THURSDAY, JUNE 20, 1889.

EVOLUTION ETHICS.

Moral Order and Progress: an Analysis of Ethical Conceptions. By S. Alexander. "English and Foreign Philosophical Library." (London: Trübner, 1889.)

"IT will be found that moral ideals move by a process which, allowing for differences, repeats the law by which natural species develop. . . . The growth of a new ideal is analogous to the growth of a new species in the organic world. According to the generally accepted view, a new species is produced through giving rise to variations which struggle with one another and with the parent species. . . . The good ideal has been created by a struggle of ideals in which it has predominated. Evil is simply that which has been rejected and defeated in the struggle with the good." These sentences contain the key-note of Mr. Alexander's able and valuable work—a work which will be read with interest by students of ethics of whatever school. Based upon a dissertation, for which Mr. Alexander obtained the Green Moral Philosophy Prize at Oxford in 1887, written by one who has carefully studied and grasped the principles set forth by Mr. Herbert Spencer and Mr. Leslie Stephen, this work is in some sense the offspring of the fertile union of the "Prolegomena" and the "Science of Ethics." Or, as he himself expresses it, coming to the ideas borrowed from biology and the theory of evolution, which are prevalent in modern ethics, with a training derived from Aristotle and Hegel, Mr. Alexander has found "not antagonism, but, on the whole, fulfilment."

Morality being a matter of conduct and the outcome of character, the first book of the three into which Mr. Alexander's work is divided deals with conduct and character, which he regards as the same thing facing different ways. Think of a man's conduct in relation to the mental conditions from which it proceeds, and you think of his character: think of his character as it produces results beyond these sentiments themselves, and you have conduct. Following in the footsteps of Prof. Max Müller, who identifies language with thought, Mr. Alexander thus identifies conduct with character. As language is the expression of thought, so is conduct the expression of character. But just as thought is not co-extensive with the psychological field, so is conduct not co-extensive with the field of action. Conduct is willed action: it implies volition. And Mr. Alexander goes so far as to deny to the brutes any share in conduct, any participation with us in volition. Character, too, as identical with conduct, or merely another aspect thereof, implies volition. Non-volitional activities are not the outcome of character; they merely arise out of the disposition or temperament of the agent. Animals have dispositions, but no character.

What, then, is the nature of that volition which distinguishes character and makes morality possible? It is this: that "when a man wills he does not merely perform an act which issues in a certain end, but has before him the idea of the end, or is conscious of his object, or, in homely language, knows what he is doing, though he need not reflect on what he is doing." The presence of the idea then, as such, distinguishes volition (human) from mere impulse (animal). But the presence of the idea also distinguishes desire: whence desire would also seem to be restricted to man. Desire consists in the feeling of tension, which may be described as a sense of disparity between the ideal object and the actual state of the agent. The act of volition is the passage from the actual state to the ideal state: it is the conscious realization of the ideal.

Moral action, then, in Mr. Alexander's system being willed action, we naturally turn to see what his position is with regard to the free-will controversy, and we find him occupying the standpoint of determinism. It would have been well, perhaps, to state this earlier than in the last chapter but one of the work. But, though there is no index, his table of contents contains a full and clear conspectus of the argument, and a little trouble enables the reader to turn to this or other points on which he may desire information in the course of his perusal. The idea of a free will in the sense of an undetermined will is, Mr. Alexander believes, "a sheer delusion." Though invented to save responsibility, free will, he says, renders it inexplicable. A will independent of motives could never be responsible because it would not be called to account. Mr. Alexander connects responsibility and punishment. When we call a bad man responsible, we mean that the good man holds him to be justly punished. "His responsibility lies in a feeling not on his own part, but on the part of the good, just as the badness of his action consists in the good man's disapprobation."

We must leave the upholders of the doctrine of free will to pick serious holes in Mr. Alexander's argument. But accepting with him the determinist position, we think there are certain points which he might have made clearer. He says, in effect, that a man is responsible for such acts as are the outcome of his character (willed acts), but not for such as are the outcome of his disposition (impulsive acts). For these but not for those he is justly punishable. It is idle, he says, to praise a feeling [or action] which cannot be commanded: what is praised is its indulgence or its cultivation. But if both are inexorably determined, why is the one more praiseworthy than the other? Why is it just to punish one set of actions and not the other? We punish the dog for certain of his actions, though in Mr. Alexander's view he cannot be responsible for them. Do we not often punish, and that wisely, men for similar acts for which Mr. Alexander would not hold them responsible? The distinction between willed acts and impulsive acts, as defined by Mr. Alexander, is a valid distinction in psychology. But does not determinism break down this distinction (or at least make it somewhat arbitrary) when we come to responsibility? Does Mr. Alexander mean that it is *practically convenient* to hold men responsible for the (determined) acts of will: or does he consider the psychological distinction a justification for the moral distinction? Undoubtedly, as it seems to us, the latter; for he contends that the sphere of morality is the sphere of willed action. The evil that a man does as the impulsive outcome of his disposition he regards as a subject for pity, but not for moral aversion. His psychological basis is clear; but we think he might have more explicitly reconciled it with his determinism.

We must now pass on to consider that part of the work which deals with the struggle of ideals. Moral order Mr. Alexander regards as an equilibrium. This is seen both in the individual and in society. The good man is described as an equilibrated order of conduct, or an equilibrium of moral sentiments. Good and bad acts and conduct are distinguished by their adjustment or failure of adjustment to the social order. Good conduct falls within the order ; bad conduct fails to adjust itself and is condemned. The equilibrium is not a state of rest, but a mobile equilibrium in which all the parts are shifting. The conception of a man's character is represented under the name of an *ideal*—a plan of conduct or way of life upon which he acts. A bad man's way of life is his ideal as much as the good man's, and every one of his acts implies such an ideal. Moral progress results from a conflict of ideals and the elimination of those which are bad. But not only are there, in any given society, a great number of interdependent individuals, each with his moral ideal, but the society itself may be regarded as an individual (the social organism) having relations to other social individuals of the same order. Hence arises the conception of a social ideal.

With regard to this social ideal, what it is, and wherein it lies, Mr. Alexander is not quite explicit—or perhaps the fault is in ourselves ; for we have always found the social organism a difficult conception. It is clear that the social ideal cannot in any sense be the mean of the individual ideals of the constituent units of the society. It is presumably not the ideal of the average man. It must be, we take it, the moral ideal of the perfectly "equilibrated" individual—of the man in completely harmonious adjustment with his social surroundings. Such a representative man may not exist in the flesh ; but he represents the ideal standard of the social morality of his time. After-times may show that there existed contemporaneously individuals with far loftier ideals than the social standard. But these were not perfectly equilibrated with their social surroundings, and not improbably paid the penalty for their want of equilibrium.

The social ideal is thus the type-form of a species of which the various ideals, as they exist in the minds of good men, are the different individuals. "But," says Mr. Alexander, "the type in the case of man is, owing to his social character, itself an organism of which the individual is an organ. Hence, if we are to use the analogy at all, we must compare the relation of a species to its individuals with that between the social ideal and the individual ideals." A little later on we read that "an ideal is nothing but a person in so far as he acts the ideal." We fail satisfactorily to correlate the idea of the type as organism of which the individual is an organ, with that of he social ideal as species of which the personal ideals are individuals.

Mr. Alexander next proceeds to show : (1) that the social ideal varies ; (2) that there is a struggle between the varieties ; (3) that the prevalence of good, and successively better ideals constitutes moral progress. "All good men, so far as good, represent ideals which are the individual members of one variety represented by the good ideal : their various degrees of perfection correspond to more or less strong, or swift, or big members of the animal species. All bad men, so far as bad, act upon ideals which form other varieties. There is the variety of thieves, of murderers, and the like. The distinction of good and bad corresponds to the domination of one variety, that of the good, which has come to prevail according to the process described in virtue of its being a social equilibrium."

The differences between the struggle of ideals and the struggle of animals under nature are not slurred over by Mr. Alexander. "In morality," he says, "the struggle is between *ideals*, and persons are concerned only as the bearers of these ideals. Ideals of conduct exist in minds (wills), not in bodies. Hence two important differences. The animal variety predominates by two concurrent methods : it multiplies its offspring, and it exterminates other animals, and these two things are practically the same, for other animals die out before the spread of the more successful. But in man the predominance of the good does not always require, and except in extreme cases never requires, the extinction of the opposing person, but only the extinction of his ideal, or its retirement from his mind or will in favour of the good ideal. In the next place, whereas animals multiply by propagation of new individuals, the moral ideal acquires strength by teaching and example, and it acquires adherents not only among the new generation but among the old. Hence, while if an animal variety were composed of only a few individuals it would perish, the reformer's cause may win though he individually is destroyed. His ideal lives on in the minds of those whom he has influenced, and his influence may grow greater with his death."

Enough has now been said—and as much as our space will permit—to indicate the scope of Mr. Alexander's conception of the nature and methods of moral progress. How he works in such biological ideas as degeneration and mimicry—the bad man simulating the external actions of the good—must be ascertained from the work itself.

And what shall we say of this conception? Fully admitting the value of Mr. Alexander's independent treatment of the subject, it still seems to us that the separation of the moral ideals from the men and women whose product they are is unsatisfactory. All that Mr. Alexander contends for could be as well, nay better, explained as the result of the interaction of moral and immoral human beings under the conditions of social co-operation and the varied play of social life. For the purposes of ethical science they may be divided, according to their ideals of conduct, into moral varieties. And in the course of their individual moral development they may pass through several varietal states. The struggle among men and women differs very considerably from the struggle among animals, from the fact that man is, in virtue of his high mental development, more plastic, that he is to so large an extent a conscious agent in his own evolution, and that his environment is a social environment of similar conscious agents. It is questionable whether the conception of a social organism and a moral organism helps us much. In any case it has to be used with extreme care and with many reservations. And if we can reach as good results with the more prosaic and less imaginative conception of a co-operative society of human individuals, we shall be wiser, and shall act more in accordance with the spirit of science, to adhere to that conception which sticks closest to the facts of organic life. We doubt whether Mr. Alexander's work would have suffered anything by dealing with men and women possessed of moral ideals, instead of ideals floated off in imagination from their bearers; and we think it would have gained considerably in practical directness, and points of application to the facts of social life.

We cannot take leave of Mr. Alexander's work without again expressing our warm appreciation of its earnestness, its ability, and its orderly method. It is a valuable contribution to ethical literature. C. LL. M.

THE ZOOLOGICAL RESULTS OF THE "CHALLENGER" EXPEDITION.

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76, *under the command of Captain George S. Nares, R.N., F.R.S., and the late Captain Frank T. Thomson, R.N.* Prepared under the superintendence of the late Sir C. Wyville Thomson, Knt., F.R.S., &c., Director of the Civilian Staff on board, and now of John Murray, LL.D., Ph.D., &c., one of the Naturalists of the Expedition. Zoology—Vol. XXX. Published by Order of Her Majesty's Government. (London: Printed for Her Majesty's Stationery Office, and sold by Eyre and Spottiswoode, 1889.)

VOLUME XXX. of the zoological series of the *Challenger* Reports contains an account of the Asteroidea by W. Percy Sladen, and is without doubt one of the most important of the whole series.

The Report contains a description not only of the species collected during the cruise of the *Challenger*, but of those collected during the cruises of the *Lightning*, *Porcupine*, *Knight Errant*, and *Triton*. In the *Challenger* collection there were 84 genera, 5 subgenera, 268 species, and 13 varieties. 184 species and 12 varieties are described as new, and several new genera are established; the new species and varieties found during the other expeditions bring up the total of new species to 196, and new varieties to 15.

In the latest summary of the Asteroidea, published by Prof. Perrier in 1878, he enumerates 52 genera, which Mr. Sladen reduces to 49, and of these, representatives of no less than 38 were obtained by the *Challenger;* thus indicating in a striking manner that the collection affords a fair representation of the general character of the Asteroid fauna of the globe.

The large number of deep-sea forms, belonging to previously unknown types, as well as the very peculiar features distinguishing most of these, demanded a quite new classification; and Mr. Sladen has framed one in accordance with morphological characters, which is certainly far in advance of any that have hitherto been made. The usefulness of this Report has been greatly increased, without its bulk being materially added to, by a list given under each genus of all its authentic species, and their geographical distribution.

At the end of the Report there is added a synoptic list of all the known species of recent Asteroidea, with particulars of their geographical distribution, also their distribution in depth and their synonymy. This most carefully compiled list will be of the greatest value to all interested in the study of this group. 137 genera and 810 species are therein enumerated.

The introduction opens with a history of the classification of the Asteroidea, the earliest attempt at which was made by Linck in 1733. This, which was a purely artificial one, was not improved on by Linnæus or Lamarck. In 1840, Müller and Troschel published their well-known classification, chiefly based on the presence or absence of an anal orifice, and on the arrangement of the ambulacral tube-feet; and this formed the basis of all systematic arrangements of the group until 1875, when Prof. Perrier insisted on the importance of the pedicellariæ from a classificatory point of view, in addition to the disposition of the ambulacral feet. A couple of years later Viguier published his elaborate researches on the skeleton of the Asteroidea, and on these also proposed an amended arrangement of the group. In 1854, Prof. Perrier again discussed the question, examining it from Viguier's standpoint, but concluded to retain the pedicellariæ as the basis of his system of classification, which indeed he but slightly modified.

Mr. Sladen briefly gives his reasons for dissenting from the views of Perrier; and passing in review the various morphological features or fundamental points of structure which are common to the whole class, selects the following: (1) the adaptation of the organism to subserve the functions of respiration and excretion; (2) the character of the ambulacral skeleton; (3) the character of the ambital skeleton.

For the first of these he selects the organs called "papulæ" by Stimpson, which penetrate the body-wall in the form of delicate transparent membranous cæca, permitting an exchange of fresh fluid from without by osmosis, thereby introducing oxygen; these "papulæ" may be distributed over the whole body, or may be confined to a limited area, and thence the division into the Stenopneusia, and the Adetopneusia.

The ambulacral skeleton exhibits two modes of growth; in the one the production of parts is accelerated in relation to the growth of the starfish, in the other the production of parts is retarded, or proceeds *pari passu* with the general development of the skeleton. The ambital skeleton is formed by the marginal plates and their supplementaries when present; these the author considers one of the most important systems of plates in the body, as determining form and superficial character.

The introduction concludes with a summary of the classification as far as the genera, and a synopsis of the orders and families is also given.

The description of the species calls for no remark, unless the critical one in passing that according to the usual practice the date of the publication of this volume, not the date when the individual sheets contained therein were passed "for press," must be taken as those for the new families, genera, and species. No less than 109 species and varieties were found at depths from 500 to 2500 fathoms. The volume consists of 935 pages, and is accompanied by an atlas of 118 plates, which well merit our special praise. In most instances the figures of the abactinal and actinal aspects of each species is given on one plate, and then in the plate following we have the magnified details of the mouth-plates, the supradorsal membrane, the adambulacral plates, and other characteristic portions.

The publication of this Report cannot fail to give a fresh stimulus to the study of this hitherto rather neglected group of the Echinoderms, and the best thanks of every student of natural history are due to Mr. Sladen for the thorough and honest manner in which he has accomplished a troublesome and arduous task.

GREEK GEOMETRY FROM THALES TO EUCLID.

Greek Geometry from Thales to Euclid. By Dr. G. J. Allman, F.R.S. (Dublin: Hodges, 1889.)

THE subject-matter of this work has at different times been brought under the notice of the readers of NATURE, for it is very little more than a collected and corrected reproduction of papers which have at varying intervals appeared during the last eleven years in *Hermathena.* In all our previous notices, we believe, we strongly insisted upon the desirability of Dr. Allman's giving a permanent form to his labours, which should render his brilliant achievements the more readily accessible to mathematical and, we may say also, to general readers. Hitherto all the original investigation in this direction has been carried on by German, French, and Danish writers, for Mr. Gow's "Short History of Greek Mathematics," interesting though it is, is confessedly not founded upon independent research, nor does Mr. Heath's "Diophantus," concerned as it is with Greek algebra, form exception to our statement. In the historical domain of mathematics, Montucla held sway until quite recently, and even the latest French work, by M. Marie, the outcome of forty years' travail, holds fast by him, so that Heiberg (quoted by our author) writes: "The author [Marie] has been engaged with his book for forty years: one would have thought rather that the book was written forty years ago." Far different is the case with Dr. Allman: all along the line of his labours he has consulted the original Greek authorities, and fought every inch of the ground with such experts as Heiberg, Bretschneider, Cantor, Tannery, and several other writers we could name, many times adopting their results, but in nearly as many cases putting forward and convincingly maintaining views of his own. In evidence that the views we have all along held of the importance of this contribution to our knowledge of the early Greek geometers was not a singular one, we have now the confirmation of the favourable reception the papers in their original form met with from many competent authorities on the Continent and elsewhere, the outcome of which has been the present handy volume. Dr. Allman states that "it has been, throughout, my aim to state clearly the facts as known to us from the original sources, and to make a distinct separation between them and conjectures, however probable the latter might be." This testimony is, we believe, true: certainly the reader is put in possession of the facts so far as they are at this date obtainable.

We may just call to mind the points discussed. In an introduction the authorities on the early history are named: had Eudemus's history come down to us we should possibly have had a summary of the period treated of here, but now we are dependent upon Proclus. Then the work of Thales, of Pythagoras and his school, of Hippocrates of Chios, of Democritus, and of Archytas, is clearly discussed in Chapters I. to IV. In Chapter V., as we showed in a former notice, ample justice is done to Eudoxus, and his right place in the history of science is duly assigned. "In astrologia judicio doctissimorum hominum facile princeps," writes Cicero; in his "Histoire de l'Astronomie ancienne" Delambre has, "rien ne prouve qu'il fut géomètre"; and even De Morgan writes, "he has more of it [of fame] than can be justified by any account of his astronomical science now in existence." M. Marie is more just; though he devotes only two pages to the account of his work, he remarks, "il n'était pas au reste moins bon géomètre que bon astronome" (cf. Delambre, *supra*). Had Dr. Allman done no more than reinstate in its proper place a name "highly estimated in antiquity," this would have been a *raison d'être* for his work. We must remember, however, with regard to this tardy act of justice, that "it is only within recent years that, owing to the labours of some conscientious and learned men, justice has been done to his memory, and his reputation restored to its original lustre." In the following chapters (VI. to VIII.), we have accounts of the successors of Eudoxus, viz. Menæchmus, Deinostratus, and Aristæus. The concluding chapter takes up the work of Theætetus, and herein we have a discussion of the part which Euclid himself most probably contributed to his well-known "Elements."

All readers of this standard contribution to the early history of geometry, which has placed its author in the first rank of writers on the subject, and thereby brought credit to the whole body of English-speaking mathematicians, must hope that Dr. Allman will not lay his armour down, but that, after a brief respite it may be, he will undertake some such work again on a kindred subject. We would have suggested a careful edition of the text of Euclid had not labour in this direction been anticipated by Dr. Heiberg in his recently completed edition of the "Elements."

A bust of Archytas, from Gronovius, forms the frontispiece, a few notes are appended at the end to bring information as to books and editions up to date of issue, and a full index completes the volume.

One of the notes (p. 218) on "the theorem of the bride" is very interesting to us. On pp. 633, 637, of "Clifford's Mathematical Papers," we have given footnotes on the term "the figure of the bride's chair," which Clifford evidently used for a particular figure of Euclid i. 47. We had an idea at the time of writing the notes that the term ought to occur in Arabic, and so made application to Mr. Spottiswoode (a fair Arabic scholar himself), and through him to Oxford authorities, but no one could identify the expression. Dr. Allman notes: "M. Paul Tannery ('La Géométrie Grecque,' p. 105) has found in G. Pachymeres ('MSS. de la Bibl. nationale') the expression τὸ θεώρημα τῆς νύμφης to designate the 'theorem of Pythagoras.'" This seems to point to the old Egyptian idea as handed down by Plutarch (cf. Allman, pp. 29–32).

R. T.

OUR BOOK SHELF.

