THURSDAY, DECEMBER 20, 1883

MERRIFIELD'S "TREATISE ON NAVIGATION"

A Treatise on Navigation for the Use of Students. By John Merrifield, LL.D., F.R.A.S., F.M.S. (London: Longman and Co., 1883.)

THE author of this volume having been engaged for many years in preparing candidates for the different examinations into which navigation enters, has felt the want of a text-book embracing all that the different examining boards embody under that head, and has endeavoured, and we think successfully, to supply that want by the present treatise.

The work, although entitled "A Treatise on Navigation," deals only with one part, viz. that particularly relating to what is generally known under the name of dead reckoning, and does not touch on astronomical observation, which we presume Mr. Merrifield classes under the head of nautical astronomy, but which is really the most important part of navigation. The title therefore is somewhat misleading. Neither do we agree with the author's definition of theoretical and practical navigation; what Mr. Merrifield terms practical navigation, viz. the management of the ship, making and shortening sail, steering, &c., is usually known as seamanship. The theory of navigation is surely the proving that by the application of certain problems the particular position occupied by a vessel can be accurately ascertained; whilst the practice is the actually finding the ship's place by means of the instruments necessary to give the data required by the theory.

But although some small points in the work may be selected which may perhaps offend the practical navigator confident in his own ability, and consequently too much inclined to look down on the instructions of schoolmen, to whom he is far more indebted than he is generally disposed to admit, to the student this work will be found most useful: the chapters are well arranged, the exercises at the end of each chapter are pertinent to the preceding text, and require him to digest the text in order to answer them satisfactorily. We propose, however, to offer some remarks and suggest some additions which the author may perhaps consider should another edition of his work be required.

In the description of the compass one type only has been selected—that in use in the mercantile marine. No account is given of the instruments used in the navy or of Sir William Thomson's invention. This is certainly a defect in the work, as if one instrument can be considered as of more importance than another, in the navigation of a vessel, it is the compass. Without it, notwithstanding all the other improvements which have taken place in navigation, we should be in much the same position as the seamen of old, who were afraid to venture out of sight of land. In fact we have always thought that the education of naval men so far as regards the compass, and magnetism generally, has been very much neglected, and its vast importance has hitherto not received that attention, in treatises on navigation, it deserves. Mr. Merrifield has made a great stride in advance, as he treats, in his ninth chapter, of the coefficients and the means of correcting the compass for the local attraction of the ship. This is a subject of great importance in the present day; all navigators should be able to adjust their own compasses, and should have the means of doing so at their disposal, as a compass might be disabled in any vessel, and in war-ships, particularly, a general action might cause the loss of the correcting magnets of every vessel in the squadron, when, unless some officer on board could replace them, and correct the compasses, the fleet might be placed in a most critical position, more especially in thick weather or when entangled amongst shoals. We doubt if the latter contingency has yet excited any attention, yet its importance will be at once seen if we suppose that one ship only in a squadron has had her compass disabled in action and that subsequently thick weather prevails. Such a ship endeavouring to obey the signals of the admiral might either fall into the enemy's hands or by fouling vessels in her own squadron temporarily render them unfit to renew the engagement.

Whilst considering this contingency, it might perhaps be as well to draw attention to the fact that, in addition to our ironclads, many large steam-vessels are now fitted with sirens in place of the ordinary steam-whistle. It would therefore seem expedient that some definite means should be enforced to prevent their signals being mistaken for the sirens sounded in foggy weather from lighthouses and lightships.

In describing the mode of correcting the compass for the effect of local attraction no notice is taken of the method of doing so by a single magnet—often adopted in the navy. We are, however, glad to see that Mr. Merrifield refers the student to the works of Sir George Airy and Sir Frederick Evans, to both of whom sailors owe a debt of gratitude. That we are able to navigate our large iron ships and armour-plated vessels with the same facility as the old wooden ships of the past is due almost entirely to their labours, combined with those of the late Archibald Smith, F.R.S.

