August; in Sleswick, later still; and in Heligoland, not till November. A closer examination of the rain-curve in North Germany showed that it consisted of two maxima, with a depression of greater dryness occurring in July. A similar double maximum was likewise found in South Germany and in North-West Germany. The first and greater rain maximum occurred with the recurrence of cold in June, and, altogether, the curve of temperature in North Germany showed a perfectly corresponding, inverse course with that of the rain-curve. The mountains of Germany—the Sudetic Mountains, the Taunus, the Harz, the Thuringian Forest—which were all separately investigated in respect of their rainfall—showed an inverse course in the yearly rain-curve as compared with that of the plain. In the mountains, the maximum of rainfall occurred in winter, whence the curve sank in spring, then rose to a small secondary maximum in summer, sank thereafter, and finally rose to its year's maximum in winter. In respect of the absolute rain maxima the observations hitherto made showed that for Germany the month's maximum amounted to about 9·45 inches, and that the greatest daily rainfall amounted for the plain to about 5·91 inches, and for the mountains to from 7·88 to 9·45 inches. The greatest hourly rainfall hitherto observed was 2·96 inches. Dr. Hellmann exhibited a self-registering rain-gauge by Hottinger, and explained its construction.—Dr. Kremser described an ascent of the Schneekoppe made by him on January 3 and 4, 1885, and submitted some meteorological observations taken by him on that occasion. On the height of the ridge he had clear sunshine over head, while the mountains under him lay enveloped in fog, the contour of which he was thus in a position to observe. In the Riesengrund, into which the sun shone clearly, he saw a huge pillar of fog, the upper end of which was curved into a whirling shape, resembling the column of smoke in an ascending air-current, as described in Herr Vettin's experiment (*vide* NATURE, vol. xxxi. p. 284). On the Schneekoppe he saw the brown-red ring around the sun in a state of remarkable completeness. About 10° around the sun was a brilliantly white space, which passed through yellow and yellow-brown into the copper-coloured ring, 6½° broad. At the point where it touched the horizon the two limbs showed different tints. Before sunrise the moon was densely surrounded by a violet halo, which extended to about as far as 18° from the moon, and gradually passed into the dark-blue sky. The observer stationed on the Schneekoppe related that he likewise had often, for now nearly a year, seen the violet halo around the moon. Lastly, it was to be stated that, like all other exposed objects, the telegraph poles were covered with immense masses of hoar-frost, so that they showed a diameter reaching to 1 m., and the rain-gauges were also so heavily covered with the hoar-frost as to be practically useless.

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