Die Meteorologie, ihrem neuesten Standpunkte gemäss, und mit besonderer Berücksichtigung geographischer Fragen dargestellt. Von Dr. Siegmund Günther. With 71 Illustrations. 304 pp. (Munich: Ackermann.)

DR. SIEGMUND GÜNTHER is already known by his "Lehrbuch der Geophysik," in two volumes, which appeared in 1884 and 1885, and runs up to nearly 1200 pages. The title of the present work is ambitious, and the endeavour to produce a text-book of the whole of meteorology in the space of 300 pages is a bold one. The work is a digest of existing text-books, such as Van Bebber's "Handbuch der ausübenden Witterungskunde," and Sprung's "Lehrbuch der Meteorologie." It is therefore excessively condensed, and to such an extent that it can only be used as a sort of index, for on all the subjects discussed, the reader is referred to other sources of information. The conception of the treatise is good enough, and the subdivisions are: (1) the general properties of the atmosphere, and observations thereon; (2) the movements of the atmosphere; (3) general climatology; and (4) the special climatology of the different zones. These are followed by two appendixes which might well have formed separate chapters; their subjects are, respectively, practical weather knowledge, and optical meteorology.

As might be expected, the sources of Dr. Günther's information are almost exclusively German, so that his *résumé* is slightly one-sided. This is especially the case when he is dealing with marine meteorology, as he almost ignores all work and all methods except those of the Deutsche Seewarte. In his notice of the marine barometer (p. 45), he entirely omits any mention of the principle by which the necessity for a capacity correction is dispensed with by the employment of a modified scale of inches. In speaking of the origin of weather telegraphy, Dr. Günther does scant justice to FitzRoy, who is merely casually mentioned as a former head of the English office. At p. 39 he gives the reader to understand that Kew, Pawlowsk, and Zikawei are the only stations in the world employing photographic self-recording instruments. A more serious slip, for a German, is at p. 243, where he speaks of two international Congresses at Leipzig and Rome, forgetting that the private meeting at Leipzig in 1872 was only preliminary to the Congress of Vienna in the following year. The correction of the press has not been carefully done: not only are letters dropped out in the printing of Latin and English words, but even in the German we have noticed several slips.

However, Dr. Günther's work is undoubtedly useful as indicating to geographers the main outlines of existing knowledge in the most important branches of science with which they come in contact at every turn, and also the lines in which further investigation is desirable.

Haunts of Nature. By H. W. S. Worsley-Benison. (London: Elliot Stock, 1889.)

SOME time ago we had the pleasure of recommending an excellent little book by Mr. Worsley-Benison, called "Nature's Fairy-land," consisting of a series of simple, pleasantly-written papers on some of those aspects of Nature which are most likely to excite the interest of children. The present volume has been planned on exactly the same lines, and is in every way worthy of its predecessor. In the opening essay the author describes the proceedings of two house-martins who did him the honour to select as the site for their nest a small wooden projection under the eaves of his roof. This paper has all the freshness and charm that spring from direct observation, and young people will read it with genuine pleasure. Among the subjects dealt with in other papers are wild roses, water scavengers, the dragon-fly's haunt, protective mimicry in insects, "fast asleep for months," and the ministry of leaves.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Structure and Distribution of Coral Reefs.

I AM somewhat disappointed that my criticism of Prof. Bonney's appendix in the last edition of Mr. Darwin's work on "Coral Reefs" has resulted only in an affair of outposts on the part of my opponents, since the main body of my arguments remains to be assailed. It would have been interesting, for instance, to obtain some further information concerning the evidence establishing the existence of the "90-fathom" reef of Rodriguez; and I should have welcomed the opinion of some zoologist as to the degree of our acquaintance with the fauna of the greater depths, say between 30 and 100 fathoms, around the shores of tropical islands in the Indian and Pacific Oceans. If this acquaintance is as scanty as I contend it is, then it is premature to fix the absolute limit of depth of the reef-coral zone.

At present, however, I shall be content with the establishment of the fact that corals occasionally grow in greater depths than 20 or 30 fathoms; and it was with this intention that I purposely singled out Commander Moore's observation in his Report on the Tizard and Macclesfield Banks. It is just this occasional greater depth of reef-coral growth that is the *crux* of the whole matter as far as the necessity for a theory of subsidence is concerned. Prof. Bonney admits in his last letter that "reef-building corals occasionally grow at depths considerably greater than 25 fathoms," and thus practically abandons the scanty foundation on which the surviving portion of the theory of subsidence now rests. My critic in this manner dispenses with the necessity of a movement of subsidence to explain the circumstance that lagoons are occasionally deeper than the usual limit of depth of the reef-coral zone, and to account for the occasional considerable thickness of upraised coral reefs. The supporters of Mr. Murray's anti-subsidence views will welcome this admission. It removes, in the first case, one of the chief points in favour of subsidence brought into prominence by Agassiz and Geikie in their hostile criticisms of the theory of Mr. Darwin—I refer to the abnormal depths of some atolls. In the second case, it shows that some of the evidence ranged in Prof. Bonney's appendix on the side of Darwin—I allude to that concerning the thickness of the upraised reefs of Cuba and the depth of limestone penetrated by the artesian borings at Oahu—should at least be placed in a neutral position. This is especially necessary in the instance of the artesian borings at Oahu, since Prof. Agassiz in his recent extensive memoir on the Hawaiian reefs,[1] which has not hitherto been quoted in this discussion, regards the borings from a point of view very different from the standpoint of Prof. Dana.

In this and in my previous letters I have shown to the best of my ability that nearly all the evidence ranged by Prof. Bonney on the side of Darwin should be placed at least in a neutral position. It almost all hinges on inferences that have not been established, or else on assumptions that cannot yet be proved. Surely the "90-fathom" reef of Rodriguez, if there has been no mistake in the matter, can be explained without subsidence by those who admit that "reef-building corals occasionally grow at depths considerably greater than 25 fathoms." The upraised reefs of Cuba must be placed on neutral ground. Masamarhu Island I have claimed for Mr. Murray. Lastly, there remain the artesian borings at Oahu; and, accepting Prof. Agassiz as our authority, we do not at present receive them as in favour of subsidence. H. B. GUPPY.

June 11.

P.S.—After writing the above, I received a letter from Mr. John Murray, relating to the "90-fathom" reef of Rodriguez; he has kindly allowed me to quote from it the following remarks:—"I have examined all the charts and other available information, and have consulted some of the surveyors of the island. The result is that I don't think Prof. Balfour had sufficient grounds for stating with regard to Rodriguez that 'an older reef exists now quite submerged in some places to a depth of over 90 fathoms. Upon it the present reef rests, and it extends westward nearly fifteen miles from the present coast, while on the east it stretches

[1] Bulletin of the Museum of Comparative Zoology at Harvard College, vol. xvii., No. 3, April 1889.

about six miles' (Phil. Trans. R.S., vol. clxviii. p. 289; quoted on p. 308 of Darwin's 'Coral Reefs,' third edition). Here he evidently refers to the shallow water extending on all sides to the 100-fathom line, where there is about that depth a sudden fall. The fact is, such a character belongs to a large number of oceanic islands, whether surrounded by fringing reefs or no reefs whatever, and is due to quite other causes than reef-building."

June 14. H. B. G.

The Fireball of May 29, 1889.

THE fireball which I mentioned in NATURE of June 13 (p. 150) as having been seen at Leeds on May 29, was also observed at Belfast by Mr. I. W. Ward, who recorded the latter part of its course as from Vega to α Cygni.

Comparing this path with that assigned by Mr. D. Booth at Leeds, I find the radiant point at $214\frac{1}{2}^\circ - 7^\circ$, which was in azimuth 11° (west of south), and altitude $28\frac{1}{2}^\circ$ at the time (10h. 45m.) of observation.

When first seen at Leeds the fireball was situated over a point in the Irish Sea, in lat. 53° 58′ N., long. 5° 22′ W., and its height was sixty-one miles. At its disappearance it was six miles west-south-west of Stranraer on the coast of Wigtown, Scotland, at a height of twenty-five miles. The earth point was ten miles west of Troon, Ayrshire. The real length of path traversed was seventy-five miles, and the velocity eight and a third miles per second deduced from the estimated time of flight (nine seconds) at Leeds.

The radiant point at $214\frac{1}{2}^\circ - 7^\circ$ in Libra is situated near the earth's anti-apex, and the motion of the fireball would therefore be extremely slow, as it must have overtaken the earth in her orbit. It is curious that several doubly-observed meteors which have made their apparitions in the spring months have given the same radiant point. Thus the large fireball of May 12, 1878, seen in Scotland and the north of England had a radiant at $214^\circ - 7^\circ$ (Prof. A. S. Herschel). The conspicuous meteor of April 21, 1889, observed by Prof. Herschel at Croydon and the writer at Bristol, had a radiant at $218^\circ - 5^\circ$. The vernal months appear to furnish us with a long-enduring shower from this special region of the zodiac. W. F. DENNING.

Bristol, June 15.

Meteor.

ABOUT 11.30 p.m. on the night of June 13, the sky being partially covered with fleecy clouds slowly drifting from the south-west, so that the full moon was frequently obscured, a shooting-star appeared in the north, at an elevation of about 50° to 60°, and descended obliquely towards the east. It was as bright as a star of the first magnitude, and was visible during a slightly zigzag flight of some 30°, leaving no trail. But the remarkable thing was that the sky in that quarter was pretty closely covered with the slowly-moving fleecy clouds, so that no fixed stars were visible. The meteor, therefore, must have been below the clouds, at least in the latter part of its course.

Birstal Hill, Leicester. F. T. MOTT.

Stationary Dust-Whirl.

YESTERDAY morning, at 9.30, I was fortunate in witnessing a stationary dust-whirl, about a hundred yards from where I stood, on a dust-covered highway lying due east and west. The morning was warm, 67°·5 in the shade, barometer at 30·06, and the sky clear, excepting a few isolated cumulus patches. The air was still, the wind-vane indicating north-west. The appearance of the whirl presented a resemblance to a fountain of water playing, only the base was broader than the upper part, which was perfectly columnar. It remained, for nearly five minutes, absolutely stationary, then suddenly ceased, recommencing for a few seconds, on a much smaller scale, some ten yards westwards. Its height, when at its best, would be about 25 feet, and its diameter, midway, 2 feet. I could not correctly ascertain the spiral motions of the whirl, but judged the outer spiral to move from right to left, and upwards. The wind jumped round into the north-east shortly afterwards, with clear sky, and the barometer steadily rising. No others were seen during the day. J. LOVEL.

Driffield, June 17.

Bunsen's Photometer.

IF we place the "grease-spot" screen between two sources of light, situated at A and B, whose intensities are I and I′ respectively, and if C be the position of the screen for which the spot disappears when viewed from the side towards A, and C′ the corresponding position when viewed from the other side, it is usual to say: Take the mean of AC and AC′, and the mean of BC and BC′; the squares of the means will be approximately proportional to the intensities.

The relation

$$\frac{I}{I'} = \frac{AC \cdot AC'}{BC \cdot BC'}$$

is more exact, as may be shown by the following:—

Let a be the fraction of the light falling on unit area of the spot from A which reaches the eye, and b the corresponding fraction for the dry part; and let c and d be the respective fractions of the light falling on the other side of the paper, which, after passing through, reach the eye. Then, since the spot and the dry part in the position C are equally bright when viewed from the side towards A, we have, equating the light per unit area from the two parts—

$$\frac{I}{AC^2}a + \frac{I'}{BC^2}c = \frac{I}{AC^2}b + \frac{I'}{BC^2}d,$$

or

$$\frac{I}{AC^2}(a - b) = \frac{I'}{BC^2}(d - c) \; . \; . \; . \; . \; . \; . \; (1)$$

If C′ be the position of the screen for which the parts appear equally bright, as seen from the other side, we have—

$$\frac{I}{AC'^2}c + \frac{I'}{BC'^2}a = \frac{I}{AC'^2}d + \frac{I'}{BC'^2}b,$$

or

$$\frac{I'}{BC'^2}(a - b) = \frac{I}{AC'^2}(d - c) \; . \; . \; . \; . \; . \; (2)$$

From (1) and (2)—

$$\frac{I}{I'} = \frac{AC \cdot AC'}{BC \cdot BC'}.$$

If $a + c = b + d$, we see that C and C′ must coincide. This condition implies that the light lost is the same for the spot and for its surroundings.

In the method of using the photometer, in which the two lights to be compared are balanced successively against a third light, and the spot in both cases is viewed from the same side, the inequality of the portions of light lost by the two parts does not disturb the result. D. M. LEWIS.

University College, Bangor, June 6.

THE TUTICORIN PEARL FISHERY.

AFTER an interval of more than twenty-seven years, the pearl-oyster (*Avicula fucata*, Gould) has produced pearls off the Madras coast of the Gulf of Manaar, in sufficient quantities to be worth the expense of fishing. The last fishery of the Tuticorin banks took place in the years 1860-62, and resulted in a net profit to Government of Rs. 3,79,297 (£37,929 at par). In olden times, when Tuticorin was in the possession of the Portuguese and Dutch, the fishery used to be carried on much more frequently than it is at the present day, and a difficult problem, which remains to be solved, is, What are the causes of the decline of the pearl fishery, and how can the Tuticorin banks be made to yield a more frequent harvest? Whether the baneful influence of the Mollusca known locally as *sooram* and *killikoy* (Modiota sp., and Avicula sp.), the ravages of the file-fishes (Balistes) and Rays (Trygon, &c.), poaching, or currents, are responsible for the non-production of an abundant crop of adult pearl-producing oysters during more than a quarter of a century, it would be impossible to decide until our knowledge of the conditions under which the pearl-oysters breed, develop, and live, is more precise than it is at present.

Superstition, as of old, still clings to the native divers; and I read, in a recent issue of the *Times of Ceylon*, that "at present there are said to be 150 boats, with their full complement of men, all waiting at Kilakarai in readiness to proceed to Dutch Bay, but they will not leave until after some festivities which occur on the 15th instant, when it is customary for them to pray for protection from sharks, &c., while engaged in diving." I can find no record of a diver being killed, in recent years, by a shark. But a case is cited, in which a native died at Tuticorin from the poisonous stings of a jelly-fish. At certain seasons of the year, jelly-fish are very abundant in the Tuticorin harbour, and a resident merchant tells me that, so great is the dread of them among the natives, that he has known coolies, engaged in carrying loads of palmyra jaggery through the shallow water to the cargo-boats, refuse to enter the water till a track free from jelly-fish was cleared for them by two canoes dragging a net between them.

The pearl-bank which is being fished at the present time, is known as the "Tholayiram Par," which covers an area of about five square miles, and lies more than ten miles east of Tuticorin, in from 8 to 10½ fathoms. The following record, by the Superintendent of the Pearl Banks, shows the condition of this bank as regards oyster-supply from the year 1860 to 1884, the oysters which are now being obtained having been first noticed at an early stage of growth in the latter year:—

April 1860.—Plenty of oysters three and a half years old.
November 1861.—Oysters scarce; nearly all gone.
April 1863.—*Sooram* and *killikoy* with some young oysters.
November 1865 to April 1869.—Blank.
March 1871.—Five oysters with a quantity of *sooram*.
February 1872.—Five oysters of three years old found.
May 1873.—Three oysters found.
January 1875.—Three oysters of two years old found.
March 1876.—North part blank.
April 1877.—South part blank.
April 1878.—Thickly stocked with oysters one year old.
May 1879.—Blank.
May 1880.—Blank.
May 1881.—Some oysters mixed with *killikoy*.
May 1882.—No oysters; dead shells and *sooram*.
April 1883.—Three oysters found.
March 1884.—Plenty of oysters one year old; clean and healthy.

This record shows very clearly how capricious is the life of the pearl-oyster, how easily the hopes of a productive bank may be banished (witness the total disappearance of the oysters in 1879), and points to the evil influence of *sooram*, which, spreading in dense masses along the rocky bottom, crowds out the young pearl-oysters.

Since 1884, the "Tholayiram Par" has been carefully watched, and the growth of the oyster, from the young to the adult stage, has steadily advanced.

				Ounces.
Ten oysters lifted,		March 1884,	weighed	1
,,	,,	October 1884,	,,	3¾
,,	,,	March 1885,	,,	6¼
,,	,,	October 1885,	,,	7
,,	,,	April 1886,	,,	7½
,,	,,	November 1886,	,,	8½
,,	,,	March 1887,	,,	10¾
,,	,,	October 1887,	,,	13
,,	,,	November 1888,	,,	15¼

In November last, 15,000 oysters were taken from the bank for the purpose of valuation by pearl-merchants, and the product was valued at Rs. 13,12,8 per 1000 oysters.

The shells of the oysters which are now being brought in daily are incrusted with various marine animals (Sponges, Polyzoa, &c.), and enveloped in masses of delicate Algæ; but, among very many thousands which I have examined, I have met with no *sooram*, and only very few specimens of *killikoy*. The oysters are living either on sand, by which they are partially buried, or on coral rocky ground (Turbinaria, Montipora, Porites, &c.), and are often brought up attached by their byssus to dead branches of Madrepores, or *Melobesian nodules*. Large specimens of the big *anai mullu shanku* (Murex sp.) are frequently brought up by the divers, and the tough animal, when removed from the shell, is served up for the evening meal.

The improvised camp, from which the fishery is conducted, is situated on the coast about two miles north of Tuticorin, and, on the way thither across a long stretch of sand, the kilns in which coral and shells are converted into *chunam* are passed, and the chank godowns, in which the chanks (*Turbinella rapa*), whose shells afford an annual source of revenue to Government, are stored, the animal matter being got rid of by the combined influence of insects and bacteria. The camp, which is built of bamboo and palmyra, is made up of residential huts, tents, and bungalows, offices (treasury, dispensary, &c.), sheds called *kottoos*, in which the oysters are counted and submitted to the unsavoury washing process, and the native *bazár*, gaily decorated with flags, in which the product of the oysters is exposed for sale.

As soon after midnight as the land wind sets in, the signal gun is fired on the shore by the native beach master, and, amid a good deal of shouting, all sail is set, and the fleet, which is unfortunately composed of less than fifty boats, with its complement of divers, makes for the bank, which should be reached by daylight. The hoisting of a flag on the schooner which is stationed on the bank is the signal for the day's fishery to commence. The limits of the entire bank are marked out by buoys, and the divers are supposed only to work, on any given day, over an area which is also indicated by buoys; but, owing to adverse winds and other causes, it is sometimes found impossible to keep the boats within the prescribed area. A stone, to which a rope is attached, is put over the boat's side, and a basket or net fastened in a similar way. These ropes the diver takes in one hand, and, placing one foot on the stone, he draws in a deep breath, closing his nostrils with his other hand; or the nose is inserted into a clip, which tightly compresses the nostrils. At a given signal the ropes are let go, and the diver descends to the bottom. The slacking of the ropes shows that this is reached. The diver then lets go the stone, which is drawn up to the surface, and, after filling the basket or net with oysters, he ascends to the surface to regain his breath. The divers work in couples, two to each stone, and the oysters brought up are kept carefully separated from those of other divers. The other day 237,000 oysters were brought up by 454 divers, in about 5½ hours, giving an average of 524 oysters to each diver. A European diver is engaged experimentally on the bank, but his greatest haul in a day has been only 1500 oysters.

The diving operations cease for the day about 1.30 p.m., and the boats start for the land, the signal gun being fired and the Union Jack run up on the flagstaff as soon as they are sighted. On reaching the shore the boats are secured, the oysters carried to the shed, rapidly counted, and divided into three heaps. The superintendent of the fishery, or some other responsible officer, touches with his stick one of these heaps, which becomes the property of the divers, who receive a pass and carry their hard-gained earnings outside the shed, where a swarming crowd of natives is waiting, eager to try their luck by purchasing a few oysters at a rate varying from about fifteen to forty for a rupee. Until long after dark crowds of natives may be seen squatting in circles on the sand, opening their oysters and carefully examining the flesh with a knife in search of even the smallest pearls. The utmost good temper prevails, and the possessor of only a few seed pearls is, apparently, perfectly happy. The two heaps which are left by the divers constitute the Government share, and are carefully counted by Government coolies. The beating of the *tom-tom* then announces that the Government auction is about to commence. The oysters are put up for sale in lots of 1000, and the purchaser has the option of taking a certain number of thousands at the same rate. As soon as the purchase money has been paid, the oysters are handed over to the purchaser, who sends them off by train, or deposits them in the *kottoo* at the northern end of the camp, where various natural agents bring about the requisite process of dissolution of the animal matter. After some days the residue is carefully washed, the prevailing maggots skimmed off, and a careful search made for the pearls.