In the chapters on the various methods of finding the position of a ship by dead reckoning, known as the "sailings," we do not find much improvement on the works of the older writers except in one particular—Mercator's sailing. This, which is the most accurate method of dead reckoning, is treated of in a separate chapter, and the formula for calculating the meridional parts for the spheroid, as well as the sphere, is now for the first time published in "A Treatise on Navigation," the only work of the sort in which we remember to have seen it before being Galbraith's "Surveying." It is true that Riddle, in a note, refers the student to Gauss's paper, published in the *Philosophical Magazine* for 1828, and Mendoza y Rios, in his tables, gives the meridional parts for the spheroid as well as the sphere, but does not say what compression he used in the calculation: Mr. Merrifield, however, seems to be the first to give the subject that prominence in "A Treatise on Navigation" we think it deserves, more especially now when the steamers running from England to the United States are reaching the extraordinary rate of 450 miles a day, and it is no unusual thing to be two or three days without obtaining astronomical observations. It therefore becomes

necessary to use the most rigorous means to calculate the position by dead reckoning, so that the errors of steering, &c., may not be augmented by errors in calculation. Such being the case, we regret that Mr. Merrifield has omitted from the chapter on traverse sailing the warning given in Raper that, especially in high latitudes, the differences of longitude should be found on each course, instead of the departures being lumped and the difference of longitude found from the result.

In the chapter on soundings and tides (No. 10), Mr. Merrifield has published the system of the late Sir Francis Beaufort for ascertaining the height of the tide at any moment provided we know the range and time of high water. This is the method generally adopted by surveyors when circumstances prevent their having a tide pole on shore, and is traditionally known amongst them, though not hitherto published. It is fairly accurate when the diurnal inequality is inconsiderable, and we can recommend it as being sufficient for all practical purposes in finding the depth of water to be added to the soundings on the chart in places like the Bristol and Irish Channels, where it is necessary, owing to the large ranges, to take the state of the tide into consideration in judging the position by soundings in foggy weather, or in calculating when a bank or flat can be safely crossed. The fact that in rivers or harbours certain winds affect the height and that atmospheric pressure also has an influence over tides may be safely ignored in the open sea, as their combined influence would probably never exceed half a fathom, but a range of from three to five fathoms can never be lightly considered by the careful navigator.

OUR BOOK SHELF

Farm Insects. Being the Natural History and Economy of Insects Injurious to Field Crops, and also those which Infest Barns and Granaries, with Suggestions for their Destruction. By John Curtis, F.L.S. Pp. 540, with 16 Coloured Plates, Royal 8vo. (London: John Van Voorst, 1883.)

THIS is simply a reissue of Curtis's classical work; it had long been "out of print" in booksellers' phraseology. It remains the best book on economic entomology that has appeared in this country, and has certainly served as a model for the Reports of various State entomologists on the other side of the Atlantic. No other author here has gone into the question of special injurious insects with the same care and minuteness, and it may be said that (with the exception of certain Reports issued in America) there is no similar collective work faithfully illustrated by the author's own pencil. The plates and woodcuts are in Curtis's best style, and if he had been an entomological *artist* only, his work would have remained unsurpassed.

Opinions may be divided as to the desirability of reissuing such a work "untouched," when so many years have elapsed since the publication of the chapters in the *Proceedings of the Royal Agricultural Society* that formed its basis. Much and valuable additional information has been obtained since the original articles were written, and very much alteration in nomenclature has resulted from the efforts of systematists to place this branch of entomological science on a sounder footing, but the facts remain practically unaltered, and there is the charm of a certain originality in the author's style that any radical reconstruction might have destroyed.

Nevertheless we do think it a pity that some one could not have been found with sufficient knowledge and courage to re-edit the book and bring it down to date. On the other hand, this process might have resulted in the work being no longer "Curtis's Farm Insects." Its value would be destroyed if rewritten, even by the most experienced, and we think the only practicable method of dealing with it in an absolutely new *edition* would be by means of copious annotations, not by recasting the whole.