Pearl Camp. EDGAR THURSTON.

CALIFORNIAN FORESTRY.

IT is matter for great satisfaction to learn that the "people of the State of California represented in Senate and Assembly" have created a Board of Forestry for the purpose of collecting and diffusing information with regard to forestry, tree-culture, and tree-preservation. The readers of NATURE will not fail to appreciate the economic significance of wisely administered forest laws so far as those laws are based upon scientific knowledge, and there are special reasons why they should feel an interest in the forests of the Pacific slope. They will consequently be glad to learn from the second biennial Report of the State Board of Forestry now before us that whereas, "under the old conditions, waste, destruction, and violation of law were rife, . . . the activity of the Board in attempting a reform, and the consequent investigations of the Government, have had a most gratifying result." Fires have been reduced in frequency and extent, watersheds and springs have been protected, slopes saved from further denudation, and replanting effected. It seems strange that, with so great a wealth of native trees, replanting should have become necessary, and still more that the Eucalypts of Australia should be preferred for this purpose to the pines of the Sierras. Nevertheless there are many sites where drought-resisting trees are specially required, and in which some of the Eucalypts, such as *viminalis* and *corynocalyx*, do better than the pines. Experimental stations have been established under different conditions of soil and climate, survey-maps have been constructed, while in the Report now before us a beginning has been made of a scientific and popular description of the forest trees of California. The preparation of this catalogue has been intrusted to Mr. J. G. Lemmon; its illustration will be undertaken by Mrs. Lemmon, and by photographs. For botanical purposes the writings of Engelmann, Sargent, Watson, Parry, and others in recent times, of Sir W. Hooker and Dr. Arnott at a more remote period, will supply what is needed.

Mr. Lemmon waxes enthusiastic, as well he may, over the forests of California. Pre-eminent over all forestal regions of the earth are the dense and extensive tree-growths clothing the slopes of that most diversified and wonderful of mountain-ranges—the Sierra Nevada of Western America—a range distinguished by the abruptness of its majestic uprise from the plain, the splintered and rough-hewn forms of its thousand peaks, the high elevation of their pinnacles ever bearing their crowns of snow, but most of all pre-eminent for its bounteous and beautiful "enrobing forest, . . . the noblest in North America, perforated along its raised centre-line by a thousand peaks rising through the mantle into perpetual winter; while both slopes, east and west, are rent by a million valleys, depressed through the robe (of forest) into the middle region of changing seasons, and the fringe of the garment trails out over the domain of almost perpertual summer." In a similar strain Mr. Lemmon proceeds at considerable length and in a style we are not accustomed to meet with in "Blue-books." The Sierra forests, so far as environment is concerned, occupy a middle position between torrid and frigid conditions. They are composed mainly of evergreen trees, not one of which is specifically identical with the trees on the Atlantic side of the Continent, though often so curiously alike that each genus has its "representative species" on either side. The "big trees," *Sequoia gigantea*, or *Wellingtonia*, have been written about so often that most people are familiar with them. "Far excelling them in loveliness" are the four species of *Abies—nobilis, grandis, magnifica*, and *concolor*. These are all, with many others, cultivated in our parks and gardens, where they thrive better as a rule than in the Eastern States of America. Already they justify in a measure Mr. Lemmon's ecstasies; though it is probable that their beauty will not be enhanced as they grow old, for many of these trees which are pictures of grace and beauty when young become "scraggy" and unlovely when old. Fortunately the standard of age is different in trees and men, and some generations of men may pass before the trees lose their charm. Of their value as timber trees in this country we need not speak here; indeed, little definite is yet known; but, at any rate, there are well-founded hopes in the case of the Douglas fir, the Nootka Sound cypress, *Thuya borealis*, the *Thuja gigantea*, and some others which seem destined to play an important part in the forestry of the future.

After some generalities Mr. Lemmon proceeds to give a classification of the true pines (*Pinus*), of the Pacific slope, a classification intended for popular purposes, and therefore one in which the histological characters of the leaves are passed over. The main divisions are into smooth-coned pines and rough-coned pines, corresponding to the sections *Strobus* and *Pinaster* respectively. In the one the scales of the cone end in thick, prominent, often spiny bosses, in the other the ends of the scale are nearly flat or project but little. Then comes a subdivision according to the length of the cone, surely a most untrustworthy criterion; for instance, Lambert's pine, the gigantic sugar pine, bears cones varying from 10 to 22 inches in length according to Mr. Lemmon's own showing. Further subdivisions are founded on the position of the young cone near the terminal leaf-bud or at some distance from it, on the length of time the cones remain on the tree, the way in which the scales eventually separate, and so forth. Having characterized the various species of *Pinus*, the author proceeds to give detailed information about each. This is the most valuable portion of Mr. Lemmon's report for European botanists. We would fain make many quotations, but our space allows us only to mention two species. The magnificent sugar-pine (*Lambertiana*), was first made known by Douglas. It sends up a magnificent shaft two hundred feet high, and sometimes much more. The value of this tree for "lumber" purposes is as great as its stateliness is imposing, hence thousands of noble trees have been shamefully destroyed. "Lawless vagabonds penetrate the Sierra forests with only the equipment of an axe and a long saw, and, levelling these monstrous trees, they saw out a cut, examine it, and perchance move on to the destruction of others, leaving to rot on the ground trees that would yield to the careful lumberman twenty-thousand to fifty thousand feet of clear lumber, worth hundreds of dollars." *Pinus Torreyana*, the lone pine, also deserves special notice here as a species of much structural interest, and as one which, it appears, is on the high road to extinction, unless that process can be obviated by forest ordinances or by the care of the cultivator. On the coast of Southern California, on the bluffs at Del Mar, San Diego County, within a range of four miles only, and nowhere else so far as known, are a few small trees, buffeted and often prostrated by ocean winds, clinging to the face of crumbling yellow sandstone. On the sheltered inner side of the hills and on the spurs of the cañons, bathed with frequent sea-fog, the trees have indeed a better chance, and they accordingly there form a trunk some thirty or even fifty feet in height, capped with a spreading crown. The leaves are in fives, as in many of the Mexican pines, and the cones have thick scales, each terminated by a short strong prickle. "In many respects this species of pine stands alone among Californian Conifers. No other species is found within fifty miles of it; none other survives such buffetings by the sea winds, and no other bears such large flowers, hard nuts, and such strong leaves. . . . In the few localities young trees of all ages are found, but always less in number than the older trees, from which it is inferred that the species is slowly succumbing to its environment, and must if not protected soon become extinct." Such a tree, apart from its interesting structure and history, would be a valuable introduction as a sea-coast pine, wherever the climatal conditions are otherwise favourable.

The Report from which we have taken these particulars is illustrated by photographs, which, if not in all cases very clear, at least show fairly well the general habit of the trees. For details of structure they are not so well suited, and we trust that in future Reports some other means may be taken to give adequate representation of such details. We look forward with eagerness to the continuation of the history of the Californian trees, the silver firs, the Douglas firs, and others that yield in no respect to the pines.

THE EXTINCT STARLING OF RÉUNION (FREGILUPUS VARIUS).

TIME alone can prove whether we are right in calling the *Fregilupus* an extinct species, for many people have imagined that the bird still exists in the interior forests of the Island of Réunion; but as year after year passes by and no specimens are discovered, we fear that we must class the starling of Réunion, along with the Dodo and other birds of the Mascarene Islands, as having been exterminated by the hand of man.

The earliest mention of the *Fregilupus* is believed to be that of Flacourt, who, in an account of a voyage to Madagascar, speaks of a bird called the "Tivouch," found in Madagascar, Bourbon, and the Cape, and described as being "black and grey, with a fine crest." The species was for a long time supposed to inhabit the Cape, and Montbeillard calls it the "Huppe noire et blanche du Cap de Bonne Espérance." Its crested head and curved bill were evidently the cause of the bird being called a Hoopoe, as was done by most of the older writers, until Levaillant in 1806 put it down as a *Merops* or Bee-eater. The latter author knew of eight specimens at least, two in the Paris Museum, one in the possession of each of the following persons, MM. Gigot Dorey, Mauduit, l'Abbé Aubry, M. Poissonier, one in the collection of M. Raye, at Amsterdam, and one in Levaillant's own collection. The fate of most of these specimens is unknown at the present day; they have doubtless decayed or been destroyed, as the mode of preservation of animals at the beginning of the century was by no means perfect.

In 1833 a very fine specimen was sent by Mr. Nivoy to the Paris Museum, where we saw it a few days ago, along with a more ancient individual, doubtless one of the two known to Levaillant. The same Museum also possesses two specimens in spirit. The only representative of the genus *Fregilupus* in this country has hitherto been a skeleton in Prof. Newton's possession. This individual was shot in 1833 by the late Jules Verreaux, who gave it to Prof. Newton. We are happy to announce, however, that the Trustees of the British Museum have recently acquired a very fine example of this extinct starling, one too which, curiously enough, was not known to Dr. Hartlaub when he gave in 1877 the list of specimens supposed to exist in Museums. The bird now in the Natural History Museum has been acquired from the well-known Riocour collection at Vitry-la-Ville. This famous collection, the work of three generations of the Counts De Riocour, consisted of a series of excellently mounted specimens, forming a choice little Museum which it would be hard to excel. The grandfather of the present Count was the founder of the collection, and was an intimate friend of Vieillot and the old French naturalists at the beginning of the century. Nearly all the specimens of that age are named by Vieillot, several of whose types are in the Riocour collection; and Dr. Günther has been successful in securing these also for the cabinets of the British Museum. A more interesting link with the past than this collection of the Counts De Riocour can scarcely be imagined, and we are glad to know that in the hands of Mr. Boucard, who is now the owner of the collection, it will receive the kindly consideration which such a famous Museum deserves.

Writing in 1877, Dr. Hartlaub, in his "Vögel von Madagascar's," gives a list of the specimens of *Fregilupus* known to him, as follows:—Four in the Paris Museum (two stuffed and two in spirits); one in the Caen Museum; one at Leyden (old and bad); one in the Stockholm Museum; one in the Museum at Florence; one in the Pisa Museum; one in the Genoa Museum; one in the Turin Museum; and one in the collection of Baron de Selys-Longchamps.

Sir Edward Newton likewise knew of two specimens in the Museum at Port Louis in Mauritius, and there is also the skeleton in Prof. Newton's possession; so that, with the one recently added to the British Museum, there are probably sixteen specimens in existence. The Italian Museums received their specimens from the same source, viz. from Prof. Savi at Pisa; and some of those in other Museums are from the same source. Count Salvadori has published a very interesting article on the *Fregilupus*, in which he informs us that Savi received several specimens from a Corsican priest named Lombardi, and that these specimens were given away by Savi in the most generous spirit, as he appears to have retained only a single specimen for the Pisa Museum.

Like other insular forms, the *Fregilupus* seems to have courted extermination by its very tameness and ignorance of danger. The late Mr. Pollen stated in 1868 that the species had become so rare in Réunion that when he visited the island not one had been heard of for ten years, though it was still believed to survive in the forests of the interior. The old people who remembered when the birds were still common told him that they were so stupid and fearless that they could easily be knocked down with sticks.

The extinct *Necropsar rodericanus*, Slater, was the representative of *Fregilupus* in Rodriguez (cf. Günther and E. Newton, Phil. Trans., vol. clxviii. p. 427), and its nearest living ally of the *Fregilupus* is probably *Falculia* of Madagascar, but there is also considerable affinity to *Basileornis* of Celebes and Ceram. An excellent account of the osteology of the genus was given by Dr Murie in the Proceedings of the Zoological Society for 1873.

R. BOWDLER SHARPE.

A MANSION HOUSE MEETING IN AID OF THE PASTEUR INSTITUTE.

THE Lord Mayor has fixed July 1, at 3 p.m., at the Mansion House, for a public meeting to hear the statements of scientific and medical men with regard to the prevention and cure of hydrophobia. Sir James Paget has promised to address the meeting, and it is expected that Sir Henry Roscoe, Dr. Lauder Brunton, Sir Joseph Lister, Prof. Ray Lankester, Sir Joseph Fayrer, Mr. Victor Horsley, Mr. Everett Millais, and others will take part in the proceedings. All scientific men interested in M. Pasteur's discoveries are earnestly requested to attend and support the Lord Mayor. The following resolutions will be moved:—

1. "That this meeting desires to express the gratitude of the people of Great Britain and Ireland to M. Pasteur and the staff of the Institut Pasteur for the generous aid afforded by them to over 200 of our fellow-countrymen suffering from the bite of rabid dogs."

2. "That this meeting, having heard the statement of Sir James Paget and others, records its conviction that the efficacy of the anti-rabic treatment discovered by M. Pasteur is demonstrated, and requests the Lord Mayor to establish a fund for the double purpose of making a suitable donation to the Institut Pasteur, and of providing for the expenses of British subjects unable to pay the cost of a journey to Paris when bitten by rabid animals."

3. "That this meeting, whilst recognizing the value of M. Pasteur's treatment, and taking steps to provide for its accessibility to Englishmen who may hereafter be bitten by rabid animals, is of opinion that rabies can easily be stamped out in these islands, and calls upon the Government to introduce at once a Bill for the simultaneous muzzling of all dogs throughout the British Islands, as provided in the measure drafted by the Society for the Prevention of Hydrophobia."

NOTES.

THE King of Sweden has invited Prof. Max Müller, the representative of Oxford, to be his guest at the Royal palace in Stockholm during the forthcoming Congress of Orientalists. Some 500 foreign members will attend the Congress. During the visit to Christiania, King Oscar will give a banquet to the members of the Congress at his villa at Bygdö, and the city has voted the necessary funds for a civic entertainment.

PROF. A. C. HADDON, whose movements in the Torres Straits we have from time to time recorded, is now on his way home. Contrary to the expectations of his friends and well-wishers, illness has overtaken him; but, as he writes from Brisbane, hope for the best would appear justifiable. He has worked indefatigably during his sojourn in the tropics, and has accumulated a vast collection, the greater part of which is now safely delivered.

MR. HENRY WILLIAM BRISTOW, F.R.S., died on Friday last at the age of seventy-two. In 1842 he was appointed a member of the staff of the Geological Survey of the United Kingdom. Mr. Bristow published various works on mineralogy and geology, and was the author of the mineralogical articles in Brande's "Dictionary of Science, Literature, and Art," and of articles on minerals and rocks in Ure's "Dictionary of Arts, Manufactures, and Mines." He became a Fellow of the Geological Society in 1843, and of the Royal Society in 1862, and an honorary Fellow of King's College, London, in 1863. He received the diploma of the Imperial Geological Institute of Vienna, and from the King of Italy the diploma and insignia of an officer of the Order of SS. Maurice and Lazarus.

SIR JOHN LAWES entertained the members of the Lawes Agricultural Trust Committee at Rothamsted on Friday last. In the afternoon the Committee inspected the experimental farm and the laboratories connected with it.

THE Geologists' Association propose to organize a geological excursion to the volcanic regions of Italy—Naples, Sicily, and the Lipari Islands, or to some of these places if not to all of them—during the month of October next. This excursion, in which ladies may take part, is not confined to members of the Association, and at the meeting of the Geological Society on June 5, Prof. Judd announced that the authorities of the Geologists' Association particularly invite the attendance of Fellows of the Geological Society.

A ROSE CONFERENCE will be held in connection with the Royal Horticultural Society at Chiswick on July 2 and 3. According to the official programme, the objects of the Conference are "to get together as large and as representative a collection of roses of all descriptions as possible; to form an Exhibition of all subjects pertaining to the rose, whether in its botanical, its horticultural, its literary, or its artistic aspects; and to bring together for the purposes of reciprocal information and fellowship all those interested in the rose and its culture." The Royal Horticultural Society appeal to lovers of the rose to help them to attain these ends.

ON Wednesday, July 10, the annual meeting of the Society of Chemical Industry will take place in the theatre of the Royal Institution at 11 a.m. In the evening the President will hold a reception and *conversazione* in the Grosvenor Gallery. On the two following days there will be various visits and excursions, and on the evening of July 11 the annual dinner of the Society will be held.

IN connection with the bequest of the late Dr. Swiney, Prof. W. R. McNab, of the Dublin College of Science, will begin a course of twelve lectures on fossil plants at the Natural History Museum, Cromwell Road, on Monday, the 24th inst. The subject will be continued from the course of last year, and will include the Ferns and Gymnosperms of the Palæozoic and Mesozoic epochs, and the dawn of the Angiospermous flora. The lectures will be given on Mondays, Wednesdays, and Fridays at half-past four o'clock, and will be free to all visitors to the Museum.

THE Indian Government has purchased the coins collected by the Afghan Boundary Commission. They are over 4600 in number, and are to be catalogued by Mr. C. J. Rogers, of Amritsar.

THE Russian Academy of Sciences offers a prize of 5000 roubles (£500) for the best inquiry into the nature and effects of the poison which develops in cured fish. The objects of competitors must be: "(1) To determine, by means of exact experiments, the physical and chemical nature of the poison which develops in fish; (2) to study, by experiments on animals, its action upon the heart, the circulation of the blood, the organs of digestion, and the nervous system; (3) to determine the rapidity of its absorption by the digestive organs; and (4) to study and describe the characteristics which may serve to distinguish contaminated fish from such as are not contaminated." The fifth and sixth questions, with which it may be impossible for any one to deal satisfactorily, relate to the means of preserving fish from the development of the poison, and to the question of counter-poisons and the medical treatment of poisoned persons. The competition is open to all. The memoirs must be sent in, either in manuscript or printed, before January 1, 1893, and may be written in any one of the following languages: Russian, Latin, French, English, German. If none of the papers is deemed worthy of the full prize, the accumulated interest upon the above-named sum may be handed over to the author who presents the best solution of some part of the problem.

A RECENT issue of the French *Journal Officiel* contains the Report of the Consultative Committee for Sea Fisheries in France on the subject of poisoning through the eating of mussels. The Committee, in the first place, recognize that the oysters which cause poisoning are those which have become stale, or have been kept in water rendered foul by decomposed organic matter, and question whether the same may not be the case with regard to mussels. Various explanations of mussel poisoning were made to the Committee. By some it was attributed to a parasite crab (*Pinnotheres pisum*). This explanation, however, was unsatisfactory, for in the United States this *Pinnotheres* is sought after as food. By others, the presence of the poison was attributed to the spawn of star-fish, and also to copper absorbed from wrecks. Both these suggestions were, however, disproved. The theory of Orfila, also, that the poisonous action of the mussels in the stomach is the result of imagination, does not find acceptance at the hands of the Committee. An authority on the subject has found that the mussels lose their poisonous property if cooked for a period of ten minutes with carbonate of soda. The Committee conclude that the poisonous nature of the mussels is due to the presence in them, especially in the liver, of a volatile organic alkaloid (*mytilotoxine de Brieger*), developed under the influence of a particular microbe, which is only found in mussels living in stagnant and polluted waters. Finally, they advocate the removal of all restrictions on mussels in artificial beds, and recommend the sale at all times, at fish markets, of mussels coming from such beds, which are usually situated in favourable localities, a sale which is at present prohibited in France during May and June.

MR. TUPPER, the Canadian Minister of Marine and Fisheries, is reported to be now arranging for the establishment at Halifax of an Intelligence Department, for the purpose of supplying fishermen on the Atlantic coasts with information as to the movement of the various food and bait fishes. Bulletins will be issued frequently upon the subject, and will be widely circulated, and in addition fishermen will always be able to obtain, by means of a telegram or letter, any reasonable information they may require regarding their industry.