LETTERS TO THE EDITOR

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

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

Evolution of the Cetacea

I AM glad to be able to assure Mr. Searles Wood that I have long been familiar with the specimen called *Palæocetus sedgwicki*, preserved in the Woodwardian Museum at Cambridge, and have repeatedly examined it with much interest. It is undoubtedly Cetacean, and allied to the genus *Balænoptera*, as Mr. Seeley demonstrated, though differing in smaller size and some other characters from any existing species. As, however, the light it throws upon the evolution of the Cetacea is very small compared to the time that would have been taken up in discussing its bearings, I did not think it worth while to allude to it in a lecture of which the length was necessarily limited. It is, after all, a most unsatisfactory fragment, as its geological age is, and probably always will remain, a matter of doubt. Allowing, however, the utmost antiquity assigned to it, my argument would rather be strengthened than weakened. Mr. Searles Wood seems to have missed the fact that my chief contention was against the prevalent view that the Cetacea have been derived from the Carnivora through the Seals. Any evidence which throws back their origin in time and derives them from some more generalised type of mammals would militate against this view. No one can suppose that the Ungulata originated at the commencement of the Tertiary period, as we know that they were then already differentiated into great and distinct sections. Their primitive ancestry must therefore be looked for far back in Mesozoic times. That I thought the Cetacea existed before the Tertiary period I distinctly intimated by suggesting, as an explanation of the absence of their remains in the chalk, that they might then have been inhabitants of great inland waters, but having had so many warnings of the fallacy of negative evidence in geology, I do not yet despair of the discovery of a veritable Cretaceous whale. W. H. FLOWER

The Java Eruption

I HAVE been greatly interested in your note on M. Renard's researches as to the composition of the volcanic material ejected during the recent eruption of Krakatoa. The ashes, as stated, are those of a magma that would have produced an andesite with rhombic pyroxene. Now such an andesite occurs at so many points, and in such immense masses, round the great Pacific "circle of fire," that one is tempted to ask if it may not specially characterise this important volcanic region. I will, with your permission, briefly refer to some published, and one or two unpublished, facts with regard to the distribution of this andesite (called hypersthene-andesite by Whitman Cross and Iddings, and bronzite-andesite by F. Becke) round the Pacific circle.

In the *Neues Jahrbuch* for 1881 (*Beilage Band* 1881, 467) Dr. Oebbeke describes, under the term augite-andesite, a rock from the Sierra de Mariveles, Luzon. Owing to the kindness of the author, I have a section of this rock before me as I write, and I have little doubt that the strongly pleochroic mineral is mainly, if not entirely, a rhombic pyroxene. Augite, however, is also present.

Passing to the other side of the Atlantic, we have recent evidence to show that a rock of the same type occurs along the line of the Rocky Mountains and the Andes.

In *Bulletin No.* 1 *of the U.S. Geological Survey* (1883), Mr. Whitman Cross describes a hypersthene-andesite from Buffalo Peaks, Mosquito Range, Colorado.

In the *American Journal of Science* for September, 1883, Messrs. Hague and Iddings prove that the four great volcanic peaks of Mount Rainvier, Mount Hood, Mount Shasta, and Lassen's Peak, rising to heights of from 10,500 to 14,444 feet above sea-level in California, Washington Territory, and Oregon, are mainly composed of andesitic lavas and tuffs, in which hypersthene is the predominating bisilicate.

In the *Geological Magazine* for July, 1883, Mr. Waller describes a similar rock from Montserrat, and I have just analysed one for Prof. Bonney from Old Providence Island in the Caribbean Sea. Prof. Bonney also informs me that he has found the rhombic pyroxene in the andesites brought by Mr. Whymper from Pichincha and Antisina.