THE Cornell University has found in Mr. Henry W. Sage, of Ithaca, a friend whose good-will reveals itself in a very practical manner. A suit is now going on, involving $1,500,000, bequeathed to the library of Cornell. In the event of the suit being lost, Mr. Sage proposes to pay for the library building—to cost over $200,000—on which work has begun; and also to give the library an endowment of $300,000. Should the suit be won, as is confidently expected, Mr. Sage's half a million will probably go to the University for other purposes. *Science* says that the giving of this sum will make Mr. Sage's benefactions to the University amount to about $1,000,000 in cash. The institution also owes much to him for counsel and services.

ON June 12, Dr. A. B. Meyer, of the Zoological and Ethnographical Museum at Dresden, received from Prince Ferdinand of Bulgaria a telegram announcing that immense numbers of the bird called *Pastor roseus*, L., had arrived some days before at Knjajevo, near Sofia, and were still there. The usual haunts of *Pastor roseus* are in the valleys of the Danube, in South Russia, and in the neighbouring districts of Asia; but this year it seems to have extended its range, and Dr. Meyer announces that he will be glad to receive any information that may be sent to him as to its appearance in new neighbourhoods. Between 1774 and 1875 the bird is said to have been seen in Germany thirty-one times, in Switzerland sixteen times. In June 1884 it was seen in Bavaria, and in the autumn of the same year in Würtemberg. It appeared again in Bavaria in May 1886. Until the other day it has not visited Bulgaria since 1876.

A LARGE meteoric stone which recently fell in Scania has been acquired by Baron Nordenskiöld for a sum of £84 for the National Museum.

ON May 31, about 11 p.m., a brilliant meteor was seen at Ljungby, near the Sound. It went in a direction east to north, emitting a bright red colour, and was accompanied by a distinctly audible hissing.

IN reference to the destructive volcanic eruption on the Island of Oshima (better known to the Western world as Vries Island), of which information has been telegraphed from San Francisco, it seems that the first news of it was brought to Yokohama by the master of a passing steamer, who described the mountain Miharaizan as being in fiercely active eruption on the morning of April 13. The eruption was of such a nature that it attracted attention on board the steamer at a great distance. Afterwards it was ascertained that the outbreak was at the western base of the mountain. From this it would appear that a new crater has been formed, as the old crater is at the top of the mountain, though there is a place to the south-west whence smoke is always issuing from the sands. The *Japan Weekly Mail*, from which this information is taken, gives the following historical account of this remarkable volcanic island. Miharaizan, according to the oldest Japanese historical records, was an active volcano so far back as 684 A.D., but the earliest authentic notice of its activity appears to have been taken in 1421, when the sea boiled, and the fish died in shoals. In 1684 an eruption commenced which lasted seven years, and in 1703 there was a great earthquake and tidal-wave, and part of the island broke down and formed the present harbour. In 1777 the mountain was in active eruption, and the island was covered several inches deep with ashes, such phenomena being almost constantly repeated from that date till 1792. It was then quiet till 1837, and more or less in action for the following twenty years. Another lull then took place, when, in 1868, it again broke out, and continued in action four days. The next eruption occurred in 1876, and lasted nearly two months. The most destructive eruptions of Miharaizan were probably those of 1781 and 1789, as, during the latter, the village of Shimotaka was entirely destroyed, and the people and their houses were completely buried in ashes. There are at present six villages on the island, containing a population of 5000 persons, mostly fishermen.

REPORTS from New Zealand describe a recurrence of volcanic activity in Mount Ruapehu. On April 29 an enormous cloud of steam was seen ascending from the summit. There is said to be every indication that considerable thermal activity is going on in the hot lake on the summit, as the outburst was of the nature of a colossal geyser ascending rapidly and subsiding in a few minutes. Since the terrible eruption at Tarawera in 1886, any new outburst, of however trifling a character, naturally gives cause for much alarm all along the belt of volcanic country from Rotorua to Tongariro and Ruapehu.

THE Pilot Chart of the North Atlantic Ocean, published by the Hydrographer of the United States, shows that the month of May was characterized by generally fair weather, and, with the exception of one day, by the absence of storms of great violence. Much fog was encountered during the month, and seriously interfered with commerce in the vicinity of New Jersey and New York. Icebergs were met with in large quantities between longitude 40° and 51°, north of latitude 46°. The approach of the hurricane season in the West Indies was marked by two well-defined depressions on the 4th and 17th respectively.

IT appears that the somewhat eccentric weather of Western Europe during the present year finds a parallel both in China and Japan, where people complain bitterly of the sudden changes of temperature, the premature heat followed by cold "snatches," the storms in quick succession and of great intensity. Thus, the *Chinese Times* of Tientsin, one of the most northern parts of China, says that since foreigners have had any connection with the place there has not been known such an inclement spring. A warm week in February broke up the ice on the Peiho River prematurely, but afterwards cold set in with great severity, and March was characterized by a succession of gales, lasting sometimes a week without intermission, and as late as the 24th the ground was covered with snow. As a rule, the country people never can have enough of snow, which they consider has a most benignant effect on the soil, but the snowfall this spring was so unusual that at last the farmers cried out that they had had too much of it.

THE *Glasgow Herald* states that last year, while some workmen were engaged in drainage operations at Lochavullin for the purpose of forming a public park, they discovered what was believed to be an old "crannog" or lake-dwelling, and several experts who visited it were of opinion that it was a very good specimen of an ancient lake-dwelling. Arrangements were made by the Town Council for its being properly investigated and preserved as far as possible, but the weather has rendered operations impracticable till within the last few days. Workmen are now engaged in excavating round the place, and recently it was visited by Mr. Cochran-Patrick, Under-Secretary for Scotland, and other gentlemen interested. Among the articles turned up by the workmen during the examination were a stone bullet, such as would have been used in the slings of the period to which the dwelling is supposed to have belonged, and portions of the wattle used in the construction of the dwelling. Prof. Hedley, of St. Andrews, took some photographs of the place.

MR. H. B. CRESSON, of Philadelphia, has been studying certain stakes or piles, which were first pointed out to him nearly twenty years ago, by a fisherman, in the mud at the mouth of Naaman's Creek, a small tributary of the Delaware River. These piles are the first indication of anything in North America resembling the remains of lake-dwellings in Europe. Prof. F. W. Putnam, in his twenty-second Annual Report relating to the work of the Peabody Museum, says that Mr. Cresson's recent investigations led to the discovery of three distinct localities, near each other, which he designated Stations A, B, and C. Around these stations were found a very important and instructive collection of stone implements, a few points and fragments of bone, and a human tooth. At one station a number of fragments of rude pottery were found, and at this were obtained several pile-ends which are now in the Museum. This collection Mr. Cresson has given to the Museum, and he proposes soon to prepare a full account of his discoveries for publication. The Museum is also indebted to Mr. A. B. Huey, of Philadelphia, for a number of specimens which he obtained while with Mr. Cresson during the examination of Station B, and to Mr. W. R. Thompson, of Philadelphia, for several potsherds, and a large stone maul with a hole drilled through it, from the same station.

MR. A. E. BROWN, Superintendent of the Philadelphia Zoological Garden, says in his last Report that among the most valued additions to the collection of reptiles, during the past year, were five iguanas from the Isle of Pines, West Indies. These were at once seen to be different from any previously in the collection, and were subsequently identified by Prof. E. D. Cope as *Cyclura nubila*, Gray. The habit noticeable among the iguanas, of remaining fixed in one position when the attention is excited, or of "striking attitudes," is specially marked in these animals, and, several of them being of large size, they have attracted considerable attention. They are of an aggressive disposition, and cannot be readily handled, as they strike blows of astonishing force with their long tails, and bite with great tenacity any object with which they are disturbed. As with the better-known iguanas, their most suitable food in captivity appears to be bananas, hens' eggs, and milk.

IN the same Report, Mr. Brown says that the Philadelphia Zoological Society lately received, from the proprietor of a menagerie, a splendid male elephant called "Bolivar." The animal came originally from Ceylon, is now about thirty years old, stands nearly 10 feet in height at the shoulder, and weighs nearly 10,000 pounds. "It may well be doubted," says Mr. Brown, "if a finer specimen of his race has ever been included in a zoological collection."

MESSRS. BLACKIE AND SON have issued the second volume of their excellent "Modern Cyclopædia of Universal Information," edited by Dr. Charles Annandale. The present volume, if we may judge from the articles we have examined, is in all respects equal to the first, which we have already noticed.

WE have received from Tashkent an interesting Russian work, by A. Wilkins, on the culture of the American cotton-tree in Russian Turkestan. It appears that, though the first attempts at cultivating the *Gossypium hirsutum* in Central Asia proved unsuccessful, a new attempt, made since 1884, under the leadership of the Tashkent model farm, and with seeds taken from the continental States of America, has proved to be a real success. In 1887, there were no less than 38,700 acres under that crop in Turkestan, and in the following year the area was trebled. The crop of 1887 was estimated at 68,000 cwts. of raw cotton. Besides giving practical advice for the culture of the American cotton-tree, M. Wilkins's book contains valuable information about the climate of Turkestan, analyses of the soil and so on, from which it appears that, although the American species can be cultivated about Tashkent, where from 214 to 237 days every year are without frost, its real domain will be on the banks of the Zerafshan and the lower Amu-Daria, and in the Transcaspian region. It is also worthy of note that a new interesting variety of *Gossypium hirsutum*, differentiated by the fact that its flowers grow in groups of two, three, and four on a common stalk, has been obtained at the Tashkent model farm.

THE additions to the Zoological Society's Gardens during the past week include two Prairie Wolves (*Canis latrans* ♂ ♀) from the Rocky Mountains, presented by Mr. Charles Martin; two Long-fronted Gerbilles (*Gerbillus longifrons*) from Western Asia, presented by Lieut.-General Sir Harry B. Lumsden, K.C.S.I.; a Chattering Lory (*Lorius garrulus*) from Moluccas, presented by Mr. Thomas Taylor; two Slender-billed Cockatoos (*Licmetis tenuirostris*) from South Australia, two Goffin's Cockatoos (*Cacatua goffini*), habitat uncertain, presented by Dr. Seton; two Razorbills (*Alca torda*), British, presented by Dr. B. Hewetson; two Viperine Snakes (*Tropidonotus viperinus*), three Green Lizards (*Lacerta viridis*), two Marbled Newts (*Molge marmorata*), two Spotted Salamanders (*Salamandra maculosa*), two Edible Frogs (*Rana esculenta*), three Green Tree-Frogs (*Hyla arborea*) from Southern France, presented by the Rev. F. H. Holmes; a Smooth Snake (*Coronella lævis*) from Southern France, presented by Miss Agnes Flemyng; a Cocoa-nut Crab (*Birgus latro* ♂) from India, presented by Commander Alfred Carpenter, R.N.; two Nicobar Pigeons (*Calœnas nicobarica* ♂ ♀) from the Indian Archipelago, a Collared Peccary (*Dicotyles tajaçu*) from South America, three Australian Waxbills (*Estrelda temporalis*) from Australia, purchased; three New Zealand Parakeets (*Cyanorhamphus novæ-zealandiæ*) from New Zealand, received in exchange; a Black Lemur (*Lemur macaco*), an Axis Deer (*Cervus axis* ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

TWO REMARKABLE CONJUNCTIONS.—Mr. Marth called the attention of the Royal Astronomical Society at its last meeting, on June 14, to two remarkable conjunctions which will occur in the autumn of the present year, and which should be most carefully watched by astronomers the world over. The first is the conjunction of Mars and Saturn on September 20, at 20h. G.M.T., the closest conjunction of the two planets on record, the geocentric distance being only 54", so that to the naked eye the two stars would probably appear to coalesce. The conjunction is rendered the more interesting from its occurring in the near neighbourhood of Regulus, which will be distant only 4' of arc; whilst Venus passes over the same region of the sky three days later, passing within 12' of Regulus. The conjunction of Mars with the Saturnian system on September 20 will be so close that it will have a very narrow escape of occulting Iapetus, the two being 12" apart at 22h.

The second remarkable conjunction will be that of Iapetus, the outermost satellite of Saturn, with Titan. This will occur on November 1 at 8h., and the two satellites, moving in different directions, will pass within 3″ of each other. Shortly after this close approach Iapetus will enter the shadow of the ring system, and as Saturn is then near quadrature, the entire passage of the satellite through the shadow will be clear of the planet as seen from the earth. The satellite's path traverses the shadow of the rings on both sides of the planet, and the clear space between the planet and ring on one side, but probably not on both. It will be a matter of the greatest interest and importance to note if the satellite shines out when crossing the projection of the Cassinian division, and if it is at all visible when in the shadow of the dusky ring or crape veil. The Australian astronomers will have the opportunity, if weather serves, of observing this most rare and interesting occurrence, whilst those of America will be best able to observe the first-named conjunction, viz. that of Saturn and Mars.

THE GENERAL RELATIONS OF THE PHENOMENA OF VARIABLE STARS.—Under this title Mr. S. C. Chandler, who has in such an especial manner made the subject of variable stars his own, contributes to *Gould's Astronomical Journal*, No. 193, the results of his discussion of the facts as yet ascertained with relation to these objects. Making abstraction of the stars of the Algol time, it appears that variables may legitimately be divided into two great classes, those of short and those of long period; the former including the stars of less than 90 days' period, the latter those of more than 120 days. The first characteristic related to the length of period is that of colour—"the redder the tint, the longer the period." The range of variability is another feature. This also appears to depend upon the period—the greater the range, the longer the period—but the relation is not one of simple proportionality. The form of the light-curve is a third point. For the short-period variables the time of increase averages about two-thirds the time of decrease, but for the long-period stars the rate varies in a curious manner. Increase and decrease take about the same time for stars, between 100 and 200 days; then the ratio lessens, until for stars of about a year's period the time of increase is only about half that of increase; the ratio then increases again, and for the stars of longest period decline and recovery proceed with about equal speed. It is also noteworthy that though it would appear that stars with a period of a year or nearly a year are less likely to be readily discovered than those of a longer or shorter variation, yet as a matter of fact they form distinctly the most numerous class of the long-period stars. Both these curious facts stand as yet without explanation.

A point of difference between the long-period and short-period stars appears to be indicated in the irregularities to which their periods are severally subject; the irregularities in the first case being, broadly speaking, periodic in their nature, but in the second case secular, or at all events requiring very many cycles of the star for their development. These irregularities are common for the first class, but quite exceptional for the second. For these reasons, and considering the absence of stars of between 90 and 120 days, the difference in colour in average range of variation, and in form of light curve between the two classes, Mr. Chandler is led to believe that the cause of variation is probably different for the two classes of stars, as it is probably different again for the third class we call after Algol. With regard to the distribution of variables, Mr. Chandler shows that our present knowledge is insufficient to justify any very substantial inferences. A certain aggregation of short-period variables near the plane of the Milky Way does, however, seem to be indicated with some distinctness.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *JUNE* 23–29.

(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 June 23

Sun rises, 3h. 45m.; souths, 12h. 1m. 57·1s.; daily increase of southing, 12·9s.; sets, 20h. 19m.: right asc. on meridian, 6h. 9·3m.; decl. 23° 26′ N. Sidereal Time at Sunset, 14h. 28m.

Moon (New on June 28, 9h.) rises, 1h. 29m.; souths, 8h. 19m.; sets, 15h. 23m.: right asc. on meridian, 2h. 25·3m.; decl. 9° 21′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury..	3 49	11 36	19 23	5 43·6	18 57 N.
Venus.....	1 41	8 58	16 15	3 4·5	13 56 N.
Mars	3 33	11 55	20 17	6 2·7	24 11 N.
Jupiter....	20 16*	0 10	4 4	18 15·8	23 14 S.
Saturn....	7 41	15 13	22 45	9 21·0	16 42 N.
Uranus ...	13 27	18 58	0 29*	13 6·9	6 26 S.
Neptune..	2 11	9 59	17 47	4 5·7	19 13 N.

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

June.	h.	
24	6	Venus in conjunction with and 1° 0′ north of the Moon.
24	19	Jupiter in opposition to the Sun.
26	7	Venus at greatest distance from the Sun.
27	8	Mercury in conjunction with and 3° 4′ south of the Moon.
28	3	Mars in conjunction with and 1° 32′ north of the Moon.
28	9	Annular eclipse of the Sun: visible principally in the southern portions of Africa.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·5	81 17 N.	June 24,	22 27	*m*
			,, 29,	22 6	*m*
δ Libræ	14 55·1	8 5 S.	,, 24,	20 50	*m*
U Coronæ	15 13·7	32 3 N.	,, 26,	0 58	*m*
V Herculis	16 54·2	35 14 N.	,, 26,		*M*
U Ophiuchi	17 10·9	1 20 N.	,, 27,	2 26	*m*
			,,	22 34	*m*
X Sagittarii	17 40·6	27 47 S.	,, 23,	22 0	*M*
			,, 28,	1 0	*m*
U Sagittarii	18 25·6	19 12 S.	,, 29,	1 0	*m*
β Lyræ	18 46·0	33 14 N.	,, 25,	22 0	*m*
			,, 29,	3 0	*M*
η Aquilæ	19 46·8	0 43 N.	,, 25,	21 0	*m*
T Aquarii	20 44·1	5 34 S.	,, 23,		*m*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A. °	Decl. °	
Near 52 Herculis	254	47 N.	Swift.
,, δ Cygni	295	40 N.	Slow.
,, ε Delphini	305	9 N.	June 28.

GEOGRAPHICAL NOTES.

THE recent telegrams relative to Mr. Stanley's movements cannot be regarded as satisfactory. There can be no doubt that he has reached the east coast of the Victoria Nyanza, but that he could do so in eighty-seven days from Yambuya, on the Aruwimi, is incredible. Therefore the date, December 2, as that on which Mr. Stanley was at Ururi, on the south-east of Victoria Nyanza, must be wrong. Moreover a message would not take six months to reach Zanzibar from there; the journey in normal times can be done in one month. It is to be feared that Mr. Stanley has had to leave the problems connected with the Mwuta Nzigé unsolved. It would seem as if he had come round by the country to the north of Uganda, and so reached the Nyoro country on the north-east of Victoria Nyanza. After Emin received all the stores which Stanley took back with him (from Mslala on the south of Victoria Nyanza), the probability is that the Pasha would return to Wadelai. However, it is expected that a letter from Mr. Stanley will arrive in a few days.

DR. FRITHJOF NANSEN arrives in London to-morrow, and during his stay will be the guest of Prof. Flower.

THE June number of the *Scottish Geographical Magazine* is a particularly good one. Mr. H. B. Guppy contributes the first part of the results of his observations on the Cocos-Keeling Islands, which promise to be an important addition to the already abundant literature on the formation of coral islands. Mr. Guppy also sends an interesting short paper on Tridacna pearls. Mr. W. B. Tripp's notes on South American rainfall south of the tropics are useful. Dr. H. R. Mill contributes a highly suggestive paper on scientific earth-knowledge as an aid to commerce. Dr. Mill really indicates the lines on which the scientific bases of commercial geography should be laid; and his paper, combined with what is being done elsewhere, leads us to hope that that hitherto ill-used and profitless subject may yet be worthy of a high place in technical education. In the same magazine is the report of an address by M. Kropotkin on the study of geography, which we commend to all interested in this important subject.

AT the recent German Geographentag, Dr. Eschenhagen, of the Imperial Marine Observatory, described the results of his magnetic survey of the Harz Mountains, begun last autumn, and comprising about 3000 measurements. He has shown that no connection can be proved to exist between the ancient geological line of fracture of the Harz and the distribution of terrestrial magnetism, such as Naumann demonstrated in the case of Japan. Dr. Eschenhagen has extended his explorations in terrestrial magnetism over the whole of the north-west of Germany, so that, inasmuch as a similar survey of Austria-Hungary will be completed about 1892, our knowledge of the distribution of terrestrial magnetism in Central Europe has made a great advance.