It must not, however, be supposed that the rock is limited either to the Pacific region or to the Tertiary and Recent periods.

M. Fouque has shown that hypersthene occurs in the Santorin lava of 1866.

Niedzwiedski described a hypersthene-andesite from Steiermark in 1872. Mr. Whitman Cross and myself have recognised the rhombic pyroxene in many well known Hungarian rocks, in which it had previously been regarded as augite. Lastly, thanks to kind assistance rendered by Prof. Rosenbusch, I have been enabled to show that some Palæozoic lavas and tuffs of the Cheviot region are of essentially the same type (*Geol. Mag.*, March, June, and August, 1883). J. J. HARRIS TEALL

12, Cumberland Road, Kew

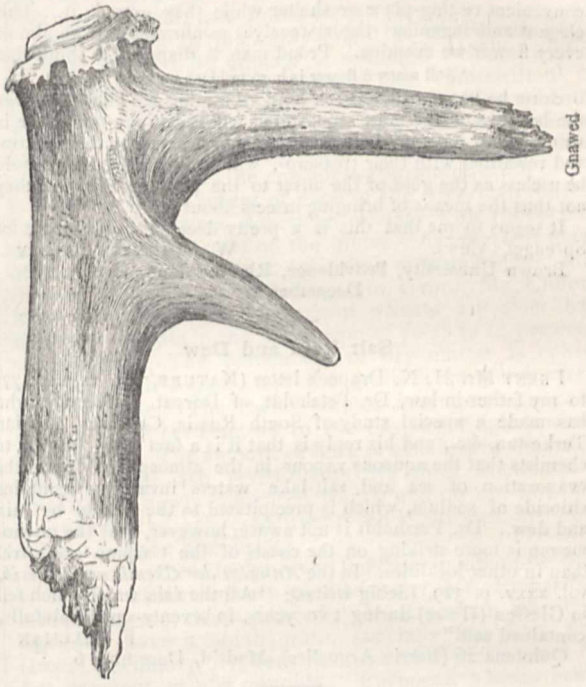
Diffusion of Scientific Memoirs

PROF. TAIT'S admirable remarks on the moral obligation laid upon "every society whose memoirs are worthy of appearing in print" to disseminate its publications must have awakened a cordial response in the minds of many whose lot is cast in some provincial city or outlying local college. It is only too true that the volumes of the *Cambridge Philosophical Transactions* are "almost inaccessible" to many like myself, who often find themselves tantalised by the desire of consulting some of the classical masterpieces of research or analysis therein enshrined, which, therefore, are not to be consulted without a pilgrimage to Cambridge or to London. Yet I hardly understand why Prof. Tait should—save for the occasion of reviewing the happily exhumed memoirs of Prof. Stokes—have chosen the *Cambridge Transactions* as the one instance of "inaccessibility," since it is at least equally to be regretted that a memoir published in the *Transactions of the Royal Society of Edinburgh*—and there are masterpieces of research and analysis by the score irrevocably buried therein—equally necessitates a pilgrimage on the part of the provincial reader. I, for one, shall be extremely glad if Prof. Tait will act upon his own prescription—that simple, easy cure—and consider himself "bound to disseminate as widely as possible" the memoirs which he has himself consigned to those very inaccessible *Transactions*. I doubt, indeed, if even Prof. Tait has realised the difficulty besetting a would-be reader of original memoirs and researches, who is compelled to journey from one shore of England to the other in order to consult the *Edinburgh Transactions*, the *Cambridge Transactions*, the *Comptes Rendus*, the volumes of *Poggendorff's Annalen*, or those of the *Annales de Chémie et de Physique*, or the memoirs of any one of the five great Academies of the European Continent. SILVANUS P. THOMPSON