DR. O. KRUMMEL contributes to the current number of *Petermann's Mitteilungen* an important paper on erosion through the agency of tidal currents, in which, by a careful examination of several specific instances, he endeavours to come to some conclusion as to the laws which govern the erosive work performed by the tides. There is paper of some practical importance on the suitability of Central Asia for Russian colonization, by General Annenkof.

THE number of the *Boletino* of the Lisbon Geographical Society is entirely occupied by a long paper in French, by M. A. Marques, giving a detailed account of the Samoan Islands in all their aspects. As a summary of our knowledge of these islands, the paper will be found useful.

IN the current number (4) of the *Mittheilungen* of the Vienna Geographical Society will be found the first part of a paper, by Herr Jankó, on the development and topography of the Rosetta mouth of the Nile.

DR. SCHWEINFURTH writes with great satisfaction of his journey in Hodeida, in Southern Arabia, in the early part of the present year. Among the places he visited were Khalife, at the foot of the Jebel Bura, Wolleje, the Jebel Melhān, Bajil, Hojela, Wossil, and Jebel Harrassa. The climate he found quite European, the nights bitterly cold, though it was hot enough for an hour or two in the middle of the day. Dr. Schweinfurth's botanical collections exceeded all his expectations; the mountain-slopes are covered with vegetation. He sent home some 600 species (1800 specimens), besides seeds and living plants.

IN a very able memoir published by the Danish Society of Northern Antiquaries (in English), Prof. Gustav Storm rediscusses the vexed question of the Vinland voyages of the Norse colonists of Greenland, for the purpose of determining as accurately as the data will permit the various lands mentioned in the old Sagas. "Helluland," Prof. Storm is inclined to think, must be Labrador; Markland corresponds to Newfoundland, and Vinland to Cape Breton Island and Nova Scotia.

MR. J. Y. BUCHANAN has been appointed Lecturer in Geography at the University of Cambridge.

IT is reported from Sydney that the New South Wales branch of the Royal Geographical Society is sending an explorer, Mr. Arthur J. Vogan, to gather information relative to the far interior. Mr. Vogan will travel northwards from Fort Bourke to Pitchiri Creek, on the Upper Mulligan (lat. 21° S.), and after exploring the country from that point to the Herbert River, will either make his way to the Gulf of Carpentaria or to Hughenden. Mr. Vogan intended leaving Sydney during May.

ALUMINIUM.[1]

CHEMISTS of many lands have contributed to our knowledge of the metal aluminium. Davy, in 1807, tried in vain to reduce alumina by means of the electric current. Oerstedt, the Dane, in 1824 pointed out that the metal could be obtained by treating the chloride with an alkali metal; this was accomplished in Germany by Wöhler in 1827, and more completely in 1845, whilst in 1854, Bunsen showed how the metal can be obtained by electrolysis. But it is to France, by the hands of Henri St. Claire Deville, in the same year, that the honour belongs of having first prepared aluminium in a state of purity, and of obtaining it on a scale which enabled its valuable properties to be recognized and made available, and the bar of "silver-white metal from clay," was one of the chemical wonders in the first Paris Exhibition of 1855. Now England and America step in, and I have this evening to relate the important changes which further investigation has effected in the metallurgy of aluminium. The process suggested by Oerstedt, carried out by Wöhler, and modified by Deville, remains in principle unchanged. The metal is prepared, as before, by a reduction of the double chloride of aluminium and sodium, by means of metallic sodium in presence of cryolite; and it is therefore not so much a description of a new reaction as of improvements of old ones of which I have to speak.

I may perhaps be allowed to remind my hearers that more than thirty-three years ago, Mr. Barlow, then secretary to the Institution, delivered a discourse, in the presence of M. Deville, on the properties and mode of preparation of aluminium, then a novelty. He stated that the metal was then sold at the rate of £3 per ounce, and the exhibition of a small ingot, cast in the laboratory by M. Deville, was considered remarkable. As indicating the progress since made, I may remark that the metal is now sold at 20*s.* per pound, and manufactured by the ton, by the Aluminium Company, at their works at Oldbury, near Birmingham. The improvements which have been made in this manufacture by the zeal and energy of Mr. Castner, an American metallurgist, are of so important a character, that the process may properly be termed the Deville-Castner process.

The production of aluminium previous to 1887, probably did not exceed 10,000 pounds per annum, whilst the price at that time was very high. To attain even this production required that at least 100,000 pounds of double chloride, and 40,000 of sodium should be manufactured annually. From these figures an idea of the magnitude of the undertaking assumed by the Aluminium Company may be estimated, when we learn that they erected works having an annually producing capacity of 100,000 pounds of aluminium. To accomplish this, required not only that at least 400,000 pounds of sodium, 800,000 of chlorine, and 1,000,000 of double chloride, should be annually manufactured, but in addition that each of these materials should be produced at a very low cost, in order to enable the metal to be sold at 20*s.* per pound.

The works, which now cover a space of nearly five acres, are divided into five separate departments, viz. (1) sodium; (2) chlorine; (3) chloride; (4) aluminium; and (5) foundry, rolling, wire mills, &c.

In each department an accurate account is kept of the production each day, the amount of material used, the different furnaces and apparatus in operation, &c. In this manner it has been found possible to ascertain each day exactly how the different processes are progressing, and what effect any modification has, either on cost, quantity, or quality of product. By this means a complicated chemical process is reduced to a series of very simple operations, so that whilst the processes are apparently complicated and difficult to carry out successfully, this is not the case now that the details connected with the manufacture have been perfected, and each operation carried on quite independently until the final materials are brought together for the production of the aluminium.

Manufacture of Sodium.

The first improvement occurs in the manufacture of sodium by what is known as the "Castner process." The successful working of this process marks an era in the production of sodium, as it not only has greatly cheapened the metal, but has enabled the manufacture to be carried out upon a very large scale with little or no danger. Practically, the process consists in heating fused caustic soda in contact with carbon whilst the former substance is in a perfectly liquid condition. By the process in vogue before the introduction of this method, it was always deemed necessary that special means should be taken to guard against actual fusion of the mixed charges, which, if it were to take place, would to a large extent allow the alkali and reducing material to separate. Thus, having an infusible charge to heat, requiring the employment of a very high temperature for its decomposition, the iron vessels must be of small circumference to allow the penetration of the heat to the centre of the charge without actually melting the vessel in which the materials are heated. By the new pro-

[1] The Friday evening discourse delivered by Sir Henry Roscoe, M.P., D.C.L., LL.D., V.P.R.S., at the Royal Institution of Great Britain, on May 3, 1889.

cess, owing to the alkali being in a fused or perfectly liquid condition in contact directly with carbon, the necessity of this is avoided, and consequently, the reduction can be carried on in large vessels at a comparatively low temperature. The reaction taking place may be expressed as follows:—

$$3NaHO + C = Na_2CO_3 + 3H + Na.$$

The vessels in which the charges of alkali and reducing material are heated are of egg-shaped pattern, about 18 inches in width at their widest part, and about 3 feet high, and are made in two portions, the lower one being actually in the form of a crucible, while the upper one is provided with an upright stem and a protruding hollow arm. This part of the apparatus is known as the cover. In commencing the operation, these covers are raised in the heated furnace through apertures provided in the floor of the heated chamber, and are then fastened in their place by an attachment adjusted to the stem; the hollow arm extends outside the furnace. Directly below each aperture in the bottom of the furnace are situated the hydraulic lifts, attached to the top of which are the platforms upon which are placed the crucibles to be raised into the furnace. Attached to the hydraulic lifts are the usual reversing valves for lowering or raising, and the platform is of such a size as, when raised, completely to fill the bottom aperture of the furnace. The charged crucible, being placed upon the platform, is raised into its position, the edges meeting those of the cover, forming an air-tight joint which prevents the escape of gas and vapour from the vessel during reduction, except by the hollow arm provided for this purpose. The natural expansion of the iron vessels is accommodated by the water-pressure in the hydraulic lifts, so that the joint of the cover and crucible are not disturbed until it is intended to lower the lift for the purpose of removing the crucible.

The length of time required for the first operation of reduction and distillation is about two hours. At the end of this time the crucibles are lowered, taken from the platforms by a large pair of tongs on wheels, carried to a dumping pit, and thrown on their side. The residue is cleaned out, and the hot pot, being again gripped by the tongs, is taken back to the furnace. On its way, the charge of alkali and reducing material is thrown in. It is again placed on the lift and raised in position against the edges of the cover. The time consumed in making the change is a minute and a half, and it only requires about seven minutes to draw, empty, recharge, and replace the five crucibles in each furnace. In this manner the crucibles retain the greater amount of their heat, so that the operation of reduction and distillation now only requires one hour and ten minutes. Each of the four furnaces, of five crucibles each, when in operation, are drawn alternately, so that the process is carried on night and day.

Attached to the protruding hollow arm from the cover are the condensers, which are of a peculiar pattern specially adapted to this process, being quite different from those formerly used. They are about 5 inches in diameter and nearly 3 feet long, and have a small opening in the bottom about 20 inches from the nozzle. The bottom of these condensers is so inclined that the metal condensed from the vapour issuing from the crucible during reduction, flows down and out into a small pot placed directly below this opening. The uncondensed gases escape from the condenser at the further end, and burn with the characteristic sodium flame. The condensers are also provided with a small hinged door at the further end, by means of which the workmen from time to time may look in to observe how the distillation is progressing. Previous to drawing the crucibles from the furnace for the purpose of emptying and recharging, the small pots each containing the distilled metal are removed, and empty ones substituted. Those removed each contain, on an average, about 6 pounds of metal, and are taken directly to the sodium casting shop, when it is melted and cast, either into large bars ready to be used for making aluminium, or in smaller sticks to be used.

Special care is taken to keep the temperature of the furnaces at about 1000° C., and the gas- and air-valves are carefully regulated, so as to maintain as even a temperature as possible. The covers remain in the furnace from Sunday night to Saturday afternoon, and the crucibles are kept in use until they are worn out, when new ones are substituted without interrupting the general running of the furnace. A furnace in operation requires 250 pounds of caustic soda every one hour and ten minutes, and yields, in the same time, 30 pounds of sodium and about 240 pounds of crude carbonate of soda. With the four furnaces at work, 120 pounds of sodium can be made every seventy minutes, or over a ton in the twenty-four hours. The residual carbonate, on treatment with lime in the usual manner, yields two-thirds of the original amount of caustic operated upon. The sodium, after being cast, is saturated with kerosene oil, and stored in large tanks holding several tons, placed in rooms specially designed both for security against either fire or water.

Chlorine Manufacture.

This part of the works is connected with the adjacent works of Messrs. Chance Bros. by a large gutta-percha pipe, by means of which, from time to time, hydrochloric acid is supplied direct into the large storage cisterns, from which it is used as desired for making the chlorine. For the preparation of the chlorine gas needed in making the chloride, the usual method is employed; that is, hydrochloric acid and manganese dioxide are heated together, when chlorine gas is evolved with effervescence, and is led away by earthenware and lead pipes to large lead-lined gasometers, where it is stored.

The materials for the generation of the chlorine are brought together in large tanks or stills, built up out of great sandstone slabs, having rubber joints, and the heating is effected by the injection of steam. The evolution of gas, at first rapid, becomes gradually slower, and at last stops; the hydrochloric acid and manganese dioxide being converted into chlorine and manganous chloride. This last compound remains dissolved in the "spent still liquor" and is reconverted into manganese dioxide, to be used over again, by Weldon's manganese recovery process. Owing to the difficulty of keeping up a regular supply of chlorine under a constant pressure directly from the stills, in order that the quantity passed into the sixty different retorts in which the double chloride is made can be regulated and fed as desired, four large gasometers were erected. Each of these is capable of holding 1000 cubic feet of gas, and is completely lined with lead, as are all the connecting mains, &c., this being the only available metal which withstands the corrosive action of chlorine. The gasometers are filled in turn from the stills, the chlorine consumed being taken direct from a gasometer under a regular pressure until it is exhausted; the valves being changed, the supply is taken from another holder, the emptied one being refilled from the still.

Manufacture of the Double Chloride.

Twelve large regenerative gas furnaces are used for heating, and in each of these are fixed five horizontal fire-clay retorts about 10 feet in length, into which the mixture for making the double chloride is placed. These furnaces have been built in two rows, six on a side, the clear passage-way down the centre of the building, which is about 250 feet long, being 50 feet in width. Above this central passage is the staging, carrying the large lead-mains for the supply of the chlorine coming from the gasometers. Opposite each retort, and attached to the main, are situated the regulating valves, connected with lead and earthenware pipes, for the regulation and passage of the chlorine to each retort. The valves are of peculiar design, and have been so constructed that the chlorine is made to pass through a certain depth of liquid, which not only, by opposing a certain pressure, allows a known quantity of gas to pass in a given time, but also prevents any return from the retort into the main, should an increase of pressure be suddenly developed in the retorts.

The mixture with which the retorts are charged is made by grinding together hydrate of alumina, salt, and charcoal. This mixture is then moistened with water, which partially dissolves the salt, and thrown into a pug mill of the usual type for making drain pipes, excepting that the mass is forced out into solid cylindrical lengths upon a platform alongside of which a workman is stationed with a large knife, by means of which the material is cut into lengths of about 3 inches each. These are then piled on top of the large furnaces to dry. In a few hours they have sufficiently hardened to allow of their being handled. They are then transferred to large waggons, and are ready to be used in charging the retorts.

The success of this process is in a great measure dependent—(1) on the proportionate mixture of materials; (2) on the temperature of the furnace; (3) on the quantity of chlorine introduced in a given time; and (4) on the actual construction of the retorts. I am, however, not at liberty to discuss the details of this part of the process, which have only a commercial interest. In carrying on the operation, the furnaces or retorts, when at the proper temperature, are charged by throwing in the balls until they are quite full, the fronts are then sealed up, and the charge allowed to remain undisturbed for about four hours, during which time the water of the alumina hydrate is completely expelled. At the end of this time the valves on the chlorine main are opened, and the gas is allowed to pass into the charged retorts. In the rear of each retort, and connected therewith by means of an earthenware pipe, are the condenser boxes, which are built in brick. These boxes are provided with openings or doors, and also with earthenware pipes, connected with a small flue for carrying off the uncondensed vapours to the large chimney. At first the chlorine passed into each retort is all absorbed by the charge, and only carbonic oxide escapes into the open boxes, where it burns. After a certain time, however, dense fumes are evolved, and the boxes are then closed, while the connecting pipe between the box and the small flue serves to carry off the uncondensed vapours to the chimney.

The reaction which takes place is as follows:—

$$Al_2O_3 + 2NaCl + 3C + 6Cl = 2AlCl_3NaCl + 3CO.$$

The chlorine is passed in for about seventy-two hours in varying quantity, the boxes at the back being opened from time to time by the workmen to ascertain the progress of the distillation. At the end of the time mentioned the chlorine valves are closed, and the boxes at the back of the furnace are all thrown open. The crude double chloride as distilled from the retorts, condenses in the connecting pipe and trickles down into the boxes, where it solidifies in large irregular masses. The yield from a bench of five retorts will average from 1600 to 1800 pounds, which is not far from the theoretical quantity. After the removal of the crude chloride from the condenser boxes the retorts are opened at their charging end, and the residue, which consists of a small quantity of alumina, charcoal, and salt, is raked out and remixed in certain proportions with fresh material, to be used over again. The furnace is immediately re-charged and the same operations repeated, so that from each furnace upwards of 3500 pounds of chloride are obtained weekly. With ten of the twelve furnaces always at work the plant is easily capable of producing 30,000 pounds of chloride per week, or 1,500,000 pounds per annum.

Owing to the presence of iron, both in the materials used (viz. charcoal, alumina, &c.) and in the fire-clay composing the retorts, the distilled chloride always contains a varying proportion of this metal in the form of ferrous and ferric chloride. When it is remembered that it requires 10 pounds of this chloride to produce 1 pound of aluminium by reduction, it will be quite apparent how materially a very small percentage of iron in the chloride will influence the quality of the resulting metal. I may say that, exercising the utmost care as to the purity of the alumina and the charcoal used, and after having the retorts made of special fire-clay containing only a very small percentage of iron, it was found almost impossible to produce upon a large scale a chloride containing less than 0·3 per cent of iron.

This crude double chloride, as it is now called at the works, is highly deliquescent, and varies in colour from a light yellow to a dark red. The variation in colour is not so much due to the varying percentage of iron contained as to the relative proportion of ferric or ferrous chlorides present, and although a sample may be either very dark or quite light, it may still contain only a small percentage of iron if it be present as ferric salt, or a very large percentage if it is in the ferrous condition. Even when exercising all possible precautions, the average analysis of the crude double chloride shows about 0·4 per cent. of iron. The metal subsequently made from this chloride therefore never contained much less than about 5 per cent. of iron, and, as this quantity great injures the capacity of aluminium for drawing into wire, rolling, &c., the metal thus obtained required to be refined. This was successfully accomplished by Mr. Castner and his able assistant, Mr. Cullen, and for some time all the metal made was refined, the iron being lowered to about 2 per cent.

The process, however, was difficult to carry out, and required careful manipulation, but as it then seemed the only remedy for effectively removing the iron, it was adopted and carried on for some time quite successfully, until another invention of Mr. Castner rendered it totally unnecessary. This consisted in purifying the double chloride before reduction. I cannot now explain this process, but I am able to show some of the product. This purified chloride, or pure double chloride, is, as you see, quite white, and is far less deliquescent than the crude, so that it is quite reasonable to infer that this most undesirable property is greatly due to the former presence of iron chlorides. I have seen large quantities containing upwards of 1½ per cent. of iron, or 150 pounds to 10,000 of the chloride, completely purified from iron in a few minutes, so that, whilst the substance before treatment was wholly unfit for the preparation of aluminium, owing to the presence of iron, the result was, like the sample exhibited, a mass containing only 1 pound of iron in 10,000, or 0·01 per cent. The process is extremely simple, and adds little or no appreciable cost to the final product. After treatment, this pure chloride is melted in large iron pots and run into drums similar to those used for storing caustic soda. As far as I am aware, it was generally believed to be an impossibility to remove the iron from anhydrous double chloride of aluminium and sodium, and few, if any, chemists have ever seen a pure white double chloride.

Aluminium Manufacture.

I now come to the final stage of the process, viz. the reduction of the pure double chloride by sodium. This is effected, not in a tube of Bohemian glass, as shown in Mr. Barlow's lecture in 1856, but in a large reverberatory furnace, having an inclined hearth about 6 feet square, the inclination being towards the front of the furnace, through which are several openings at different heights. The pure chloride is ground together with cryolite in about the proportions of two to one, and is then carried to a staging erected above the reducing furnace. The sodium, in large slabs or blocks, is run through a machine similar to an ordinary tobacco-cutting machine, where it is cut into small thin slices; it is then also transferred to the staging above the reducing furnace.

Both materials are now thrown into a large revolving drum, when they become thoroughly mixed. The drum being opened and partially turned, the contents drop out into a car on a tramway directly below. The furnace having been raised to the desired temperature, the dampers of the furnace are all closed to prevent the access of air, the heating gas also being shut off. The car is then moved out on the roof of the furnace until it stands directly over the centre of the hearth. The furnace roof is provided with large hoppers, and through these openings the charge is introduced as quickly as possible. The reaction takes place almost immediately, and the whole charge quickly liquefies. At the end of a certain time the heating gas is again introduced and the charge kept at a moderate temperature for about two hours. At the end of this period the furnace is tapped by driving a bar through the lower opening, which has previously been stopped with a fire-clay plug, and the liquid metal run out in a silver stream into moulds placed below the opening. When the metal has all been drawn off, the slag is allowed to run out into small iron waggons and removed. The openings being again plugged up, the furnace is ready for another charge. From each charge, composed of about 1200 pounds of pure chloride, 600 pounds of cryolite, and 350 pounds of sodium, about 115 to 120 pounds of aluminium are obtained.

The purity of the metal entirely depends upon the purity of the chloride used, and without exercising more than ordinary care the metal tests usually indicate a purity of metal above 99 per cent. On the table is the metal run from a single charge, its weight is 116 pounds, and its composition, as shown by analysis, is 99·2 aluminium, 0·3 silicon, and 0·5 iron. This I believe to be the largest and the purest mass of metal ever made in one operation.

The result of eight or nine charges are laid on one side, and then melted down in the furnace to make a uniform quality, the liquid metal, after a good stirring, being drawn off into moulds. These large ingots, weighing about 60 pounds each, are sent to the casting shop, there to be melted and cast into the ordinary pigs, or other shapes, as may be required for the making of tubes, sheets, or wire, or else used directly for making alloys of either copper or iron.

The following table shows approximately the quantity of each material used in the production of one ton of aluminium:—

Metallic sodium	6,300 pounds
Double chloride	22,400 ,,
Cryolite...	8,000 ,,
Coal	8 tons.

To produce 6,300 pounds of sodium is required:—

Caustic soda	44,000 pounds
Carbide, made from pitch, 12,000 pounds, and iron turnings, 1,000 pounds	7,000 ,,
Crucible castings	2½ tons
Coal	75

For the production of 22,400 pounds double chloride is required :—

Common salt	8,000	pounds
Alumina hydrate	11,000	,,
Chlorine gas	15,000	,,
Coal	180	tons.

For the production of 15,000 pounds of chlorine gas is required :—

Hydrochloric acid	180,000	pounds
Limestone dust...	45,000	,,
Lime	30,000	,,
Loss of manganese	1,000	,,

[These figures were rendered more evident by the aid of small blocks, each cut a given size, so as to represent the relative weights of the different materials used to produce one unit of aluminium.]

It might seem, on looking over the above numbers, as if an extraordinary amount of waste occurred, and as if the production is far below that which ought to be obtained, but a study of the figures will show that this is not the case. I would wish to call attention to one item in particular, viz. fuel, it having been remarked that the consumption of coal must prevent cheap production. I think, when it is remembered that coal, such as is used at the works, costs only 4*s*. per ton, while the product is worth £2240 per ton, the cost of coal is not an item of consequence in the cost of production. The total cost of the coal to produce one ton of metal being £50, the actual cost for fuel is less than 6*d*. for every pound of aluminium produced. The ratio of cost of fuel to value of product is indeed less than is the case in making either iron or steel. In concluding my remarks as to the method of manufacture and the process in general, I do not think it is too much to expect, in view of the rapid strides already made, that, in the future, further improvements and modifications will enable aluminium to be produced and sold even at a lower price than appears at present possible.

Properties of Aluminium.

In its physical properties, aluminium widely differs from all the other metals. Its colour is a beautiful white, with a slight blue tint. The intensity of this colour becomes more apparent when the metal has been worked, or when it contains silicon or iron. The surface may be made to take a very high polish, when the blue tint of the metal becomes manifest, or it may be treated with caustic soda and then nitric acid, which will leave the metal quite white. The extensibility or malleability of aluminium is very high, ranking with gold and silver if the metal be of good quality. It may be beaten out into thin leaf quite as easily as either gold or silver, although it requires more careful annealing.

It is extremely ductile, and may be easily drawn, especial care only being required in the annealing.

The excessive sonorousness of aluminium is best shown by example [large suspended bar being struck]. Faraday has remarked, after experiments conducted in his laboratory, that the sound produced by an ingot of aluminium is not simple, and one may distinguish the two sounds by turning the vibrating ingot.

After being cast, it has about the hardness of pure silver, but may be sensibly hardened by hammering.

Its tensile strength varies between 12 and 14 tons to the inch [test sample which was shown having been broken at 13 tons or 27,000 pounds], ordinary cast iron being about 8 tons. Comparing the strength of aluminium in relation to its weight, it is equal to steel of 38 tons tensile strength. The specific gravity of cast aluminium is 2·58, but, after rolling or hammering, this figure is increased to about 2·68.

The specific gravity of aluminium being 1, copper is 3·6, nickel 3·5, silver 4, lead 4·8, gold 7·7.

The fusibility of aluminium has been variously stated as being between that of zinc and silver, or between 600° and 1000° C.

As no reliable information has ever been made public on this subject, my friend Prof. Carnelley undertook to determine it. I was aware, from information gained at the works at Oldbury, that a small increase in the percentage of contained iron materially raised its point of fusion, and it has been undoubtedly due to this cause that such wide limits are given for the melting-point. Under these circumstances two samples were forwarded for testing, of which No. 1, containing ½ per cent. of iron, had a melting-point of 700° C. No. 2, containing 5 per cent. of iron, does not melt at 700°, and only softens somewhat above that temperature, but undergoes incipient fusion at 730°.

According to Faraday, aluminium ranks very high among metallic conductors of heat and electricity, and he found that it conducted heat better than either silver or copper. The specific heat is also very high, which accounts for length of time required for an ingot of the metal to either melt or get cold after being cast.

Chemically, its properties are well worthy of study.

Air, either wet or dry, has absolutely no effect on aluminium at the ordinary temperature, but this property is only possessed by a very pure quality of metal, and the pure metal in mass undergoes only slight oxidation even at the melting-point of platinum.

Thin leaf, however, when heated in a current of oxygen, burns with a brilliant, bluish-white light. [Experiment shown.] If the metal be pure, water has no effect on it whatever, even at a red-heat. Sulphur and its compounds also are without action on it, while, under the same circumstances, nearly all metals would be discoloured with great rapidity. [Experiment shown using silver and aluminium under the same conditions.]

Dilute sulphuric acid and nitric acid, both diluted and concentrated, have no effect on it, although it may be dissolved in either hydrochloric acid or caustic alkali. Heating in an atmosphere of chlorine it burns with a vivid light, producing aluminium chloride. [Experiment shown.] In connection with the subject it may be of interest to state the true melting-point of the double chloride of aluminium and sodium, which has always been given at 170° to 180° C., but which Mr. Baker, the chemist to the works, finds lies between 125° and 130° C.

Uses of Aluminium.

Its uses, unalloyed, have heretofore been greatly restricted. This is, I believe, alone owing to its former high price, for no metal possessing the properties of aluminium could help coming into larger use if its cost were moderate. Much has been said as to the impossibility of soldering it being against its popular use, but I believe that this difficulty will now soon be overcome. The following are a few of the purposes to which it is at present put: telescope tubes, marine glasses, eye-glasses and sextants, especially on account of its lightness ; fine wire for the making of lace, embroidery, &c ; leaf in the place of silver leaf, sabre sheaths, sword handles, &c., statuettes and works of art, jewellery and delicate physical apparatus, culinary utensils, harness fittings, metallic parts of soldiers' uniforms, dental purposes, surgical instruments, reflectors (it not being tarnished by the products of combustion), photographic apparatus, aëronautical and engineering purposes, and especially for the making of alloys.

Alloys of Aluminium.

The most important alloys of aluminium are those made with copper. These alloys were first prepared by Dr. Percy, in England, and now give promise of being largely used. The alloy produced by the addition of 10 per cent. of aluminium to copper, the maximum amount that can be used to produce a satisfactory alloy, is known as aluminium bronze. Bronzes, however, are made which contain smaller amounts of aluminium, possessing in a degree the valuable properties of the 10 per cent. bronze. According to the percentage of aluminium up to 10 per cent., the colour varies from red gold to pale yellow. The 10 per cent. alloy takes a fine polish, and has the colour of jeweller's gold. The 5 per cent. alloy is not quite so hard, the colour being very similar to that of pure gold. I am indebted to Prof. Roberts Austen for a mould in which the gold at the mint is usually cast, and in this I have had prepared ingots of the 10 and 5 per cent. alloy, so that a comparison may be made of the colour of these with a gold ingot cast in the same mould, for the loan of which I have to thank Messrs. Johnson, Matthey, and Co., all of which are before you.

I have also ingots of the same size, of pure aluminium, from which an idea of the relative weights of gold and aluminium may be obtained.

To arrive at perfection in the making of these alloys, not only is it required that the aluminium used should be of good quality, but also that the copper must be of the very best obtainable. For this purpose only the best brands of Lake Superior copper should be used. Inferior brands of copper or any impurities in the alloy give poor results. The alloys all possess a good colour, polish well, keep their colour far better than all other copper alloys, are extremely malleable and ductile, can be worked either hot or cold, easily engraved, the higher grades have an elasticity exceeding steel, are easily cast into complicated objects, do not lose in remelting, and are possessed of great strength, dependent, of course, on the purity and percentage of contained aluminium. The 10 per cent. alloy, when cast, has a tensile strength of between 70,000 and 80,000 pounds per square inch, but when hammered or worked, the test exceeds 100,000 pounds. [A sample shown broke at 105,000 pounds.]

An attempt to enumerate either the present uses or the possible future commercial value of these alloys is beyond my present purpose. I may, however, remark that they are not only adapted to take the place of bronze, brass, and steel, but they so far surpass all of those metals, both physically and chemically, as to make their extended use assured. [Sheets, rods, tubes, wire, and ingots shown.]

But even a more important use of aluminium seems to be its employment in the iron industry, of which it promises shortly to become an important factor, owing to certain effects which it produces when present, even in the most minute proportions. Experiments are now being carried on at numerous iron and steel works, in England, on the Continent, and in America. The results so far attained are greatly at variance, for whilst in the majority of cases the improvements made have encouraged the continuance of the trials, in others the result has not been satisfactory. On this point I would wish to say to those who may contemplate making use of aluminium in this direction, that it would be advisable before trying their experiments to ascertain whether the aluminium alloy they may purchase actually contains any aluminium at all, for some of the so-called aluminium alloys contain little or no aluminium, and this may doubtless account for the negative results obtained. Again, others contain such varying proportions of carbon, silicon, and other impurities, as to render their use highly objectionable.

It seems to be a prevailing idea with some people, that, because aluminium is so light compared with iron, they cannot be directly alloyed, and, furthermore, that, for the same reason, alloys made by the direct melting together of the two metals would not be equal to an alloy where both metals are reduced together. Now, of course, this is not the case, and the statement has been put forward by those who were only able to make the alloys in one way.

Aluminium added to molten iron and steel lowers their melting-points, consequently increases the fluidity of the metal, and causes it to run easily into moulds and set there, without entrapping air and other gases, which serve to form blow-holes and similar imperfections. It is already used by a large number of steel founders, and seems to render the production of sound steel castings more certain and easy than is otherwise possible.

One of the most remarkable applications of the property which aluminium possesses of lowering the melting-point of iron has been made use of by Mr. Nordenfeldt in the production of castings of wrought iron.

Aluminium forms alloys with most other metals, and although each possesses peculiar properties which in the future may be utilized, at present they are but little used.

In conclusion, I beg to call your attention to the wood models on the table, one being representative of aluminium, the other aluminium bronze. The originals of these models are now in the Paris Exhibition, each weighing 1000 pounds. With regard to aluminium bronze, I cannot speak positively, but the block of pure aluminium is undoubtedly the largest casting ever made in this most wonderful metal. I have to thank the Directors of the Aluminium Company, and especially Mr. Castner, for furnishing me with the interesting series of specimens of raw and manufactured metal for illustrating my discourse.

THE PALÆONTOLOGY OF STURGEONS.[1]

THE palæontological history of the Acipenseroid fishes is at present very imperfectly known. In the existing fauna, only two families are recognizable—that of the Acipenseridæ, with series of bony dermal scutes upon the trunk, and that of Polyodontidæ, destitute of any such armour; both these occupy so low a position in the scale of organization, that considerable evidence of numerous extinct allies might naturally be expected to occur among the fossils of the older rocks. Such evidence, however, can as yet be only slightly recognized. Remains of typical members of the two existing families seem to occur as low in the Tertiary series as the Eocene formation. Pectoral spines and dermal scutes, indistinguishable from those of the living *Acipenser*, are met with in the Upper Eocene of the Hampshire Basin, and the London Clay (Lower Eocene) of the Isle of Sheppey; and Prof. E. D. Cope has described a fish (*Crossopholis*) from the Eocene Green River Shales of Wyoming, U.S.A., differing only from the typical Polyodontidæ in the possession of rudimentary scales upon the sides of the trunk.

The only Cretaceous fossils yet known, which are at all comparable with characteristic parts of the Acipenseroid skeleton, are two specimens from the English Chalk. The remains of a tail from Gravesend, in the British Museum, are most satisfactorily interpreted as belonging to a fish of this type; and the extremity of a snout from Sussex, in the Willett Collection, Brighton, seems to be more nearly paralleled by the snout of *Acipenser* than by that of any other known fish. Other fragmentary evidence of Acipenseroids in Upper Jurassic rocks will probably soon be recognized, thanks especially to the investigations of Mr. Alfred N. Leeds in the Oxford Clay of Peterborough; but the most complete and unmistakable fossils occur in the English Lower Jurassic—both in the Upper Lias of Whitby and the Lower Lias of Lyme Regis.

The gigantic Acipenseroid of Whitby was first noticed by Agassiz, under the name of *Gyrosteus mirabilis*, but it has not hitherto been scientifically investigated and described. The head seems to have been enveloped in few membrane bones, none externally ornamented or covered with ganoine; the chondrocranium is scarcely ossified; and the jaws are toothless. The opercular apparatus is incomplete, without branchiostegal rays; and the membrane bones of the pectoral arch are unornamented. There is evidence of a persistent notochord, and a few ossified ribs occur anteriorly. The upper lobe of the tail exhibits the characteristic series of large fulcra, and the trunk seems to have been naked.

Gyrosteus thus conforms to the normal Acipenseroid type as represented at the present day; but the genus of the Lower Lias, *Chondrosteus*, displays many striking differences. As pointed out especially by Dr. R. H. Traquair, these differences tend to place the fish half-way between the modern Sturgeons and the typically Palæozoic group of Palæoniscidæ. The roof of the skull exhibits definite frontal, parietal, squamosal, and supra-temporal membrane bones; in addition to the operculum and sub-operculum there are distinct branchiostegal rays; and in minor features there are several interesting resemblances to points of Palæoniscid osteology. Dr. Traquair, indeed, places the Palæoniscidæ in the "Acipenseroidei"; and it may be that, as no typical Acipenseroids of corresponding antiquity are known, the Sturgeons and Polyodons are the somewhat degenerate descendants of Palæozoic fishes upon this biological level. At the same time, it must be remembered that the Palæoniscidæ pass by several known gradations into the characteristic bony Ganoids of Mesozoic age; and if the ascertained facts of palæichthyology are already a sufficient basis for phylogenetic speculation, it thus appears that two diverging series arise from this primitive stock. In his latest classification (*American Naturalist*, 1887, p. 1018), Prof. Cope admits the origin of the later Ganoids from fishes of a Palæoniscid type; but, on the assumption that the basal cartilages (baseosts) of the pelvic fin in Palæoniscidæ were minute or absent, the Sturgeons are placed lower in the series than the latter. Under any circumstances, the relative development of a single structural feature is a slight point for the distinction of two "superorders"; and if "Podopterygia" and "Actinopterygia" are to hold separate rank, the Palæoniscidæ (so far as all positive evidence is concerned) may be as justly placed in the former as in the latter.

[1] Abstract of a Paper, by A. Smith Woodward, read before the Geologists' Association on January 4.

NITRATE OF SODA, AND THE NITRATE COUNTRY.

I.

TILL lately, nitrate of soda has only been known to the few who dealt in manures, or who were engaged in chemical manufactures; but within the last two years the British public have invested vast sums of money in the shares of Nitrate Companies, while the presence in society of live millionaires who have made their money in Tarapaca, and the strong personality of a "Nitrate King," have made "nitrates" a household word.

Deposits of nitrate of soda are known along the west coast of South America for a distance of 500 miles at least, from a little south of Taltal up to the River Camerones; and it is reported that beds have been discovered 150 miles further north, in the province of Arequipa (see Fig. 1).

The physical structure of the coast is identical throughout all that great length. Everywhere an arid range of hills 4000–6000 feet high rises abruptly out of the sea; while, behind them, a flat, waterless desert Pampa slopes gradually up for 50–100 miles to the foot of the snowy Cordillera. Nitrates are only found on this desert Pampa, but under somewhat variable conditions. On the Tamarugal Pampa—where all the great English companies have their factories—the nitrate is found exclusively on the western or seaward edge of the Pampa, on the first slopes of the coast-range; in the Noria district, on the lowest portion of a district surrounded by hills; and above Antofagasta on the sides of a dry river-bed.

The aspect of the Pampa is always essentially of the desert type. Above Iquique, the plain is sparsely covered with Tamarugal bushes; and the bold features of the Cordillera above Tarapaca form a sufficiently pleasing landscape. Inside from Antofagasta, on the desert of Atacama, there is no view of the mountains, and nothing greets the eye but a sloping plain of brown earthy sand, whose distant outlines can scarcely be distinguished through the quivering air. No cloud on the sky tempers the rays of a nearly vertical sun, blue mirage lakes tantalize the thirsty traveller, the hand can scarcely touch the scorching sand at 130°, the parched air may indicate 90°, and a light south-west wind raises whirlwinds of dust in every direction. Not a bird, nor a beast, nor a plant of the lowest type can live on these barren wastes; and yet the hidden wealth below has led to the erection of villages which contain more than 500 people, whose every necessary of life has to be brought from a great distance.

The absence of water has always been a great difficulty in the way of carrying on any industry in these deserts. Fifteen years ago, water sold on the Atacama desert for $20 the *arroba*—say 10*s*. a gallon—and a drink for a mule cost 15*s*. At Carmen Alto, in the same district, a sun condenser, with 50,000 square feet of glass, was employed to distil fresh from salt water; and though this was afterwards wrecked by a whirlwind, a smaller apparatus, on the same principle, is now working at a profit at Sierra Gorda, though the water is sold at only 30 cents. the *arroba*, or about 1½*d*. a gallon.

Fresh water is now supplied to most of the towns on the coast, and to the factories inland, by means of condensed steam. Some of the condensers can produce no less than 25 tons of good water for every ton of coal burnt in the boilers; and some are even reported to have attained an efficiency of 30 tons of water for the same amount of fuel.

More recently, schemes have been started for the water supply of the towns on the coast by pipes from springs at the foot of the mountains beyond the Pampa; and Mollerdo, Iquique, Antofagasta, and Taltal are either actually supplied with drinking-water by this means, or works are in progress for the same purpo e.