University College, Bristol, December 14

Deer and their Horns

THE question is often asked, What becomes of the horns shed every year in the deer forests? the number picked up or found hardly accounts for all those which have been shed. It is said that the deer themselves eat them. It is difficult to conceive how a deer, with its toothless upper jaw, can eat a hard bone—for such is a shed horn—but it seems probable, nevertheless, that they do so. I picked up a horn recently in the deer forest at Dunrobin which appears to show that it has been in great part eaten away; and this, I think, was the opinion of the members of the Zoological Society to whom I exhibited it last Monday. On inquiry from the head-keeper at Dunrobin, Mr. James Inglis, I find that it is the general belief that the deer do eat the shed horns, whilst the appearance of the specimen here referred to, confirms the popular belief. The marks on it are such as would be made by the broad incisors of the lower jaw, and the appearance generally suggests that the horn has been gnawed and mumbled by the cutting teeth of the lower and the toothless gums of the upper jaw. It would appear, therefore, I think, that deer do eat some at least of the shed horns, and this



Red deer's horn, eaten (by other deer?), picked up in deer forest, Sutherland, 1883. A young stag's horn.

is rendered the more probable by the fact, according to Mr. Inglis, that there are no foxes or other animals in this particular forest to account for the mischief. J. FAYRER

December 8

"I BEG leave to inform you that I am unable to say from personal knowledge whether it is the stags or hinds that eat the shed horns in the forest. I have never seen either eating horns, but I have no doubt they do so, probably both stags and hinds.

"I have never known dogs to eat deer-horns, and we have no foxes in our forest, and very rarely any dogs are to be seen in it; 'even although they should eat them,' the number of pieces we find all the year round, nearly all partially eaten, leaves no room to doubt that no other animal could have eaten them. I think they commonly eat them after they have been lying exposed to the weather for some time; the horns are then softer from exposure.

"In every case that I have seen, they commence at the top or point of the horn, and eat down towards the root or burr; the latter part is often left uneaten. As soon as I can collect a few specimens I will send them to you.

"We often find horns entire without any marks of teeth on them, but those are mostly not long shed. I have also got horns that had apparently lain for years without any marks on them. But of course no one would expect all the shed horns to be eaten.

"I am sorry that I cannot give you more information, and I am also sorry that as yet I have not been able to collect more information than I know myself, but when I have any fresh evidence I will let you know. "JAMES INGLIS

"November 18"

Sprengel on the Fertilisation of Flowers

IN NATURE, vol. xxix. p. 29, is a letter from Prof. Hagen of Cambridge, Mass., calling attention to the fact that Sprengel's treatise on the structure and fertilisation of flowers was not unappreciated in his own day. Now it so happened that only a week or two before reading this I took up by chance the "Introduction to Physiological and Systematical Botany," by Sir James Edward Smith, the American edition, dated 1814. On p. 208 the author says :—

"Sprengel has ingeniously demonstrated, in some hundreds of instances, how the corolla serves as an attraction to insects, indicating by various marks, sometimes perhaps by its scent, where they may find honey, and accommodating them with a convenient resting-place or shelter while they extract it. This elegant and ingenious theory receives confirmation from almost every flower we examine. Proud man is disposed to think that

'Full many a flower is born to blush unseen,'

because he has not deigned to explore it; but we find that even the beauties of the most sequestered wilderness are not made in vain. They have myriads of admirers, attracted by their charms and rewarded with their treasures, which very treasures would be useless as the gold of the miser to the plant itself, were they not thus the means of bringing insects about it."