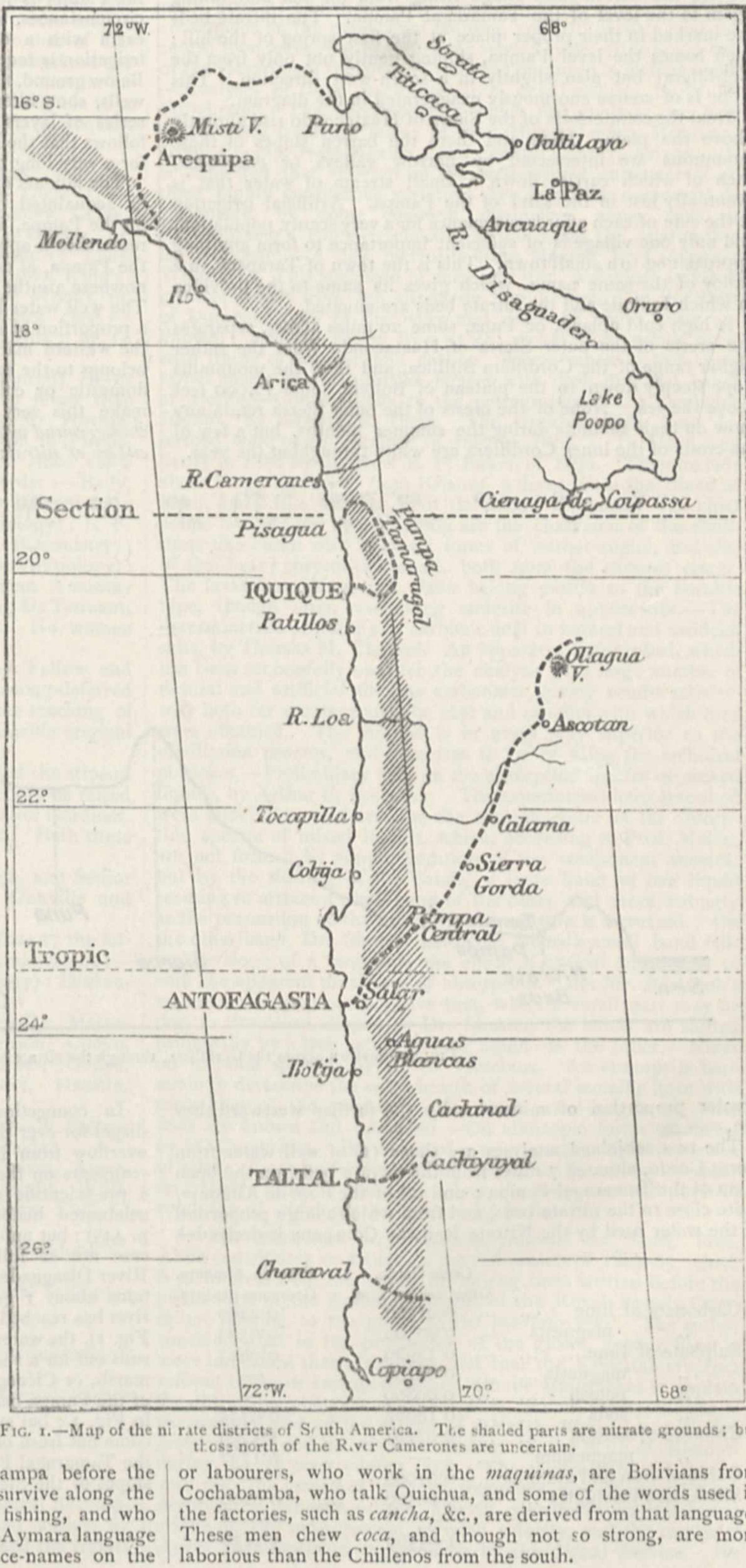


FIG. 1.—Map of the ni rate districts of S uth America. The shaded parts are nitrate grounds; but those north of the River Camerones are uncertain.

Very few Indians can have lived on the Pampa before the arrival of Europeans. A few Changos still survive along the seaward face of the coast range, who live by fishing, and who till recently had no knowledge of metals. The Aymara language is still spoken in Tarapaca, and all the place-names on the Tamarugal Pampa—such as Paccha, Jaz Pampa, Puntunchara, &c.—belong to that idiom. In the Antofagasta and Taltal districts, on the contrary, though further to the south, the place-names, such as Cachinal, &c., are Quichua, and any Indians of the Cordillera speak in that tongue. A good many of the *peons*, or labourers, who work in the *maquinas*, are Bolivians from Cochabamba, who talk Quichua, and some of the words used in the factories, such as *cancha*, &c., are derived from that language. These men chew *coca*, and though not so strong, are more laborious than the Chillenos from the south.

Passing from these generalities, we will now examine in more detail the structure and climate of the Tamarugal Pampa, between Iquique and Pisagua, in which most English people are interested. Fig. 2 is a diagrammatic section from the sea across the Cordillera, through the nitrate beds of Tarapaca. To the left we see the barren coast range rising from the sea and falling again to the level of the Tamarugal Pampa. The nitrate beds are marked in their proper place at the first spring of the hill; then comes the level Pampa, sloping gently not only from the Cordillera, but also slightly in a south-west direction. This slope is of course enormously exaggerated in the diagram.

Next the counterforts of the Sierra of Huatacondo rise abruptly above the plain. Here and there the barren slopes of these mountains are intersected by narrow valleys or *quebradas*, each of which carries down a small stream of water that is eventually lost in the sand of the Pampa. Artificial irrigation at the side of each affords sustenance for a very scanty population, and only one village is of sufficient importance to form anything approaching to a small town. This is the town of Tarapaca, in a valley of the same name, which gives its name to the province in which Iquique and the nitrate beds are situated.

A high cold upland, or Puna, some 20 miles across, separates the crests of the outer Sierra of Huatacondo from the rather higher range of the Cordillera Silillica, and then the mountains slope steeply down to the plateau of Bolivia, some 12,000 feet above the sea. None of the crests of the outer Sierra retain any snow on their summits during the summer months, but a few of the crests of the inner Cordillera are white throughout the year.

Allusion has been already made to the Tamarugal bushes which are found in places on the Pampa. These owe their existence to the floods, or *avenidas* as they are called locally, which every few years rush down from the Sierra, and run over the plain almost to the edge of the nitrate grounds. The soil of the Pampa is just what might have been expected under such circumstances, for the surface is not sharp sand, but really dry earth with a certain proportion of sandy particles, and only irrigation is required to turn the desert Pampa into a fertile plain. Below ground, numerous sections which have been made in sinking wells, show alternating layers of gravel, sand, mud, and as each series of layers represents the sequence of a single flood, it follows that the Pampa has been subject to periodical inundations for a very long period.

The labours of Signor Don Guillermo Billinghurst have made us acquainted both with the *régime* of underground waters on the Pampa, and with their chemical constitution. From his researches it appears that water is found almost anywhere under the Pampa, at depths varying from about 50 to 150 feet, but that nowhere are the conditions necessary for artesian wells fulfilled. The well water from the centre of the Pampa contains too great a proportion of salts to be considered drinkable; and that from the western margin of the plain, but not in the nitrate beds, belongs to the calcareo-magnesian class, which is totally unfit for domestic or culinary purposes. The following examples will make this very clear, and also the remarkable fact that *the underground waters of the Pampa do not contain the slightest trace either of nitrate of soda, or of iodine*, though they contain a greater proportion of mineral salts the further westward they run.

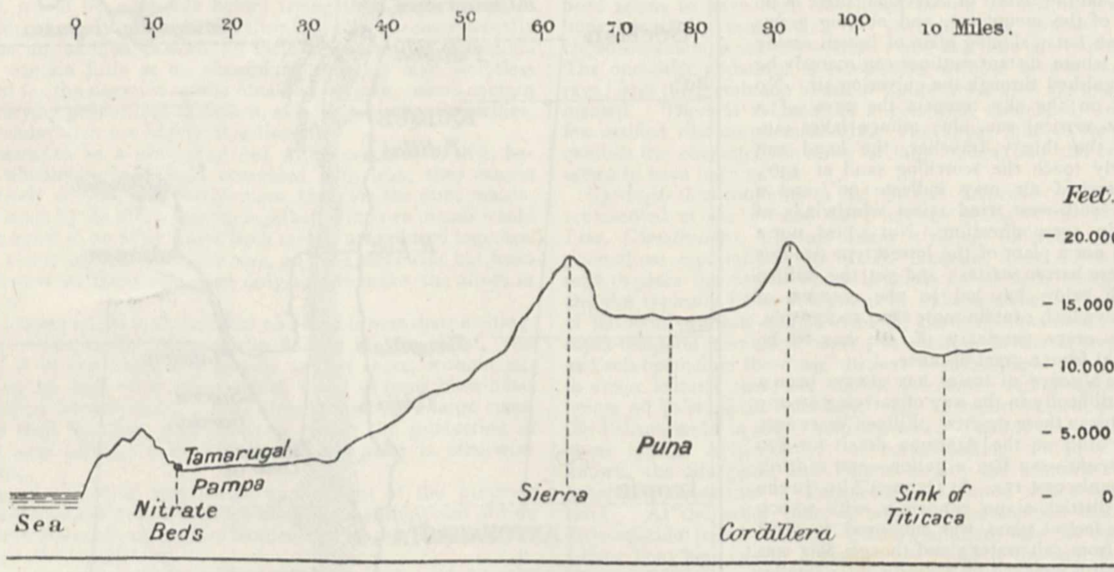


FIG. 2.—Section across the Cordillera, through the nitrate beds of Tarapaca.

The two subjoined analyses are those (1) of well water from Cerro Gordo, situated 7 miles from the nitrate beds, on the open plain of the Tamarugal Pampa; and (2) of the Pozo de Almonte, quite close to the nitrate beds, and from which a large proportion of the water used by the Nitrate Railway Company is derived—

	Cerro Gordo. Grammes per litre.	Pozo de Almonte. Grammes per litre.
Carbonate of lime	0·01500	0·2499
,, magnesia ...	0·00300	0·0323
Sulphate of lime	0·12920	0·9843
,, magnesia	0·08166	—
,, potash	0·00860	—
,, soda	0·18062	0·0735
Chloride of sodium	0·62261	1·5799
,, magnesium ...	—	0·1737
Oxide of iron and alumina ...	0·01000	—
Silica, and insolubles	0·00500	0·0200
	1·05569	3·1136

In connection with underground waters we may as well dispel for ever the fiction so commonly believed that some of the overflow from Lake Titicaca filters under the Cordillera and reappears on the Tamarugal Pampa. This idea was started in a pre-scientific age, more than 300 years ago, in 1550, by the celebrated historian Cieza de Leon ("La Cronica del Peru," p. 445); but unfortunately for such a supposition the facts of the case are as follows. The only outlet of Lake Titicaca is the River Disaguadero (Span. drain), and the water at starting contains about 1 gramme of salts in every litre. By the time the river has reached the shallow lake of Poopo or Aullagas (see map, Fig. 1), the water is so salt as to be undrinkable, and then the river runs out for a short distance till it is finally lost in the salt mud marsh, or Ciénaga de Coipasa. No doubt this marsh is due east of the Pampa near Pisagua, and is marked "Sink of Titicaca" in Fig. 1; but still it is impossible to believe that salt water can come out fresh on the other side of the Cordillera. The water of the Tamarugal Pampa must be derived from the rainfall on the slopes of the Sierra, immediately above the plain.

RALPH ABERCROMBY.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Savilian Professor of Geometry, J. J. Sylvester, will deliver, early next term, a public lecture on the sufficiency of Barbier's principle to furnish a universal and geometrical solution of a celebrated problem of chances originated by Buffon, but whose solution of it, and also that of Laplace, was limited to the two simplest cases, and involved the use of the integral calculus. The lecture will be divested as far as possible of technical terms, so as to be made intelligible to a general audience. Time and place will be stated in a subsequent notice.

CAMBRIDGE.—In the Natural Sciences Tripos, Part I., lately issued, the following men are placed in Class I. :—Beddard, Trinity; Blackman, St. John's; Bottomley, Caius; Cole, Christ's; de Havilland, Peterhouse; L. G. Glover, St. John's; Hewitt, St. John's; Lehfeldt, St. John's; Luce, Christ's; Peters, Caius; Reynolds, Trinity; Rolleston, King's; Spivey, Trinity; Thomas, Sidney; Wood, Caius; Woods, St. John's. The following women also obtained a first class:—A. I. M. Elliot, Newnham; L. Martin-Leake, Girton; M. O. Mitchell, Newnham.

In the Natural Sciences Tripos, Part II. (advanced), eleven candidates are placed in Class I. Of these no fewer than six are scholars of St. John's College, including Mr. Horton-Smith, who receives the coveted mark of distinction in Physiology. No mark of distinction has been granted since 1883. The following are the names, in alphabetical order:—Baily, St. John's (Physics); d'Albuquerque, St. John's (Chemistry); Ds Daniel, Trinity (Human Anatomy with Physiology); S. F. Dufton, Trinity (Chemistry); Elliott, Christ's (Chemistry); Groom, St. John's (Geology); Hankin, St. John's (Physiology); Horton-Smith, St. John's (Physiology and Human Anatomy with Physiology); Locke, St. John's (Physiology); Ds Tennant, Caius (Chemistry); Whetham, Trinity (Physics). No women obtained a first class in this part.

Dr. W. H. Gaskell, F.R.S., has been elected Fellow and Prælector in Natural Science of Trinity Hall. This long-deferred recognition of Dr. Gaskell's eminent services to the teaching of physiology at Cambridge, and also of his many valuable original researches, will be welcomed by all scientific men.

The General Board of Studies recommends that the stipend of Dr. Gaskell, as University Lecturer in Physiology, be raised from £50 to £150 per annum, and that of Mr. Walter Gardiner, University Lecturer in Botany, from £50 to £100. Both these gentlemen hold College Fellowships in addition.

Mr. E. G. Gallop, late Fellow of Trinity College, and Senior Wrangler, has been elected to a Fellowship at Gonville and Caius College.

At the annual election at St. John's College on June 17 the following awards were made in Mathematics and Natural Science:—

Hutchinson Studentship (for research in Physiology): Horton-Smith.

Foundation Scholarships (continued or increased): Mathematics—Flux, R. A. Sampson, Rudd, Lawrenson, Cooke, Monro, Burstall, G. T. Bennett, Dobbs, Reeves, Gedye. Natural Science—Groom, d'Albuquerque, Locke, Hankin, Baily, Horton-Smith, Hewitt.

Foundation Scholarships (awarded): Mathematics—W. Brown, Alexander, Finn. Natural Science—Lehfeldt, Woods.

Exhibitions: Mathematics—Bennett, Finn, Reeves, Ayers, Blomfield, Maw, O. W. Owen, Schmitz, Speight, Wills. Natural Science—Baily, Lehfeldt, Locke, Blackman, Cuff, L. G. Glover, MacBride.

Proper Sizarships: Mathematics—Ayers, Maw, Pickford, C. Robertson.

Wright's Prizes: Mathematics—Bennett. Natural Science—Horton-Smith, Hewitt, MacBride.

Hockin Prize (for Physics): Baily.

Herschel Prize (for Astronomy): Monro, *proxime accessit* Bruton.

Hughes Prize (for best student of third year): Natural Science—Horton-Smith.

SCIENTIFIC SERIALS.

American Journal of Science, June.—Topographical development of the Triassic formation of the Connecticut Valley, by William Morris Davis. In this paper are embodied the results of two visits paid to the region about Meriden with the Harvard Summer School of Geology in 1887 and 1888. After describing the topographical development of the Triassic belt, the author shows that the whole region was base-leveled in late Cretaceous times, and the present valleys worn in the Cretaceous base-level plain after its elevation. The Connecticut River was originally consequent on the monoclinal faulting, and still persists near the course then taken, but has entered a second cycle of life as a result of the elevation of the lowland that was produced in its first cycle.—Analyses of three descloizites from new localities, by W. F. Hillebrand. The specimens, of which full analyses are here given, came from the mines of Beaverhead County, Montana; Grant County, New Mexico; and Cochise County, Arizona. It is suggested that, in view of the well-defined character of all these highly cupriferous varieties, they might be appropriately designated by some common distinctive name, such as Rammelsberg's cupro-descloizite, as indicating the relationship to descloizite.—A new meteorite from Mexico, by J. Edward Whitfield. This specimen of meteoric iron, weighing 33 kilos, came originally from the Sierra de San Francisco in the State of Durango, date of discovery and name of finder being unknown. Analysis shows iron 91·48, nickel 7·92, cobalt 0·22, with traces of sulphur and carbon. Slices when etched show rather coarse Widmanstättian figures with dark diagonal bands of triolite.—Contributions to the petrography of the Sandwich Islands, by Edward S. Dana. The eruptive rocks here described were partly obtained in 1887 by Prof. J. D. Dana, and partly in 1888 by the Rev. E. P. Baker, of Hilo. They include about thirty specimens from Kilauea, a dozen from the island of Maui, and a like number from the island of Oahu. The chief points brought out by their study are the characters of the clinkstone-like basalt with its novel forms of feather-augite, and also of the heavy chrysolitic basalt, both from the summit crater. The lavas from Maui and Oahu belong mostly to the basaltic type, though often resembling andesite in appearance.—The determination of water and carbonic acid in natural and artificial salts, by Thomas M. Chatard. An apparatus is described, which has been successfully used for the analysis of a large number of natural and artificial alkaline carbonates, giving results satisfactory both for accuracy and the ease and rapidity with which they were obtained. The method is in every way superior to the distillation process, and promises to be of value for technical purposes.—Preliminary note on the absorption spectra of mixed liquids, by Arthur E. Bostwick. The experiments here described were undertaken to determine the true character of the absorption spectra of mixed liquids, which, according to Prof. Melde, are not formed by simple addition of the component spectra, but by the shifting of the bands, a large band of one liquid seeming to attract a small band of the other, and more strongly as the proportion of the former in the mixture is increased. On the other hand, Dr. Shuster held that where a small band falls on the slope of a large one the effect of optical addition is to shift the apparent maximum of absorption. But Mr. Bostwick's experiments apppear to prove that, while a small part may be due to the cause alleged by Dr. Shuster, the bands are shifted principally by a true action of one liquid on the other.—Notes on metallic spectra, by C. C. Hutchins. An attempt is here made to determine the wave-length of several metallic lines with something of the precision with which wave-lengths of solar lines are known and tabulated.—On allotropic forms of silver, by M. Carey Lea. By means of a new reaction (the reduction of silver citrate by ferrous citrate) the author has obtained three remarkable forms of allotropic silver, the properties and physical condition of which are here described in detail.

IN the *American Meteorological Journal* for April, Prof. Abbe contributes an article on the red sunsets of 1884–85, which is of interest from the fact of its having been written before the publication of the Krakatão Report of the Royal Society Committee relating to the glows of the previous year. The author considers that in the production of the glows, vapour haze is more important than dust haze, and that the Krakatão eruption sufficed to throw enough moisture into the atmosphere to explain the diffraction phenomena of 1883–84, without the hypothesis of the accumulation of the vapour of meteoric dust.—Lieut. Finley gives a chart and list of the tornadoes in the State of Missouri during the 75 years ending 1888. The total number of storms was 169, the month of greatest frequency was May, and none occurred in January.—Prof. Marvin contributes an interesting article on the measurement of wind velocity, and the results of recent anemometrical experiments by the Signal Service. He points out that if the equation of an anemometer, whose constants have been determined by a whirling machine, be used to reduce observations made in the open air, the computed wind velocities will be too high, by an amount which will depend upon the moment of inertia of the cups and revolving parts. Some of the experiments described were of a delicate nature, the cups being made of paper fastened to pieces of fine knitting-needles, which served as arms.—The concluding article is by Prof. R. Owen, on magnetic phenomena in the southern hemisphere, the object being to give some particulars regarding the experiments made in that hemisphere, as compared with results obtained in the northern half of the globe.

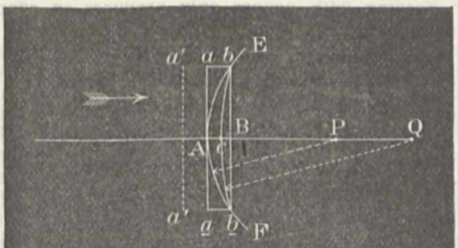
SOCIETIES AND ACADEMIES.

London.

Royal Society, June 6.—"Report on the Effects of Contact Metamorphism exhibited by the Silurian Rocks near the Town of New Galloway, in the Southern Uplands of Scotland." By S. Allport and Prof. Bonney, F.R.S.

In the neighbourhood of New Galloway a mass of granite cuts across and sends veins into a series of Silurian rocks, which are considerably altered near the junction. These, originally, were a variable series of more or less sandy rocks, such as older authors would call greywacke. The minerals resulting from the "contact-metamorphism" were enumerated: these were quartz brown mica (which, as was pointed out, must be much richer in iron than in magnesia), white mica, and iron oxides, with some hornblende, augite, garnet, and perhaps epidote. Chiastolite is absent; andalusite very inconspicuous; tourmaline very rare The point to which special attention was directed was that in several of the slides, the larger fragments which had been present in the original greywacke could still be recognized, such as clastic quartz, feldspar (often more or less converted into white mica and quartz), bits of argillite or earthy sandstone (represented by mixtures of brown mica and quartz in varying proportions). The bearing of the results of the investigation on general questions of metamorphism was indicated: (1) that heat, in presence of water, and probably under considerable pressure, had produced rocks which bore some resemblance to, but could be distinguished from, crystalline schists, such as those of known Archæan age; (2) that, while these agents of metamorphism have produced a crystalline rock from a clastic one, they have not obliterated the original structure, when this was somewhat coarse. Hence that it is safe to conclude that, at any rate in the less highly crystalline schists, the alternation of mineral constituents which so closely simulates bedding is due to an original stratification of clastic constituents.

Physical Society, June 8.—Prof. Ayrton, F.R.S., Vice-President, in the chair.—The following communications were made:—A photograph of lightning flashes was exhibited and described by Dr. Hoffert. The photograph was obtained during the storm on the 6th inst., whilst the camera was being waved about in the hand, and shows three similar and parallel flashes, thus proving that successive sparks in multiple flashes may traverse the same path and may be separated by appreciable intervals of time. The supposed primary spark is intersected by numerous tributary ones spread out on both sides, the second spark shows one tributary, and the third none. Faint bands of light pass across the plate parallel to the direction of motion, and these prove that some residual illumination exists during the intervals between the successive flashes. A dark flash is also seen on the plate. Prof. Herschel, who had taken photographs during the same storm, referred to the fluttering appearance of the flashes, and on their long duration; in many cases the time was sufficient to allow him to direct the camera towards the flash, and make a successful exposure. He had also observed multiple flashes with the unaided eye, and on waving his hand about he had sometimes noticed about a dozen distinct images of it during one discharge. Mr. Gregory said that he watched the storm along with two others, and they could seldom agree as to the shape of the flashes, or on their simple or multiple character. The want of agreement as to multiplicity he thought might be caused by their eyes being directed towards different parts of the sky when a multiple flash occurred; the one who happened to be looking towards the flash might be conscious of only one impression, whereas the others in directing their eyes would receive the flashes on different parts of the retina. In some cases as many as three distinct flashes (occurring at intervals of about ten seconds) traversed the same path, and a number of the discharges presented a beaded or striated appearance. The beads seemed to remain after the main flash had faded, and this might account for the bands shown in Dr. Hoffert's photograph. Mr. C. V. Boys, in referring to multiple flashes, said that although his statements made in the discussion of Mr. Whipple's paper on April 13 were not readily accepted, yet no one who watched the recent storm could doubt their existence. Prof. S. P. Thompson thought the order of the flashes on the photograph may have been the reverse of that supposed, for he observed that the band of light extended on both sides of the (so called) primary flash, whereas the outside of the third flash was quite dark. Mr. E. W. Smith noticed many cases of "sympathetic discharge," in which a flash in the north seemed to precipitate another in the north-west within a few seconds, and in this he was corroborated by Mr. Gregory, who viewed the storm from a different locality. Mr. C. V. Burton thought the heating of the air by the first spark of a multiple flash might give rise to the tributaries intersecting the succeeding main sparks. Mr. A. W. Ward mentioned a long flash observed at Cambridge which passed from the zenith, and struck some farm-buildings at a distance, and he was particularly impressed by the considerable time occupied in its progress.—On the methods of suppressing sparking in electro-magnets, by Prof. S. P. Thompson. The object of this paper is to classify the methods which have been suggested, and to draw attention to a novel method of some importance. The classification is as follows: (1) *Mechanical devices:* (*a*) simple snap switch; (*b*) break in magnetic field; (*c*) break under liquid; (*d*) wiping break (asbestos, &c., brushes); (*e*) blow out. *Electrical devices:* (A) use of condensers, (*a*) placed across gap, and (*b*) across terminals of magnet; (B) mutual induction protectors, (*a*) copper sheath around core, and (*b*) layers of foil between windings; (C) short-circuit working; (D) differential winding; (E) high-resistance shunt (non-inductive); (F) voltameter or liquid resistance across gap; (G) multiple wire arrangement of Mr. Langdon Davies; (H) electro-magnet with two bobbins in series or parallel. The merits and demerits of the different methods are indicated. The multiple-wire arrangement used by Mr. Langdon Davies in his harmonic telegraph consists in winding each layer separately and uniting all in parallel. The effect of this is to make the time constants of the layers different, and on breaking the circuit the energy is spent in mutual discharges.—A shunt transformer, by Mr. E. W. Smith. Two conductors, A and B, of equal impedance, are placed in series between alternate current mains, and the same mains are connected through two incandescent lamps in series. The conductor A has great resistance, and B has large self-induction, and when their junction is joined to that of the two lamps, both lamps become brighter, and the main current may be reduced. These phenomena were shown before the Society. Since A may consist of lamps and B may be a choking coil, the arrangement will serve to increase the P.D. between the terminals of the lamps without wasting much energy. Experiments of a similar nature have been made on a Mordey transformer wound with three equal coils. One coil was used as primary, and the other two as separate secondaries, their respective circuits consisting of lamps and an alternate current motor. Under these conditions the arithmetical sum of the mean secondary currents exceeded the primary current by about 14 per cent., and the secondary volts were 8 per cent. less than the primary. All these experiments strikingly illustrate the effects of acceleration and lag in alternate current circuits, and (as was pointed out by the author) show that meters registering "ampere hours" merely, may give readings differing greatly from the numbers representing the energy used.—Notes on geometrical optics: (1) on the deduction of the elementary theory of mirrors and lenses from wave principles; (2) on a diopteric spherometer; (3) on the formula of the lenticular mirror, by Prof. S. P. Thompson. Instead of deducing the formulæ for lenses and mirrors by means of "rays," and the relations between angles of incidence, reflection, and refraction, the author considers it better to derive them from the curvatures impressed on waves at the bounding surfaces of the different media. Indices of refraction are replaced by their reciprocals, which express the relative velocities of light, and curvature is measured by the camber at the middle of chords of equal, but small, lengths. An example will assist in making the method of treatment clear. Suppose a',a', a,a two successive positions of a plane wave-front in air, which impinges on a curved surface, EAF, at A, and let the curvature at A be R, and the velocity constant of the substance h. Then, whilst the part a travels in air to b, the part in the denser medium reaches C, where $AC = h \cdot ab$, and a curvature, F, represented by BC, is impressed on the wave, which thus converges to a point Q. Since $AC = h \cdot ab = h \cdot AB$, and $\frac{BC}{AB} = \frac{AB - AC}{AB}$, $\therefore \frac{BC}{AB} = 1 - h$, and the relation between the impressed curvature and that of the surface becomes $F = R(1 - h)$. By successive application of the above method, all the ordinary lens problems may be treated,



and the resulting expressions are simplified by being expressed in curvatures. The ordinary mirror formula, $f = \frac{r}{2}$, becomes $F = 2R$, and that for the lenticular mirror, $F' = 2R + F$. The method readily lends itself to the determination of the changes in the shape of wave-fronts entering or emerging from surfaces of irregular outline. The diopteric spherometer has its outer feet situated on a circle of 44·71 millimetres radius, and is provided with a screw of 1 millimetre pitch. The instrument so constructed reads off directly in "diopteries," *i.e.* curvatures expressed on a scale in which that of a sphere of 1 metre radius is taken as unity.—On the use of the biquartz, by Mr. A. W. Ward. This is a mathematical investigation into the causes of the varying degrees of accuracy obtained by different observers who have used the biquartz in rotation measurements. Assuming that elliptically polarized light passes through the biquartz, the equation which must be satisfied to give equality of tint on the two halves is shown to be: $\cos 2\gamma \cdot \sin 2\phi \cdot \sin 2\,\omega - \theta = 0$, where $\tan \gamma$ = ratio of axes of ellipse, ϕ = rotation produced by quartz for wave-length λ, θ = angle between plane of vibrations of analyzer and that of xz, the axis of z being parallel to the direction of transmission, and ω = angle between one axis of the ellipse and that of x. The equation is satisfied by either $\cos 2\gamma = 0$, or $\sin 2\phi = 0$, or $\sin \overline{2\omega - \theta} = 0$. The first solution relates to circularly polarized light, and need not be considered; the second can only hold for one particular wave-length depending on the thickness of the quartz; and, in interpreting the third solution, it is shown that a satisfactory result is only obtained when the light is plane-polarized. The deductions are in accordance with experiment, for the biquartz has been used with considerable accuracy when experimenting on isotropic media; but with doubly refracting substances, where the light is liable to become elliptically polarized, the results are very discordant.

Errata.—Page 143, lines 27 and 29, for "volumes" read "densities."

Mathematical Society, June 13.—Mr. J. J. Walker, F.R.S., President, in the chair.—The President opened the proceedings of this the last meeting of the session with commenting on the losses the mathematical world had recently sustained by the deaths of Prof. Genocchi, of Turin, Prof. Du Bois-Reymond, Berlin, and M. Halphen, of Paris.—The following communications were made:—The square of Euler's series, by Dr. Glaisher, F.R.S.; a theorem in the calculus of linear partial differential operations, by Major Macmahon, R.A.; on crystalline reflection and refraction, by A. B. Basset, F.R.S.; on some rings of circles connected with a triangle and the circles (Schoute's system) that cut them at equal angles, by W. W. Taylor; the figures of the Pippian and Quippian of a class of cubic curves, by the President (Sir J. Cockle, F.R.S., in the chair); and a generalization of Buffon's problem, by Prof. Sylvester, F.R.S., (communicated by J. Hammond).—The following papers, on the small wave-motions of a heterogeneous fluid under gravity, by Prof. W. Burnside, and on the uniform deformation in two dimensions of a cylindrical shell of finite thickness, with applications to the general theory of deformation of thin shells, by Lord Rayleigh, Sec. R.S., were taken as read.

Zoological Society, June 4.—Mr. Osbert Salvin, F.R.S., Vice-President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of May 1889.—Mr. H. E. Dresser exhibited and made remarks on some eggs of the Adriatic Black-headed Gull (*Larus melanocephalus*) and of the Slender-billed Gull (*Larus gelastes*), which had lately been obtained at their nesting-places in the marshes of Andalusia by Colonel Hanbury Barclay and himself.—Dr. G. J. Romanes, F.R.S., read a paper on the intelligence of the Chimpanzee, as shown in the course of experiments made with the female Chimpanzee called "Sally," which has been living several years in the Society's Menagerie.—A communication was read from Signor Fr. Sav. Monticelli, containing notes on some Entozoa in the collection of the British Museum.—Mr. Sclater read a list of the birds collected by Mr. George A. Ramage (the collector employed by the joint Committee of the Royal Society and the British Association for the exploration of the Lesser Antilles) in Dominica, West Indies, and made remarks upon some of the species.

Entomological Society, June 5.—The Right Hon. Lord Walsingham, F.R.S., President, in the chair.—Mr. S. Stevens exhibited a specimen of *Acrolepia assectella*, Zeller, included in a lot of *Tineidæ*, purchased by him at the sale of the late Mr. A. F. Sheppard's collection. He also exhibited, for comparison, a specimen of *A. betuletella*.—Mr. J. J. Walker, R.N., exhibited a collection of Lepidoptera made in 1887 and 1888 in the immediate vicinity of the Straits of Gibraltar. The collection included sixty-eight species of butterflies, of which thirty-six were obtained on the Rock of Gibraltar itself, and the remainder on the European side of the Straits; and about 160 species of moths.—Dr. P. B. Mason exhibited a number of specimens of a South European species of ant—*Crematogaster scutellaris*, Oliv. He said that the specimens were all taken in the fernery of Mr. Baxter, of Burton-on-Trent, and had probably been imported with cork.—Mr. O. E. Janson exhibited a pair of *Neptunides stanleyi*, a species of *Cetoniidæ*, recently received from Central Africa, and described by him in the February number of the *Entomologist*; also some varieties of *N. polychrous*, Thoms., from the Zanzibar district.—Dr. N. Manders exhibited a number of Lepidoptera collected by himself in the Shan States, Burmah; also a collection of Lepidoptera made by Captain Raikes in Kárenni.—Mr. McLachlan exhibited over 400 specimens of Neuroptera, being a portion of the collection formed in Japan by Mr. H. J. S. Pryer. They represented nearly all groups (excepting *Odonata*, now in the hands of Baron De Selys). Some of the *Ascalaphidæ*, *Panorpidæ*, and *Trichoptera*, were of great beauty.—Dr. Sharp exhibited the peculiar cocoons of an Indian moth, *Rhodia newara*, Moore; these were the cocoons possessing a drain at the bottom in order to allow water to escape, already described in the Proceedings of the Zoological Society for 1888, p. 120, where, however, their great resemblance to the pods of a plant had not been alluded to.—Mr. Enock exhibited, and made remarks on, specimens of *Cecidomyia destructor*, bred from American wheat.—Mr. W. Warren exhibited a bred specimen of *Retinia posticana*, Zett., from Newmarket; also specimens of *Eupithecia jasioneata* and *Gelechia confinis*, bred by Mr. Gardner.—Mr. C. O. Waterhouse exhibited and explained a number of diagrams illustrative of the external characters of the eyes of insects.—Mr. A. G. Butler communicated a paper entitled "Descriptions of some new Lepidoptera-Heterocera in the collection of the Hon. Walter de Rothschild." He also contributed a second paper entitled "Synonymic Notes on Moths of the earlier genera of Noctuites."—Dr. Sharp read a paper entitled "An Account of Prof. Plateau's Experiments on the Vision of Insects" Lord Walsingham, Mr. Jacoby, Mr. White, and Mr. Waterhouse took part in the discussion which ensued.

PARIS.

Academy of Sciences, June 11.—M. Des Cloizeaux, President, in the chair.—On the exceptional deviations of some tropical cyclones, by M. H. Faye. As far as 35° of latitude tropical cyclones present a remarkable regularity, with the exception that the geometrical figure described by their trajectory is deflected towards the north between 20° and 30° according to the seasons, as has been clearly determined by le Père Viñez, of the Havana Observatory. But although the laws laid down by this meteorologist appeared to be absolute, they were certainly deviated from by the tornado of September 3–4, 1888, in the West Indies, as well as by that of June 1885, in the Gulf of Aden. The disturbing cause in the first instance was attributed by Viñez to a second cyclone exercising a strong repellent action on the other, and driving it with disastrous consequences across the island of Cuba. But Mr. E. Hayden, of the United States Meteorological Bureau, rejects this explanation, and traces the disturbance to the influence that zones of high pressure appear to exercise on low pressures and especially on cyclones. M. Faye seems inclined to accept this view, if it could be shown that the action of high-pressure zones is felt in the higher atmospheric regions far above the crests of the loftiest mountain ranges.—On the value of a finite continuous and purely periodical fraction, by Prof. Sylvester. The positive root of the equation

$$[{}^{\backprime}t]x^2 - ([t] - [{}^{\backprime}t'])x - [t'] = 0$$

gives the value of the purely periodical infinite fraction (t^{∞}), where t is a type—that is, a succession—of any elements whatever. By means of a formula given in a previous communication the author here offers an easy solution for the problem : To find the value of the analogous periodical but finite continuous fraction (t_n).—Researches on the elasticity of solids, by M. E. H. Amagat. The method applied by the author to crystal, as described in a former note (*Comptes rendus*, October 15, 1888), is here employed for other substances, such as glass, steel, copper, brass, and lead, which are also treated by the Wertheim process. The tabulated results, obtained at a mean temperature of 12° C., seem to show that for metals the value of Poisson's coefficient μ increases with the coefficient of compressibility, and for the other substances with the facility with which they undergo permanent deformation. The value of μ, theoretically equal to 0·50 for fluids, would appear to increase in the scale of bodies, passing through all the intermediate states (pasty, viscous, &c., and consequently for the same body passing through these various states), and approaching 0·25 according as the bodies become more and more refractory to permanent deformations —that is, more perfectly elastic. Glass approaches nearest to this theoretic condition, the next in order being steel, copper, and lead, while caoutchouc occupies the opposite extremity of the scale. Hence the perfect solid, for which the value of μ would be 0·25, should realize the double condition of being at once perfectly elastic and perfectly isotropic.—On the solubility of saccharose in distilled water, by M. Léon Périer. After the disastrous vintages of 1888 in the Gironde district, various growers attempted to substitute for the ordinary wines a drink prepared from grape-cake and sugar refermented. M. Périer here describes the results of the examination he has made of numerous specimens of these liquids submitted to his inspection. —Erosions due to wind action, by M. Contejean. During a recent visit to Corinth the author observed a remarkable instance of this phenomenon on the neighbouring plateau, where an old amphitheatre some fifteen metres from the edge of the escarpment communicates with the beach through a cavern with wide opening at both ends, and above which the limestone rock forms a natural bridge. The walls of this cavern, which is formed in the sandstone stratum at the foot of the cliff, are extremely rugged and irregularly corroded, nowhere showing traces of human workmanship. The tunnel could not possibly have been excavated either by the rains or the running waters, and its existence can be explained only by the action of the sands playing on a point of least resistance under the influence of the fierce northern gales prevalent in this region.—On the rectification of alcohol, by M. E. Sorel. In continuation of his previous communication on this subject (*Comptes rendus*, May 27, 1889), the author here shows how the theoretical data may be verified, and indicates the practical conclusions that may be drawn from them. —Some documents were submitted to the Academy by le Père Denza, on the recent earthquakes in the north-west of France, slight vibrations of which were also felt in Genoa, Sinigaglia, Sienna, and other parts of Italy. At the Observatory of Moncalieri the seismic instruments showed some indications of the underground disturbances.

BERLIN.

Physiological Society, May 31.—Prof. du Bois-Reymond, President, in the chair.—Dr. Nitze described and demonstrated his apparatus for observing and examining the interior of the urinary bladder. The apparatus, called a cystoscope, consists of a small incandescent electrical lamp, a prism, and a small ocular and objective, the whole arranged in the form of a catheter. Before making an observation the bladder is washed out with water, the instrument is then introduced, and the terminals of the electric lamp are connected with a battery. While intended in the first instance to facilitate the ocular inspection of pathological conditions of the bladder, this instrument also makes it possible to observe various physiological functions, such as the periodic extrusion of small quantities of urine from the mouths of the ureters, and the peristaltic movements of the ureters themselves. The applicability of the method was demonstrated on two patients.—Starting with the observed fact that canaries fed with cayenne pepper acquire a ruddy plumage, Dr. Sauermann has based upon it a scientific investigation of canaries, fowls, pigeons, and other birds. From these he has obtained the following results. Feeding with pepper only produces an effect when given to young birds before they moult; the colour of the feathers of older birds cannot be affected. Moisture facilitates the change of colour to a ruddy hue, which is again discharged under the influence of sunlight and cold. A portion of the constituents of cayenne pepper is quite inactive, as for instance piperin and several extractives: similarly the red colouring-matter alone of the pepper has no effect on the colour of the feathers. It is rather the triolein, which occurs in the pepper in large quantities, together with the characteristic pigment, which brings about the change of colour by holding the red pigment of the pepper in solution. Glycerin may be used instead of triolein to bring about the same result. The same statement holds good with regard to the feeding of birds with aniline colours. The red pigment of the pepper is also stored up in the egg-yolk as well as in the feathers. The first appearance of the pigment in the yolk may be observed as a coloured ring four days after the commencement of feeding with the pigment dissolved in fat; after a further two days' feeding the whole yolk is coloured. Dr. Sauermann is still engaged in carrying on his researches.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

The Flora of Switzerland for the Use of Tourists and Field Botanists: A. Gremli; translated by S. W. Paitson (Nutt).—Commercial Organic Analysis, vol. iii. Part 1, 2nd edition: A. H. Allen (Churchill).—Morocco: H. M. P. De la Martinière (Whittaker).—Woolwich Mathematical Papers for the Years 1880-88, edited by E. J. Brooksmith (Macmillan).—Physiological Diagrams for Use in Schools; also Index: G. Davies (W. and A. K. Johnston).—Days with Industrials: A. H. Japp (Trübner).—New Verse in Old Vesture: J. C. Grant (E. W. Allen).—Catalogue of the Fossil Reptilia and Amphibia in the British Museum (Natural History), Part 2: R. Lydekker (London).—Climatology of New Jersey (Trenton, N.J.).—Bulletin of the United States National Museum, No. 33: T. Egleston (Washington).

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