It seems to me that this is a pretty decided indorsement of Sprengel's views. W. WHITMAN BAILEY

Brown University, Providence, Rhode Island, U.S.A., December 4

Salt Rain and Dew

I SENT Mr. H. N. Draper's letter (NATURE, vol. xxix. p. 77) to my father-in-law, Dr. Petzholdt, of Dorpat University, who has made a special study of South Russia, Caucasus, Russian Turkestan, &c., and his reply is that it is a fact long known to chemists that the aqueous vapour in the atmosphere due to the evaporation of sea and salt-lake waters invariably contains chloride of sodium, which is precipitated to the ground by rain and dew. Dr. Petzholdt is not aware, however, that the phenomenon is more striking on the coasts of the Caspian and Aral than in other localities. In the *Annalen der Chemie und Physik*, vol. xxxv. p. 329, Liebig writes: "All the rain water which fell in Giessen (Hesse) during two years, in seventy-seven rainfalls, contained salt." F. GILLMAN

Quintana 26 (Barrio Arguelles), Madrid, December 6

Lunar Rainbow

ABOUT 6.20 this evening I was fortunate enough to observe a fine lunar rainbow. Previous to its appearance there was a halo caused by a band of cirro-strati, which gradually developed into a crescent-shaped rainbow, which, after disappearing for a minute or two, again was observed, only circular, finally fading away as the clouds dispersed about 6.40. C. H. ROMANES

Beckenham, Kent, December 11

AT 1.30 on the morning of the 12th inst., during the progress of the storm, I looked out of the window in a north-easterly direction and observed a beautiful lunar rainbow. The arc at first was complete, and faint traces of prismatic colours, especially on the outside, were noticeable. A portion in the middle having for a moment disappeared, the complete arc again again became visible, but with only a whitish colour. M. F. DUNLOP

Greenwich, December 15

PROFESSOR NILSSON

THE oldest naturalist in the world, as respects both age and the priority of his writings, has now left it. S. Nilsson of Lund, in Sweden, was born in 1787, and therefore was nearly a centenarian at the time of his death. His earliest publication was in 1812, being a paper on the various methods of classifying the Mammalia; and in every subsequent year he enriched the scientific literature of his own and other countries. The *Annals and Magazine of Natural History* and the Reports of the British Association for the Advancement of Science, for instance, contained several articles from his experienced pen. He especially devoted himself to the fauna of Scandinavia, and became the pioneer of that host of naturalists who have so ably distinguished themselves by similar researches and publications. He was a zoologist, palæontologist, anthropologist, ethnologist, and antiquary. *Nihil tetigit quod non ornavit.*

His works consisted chiefly of scattered papers; but in 1822 he published his "Historia Molluscorum Sueciæ Terrestrium et Fluviatilium," which has still a standard reputation. As it did not include the marine or Baltic Mollusca, the gap was twenty-four years afterwards more than filled up by the eminent Prof. Lovén; and that department of the Scandinavian fauna has now, through the continual labours of the late Prof. Sars and his no less eminent son, Dr. Danielssen, Mr. Herman Friele, the Fraulein Esmark, Dr. Westerlund, the late Mr. Malm and his son, Prof. Steenstrup, the late Dr. Mörch, Dr. Berg, Dr. Collin, and many other conchologists, received as great a degree of attention as has been bestowed on any region of the earth's surface and its circumjacent seas.

The subject of this memoir was, at the last-mentioned date (1822), Regius Professor in the Academy of Lund, and the Director of the Museum of Natural History there. One of his former pupils, Prof. Otto Torell, is well known to all naturalists by his exploration of Spitzbergen, and his present position as the Director of the Geological Survey of India.

We ought to be thankful in recollecting that other veterans of science are still among us, viz. Professors Owen and Milne-Edwards at the age of eighty-three, and Dr. Isaac Lea, in his ninety-third year. The study of natural history is evidently conducive to longevity.

J. GWYN JEFFREYS

SEMITICO-OCEANIC LINGUISTIC AFFINITIES

TO the *Transactions of the Royal Society of Victoria* for May, 1883, the Rev. D. Macdonald contributes a paper, in which he endeavours to establish the identity of the Oceanic and Semitic languages. This is announced as an important discovery both ethnologically and from the theological standpoint. It clears up, we are told, "the hitherto impenetrable mystery surrounding the origin of the Oceanians," because "the Semitic language could only have been carried into Oceania by Semites from the Semitic mainland." It also disposes of the new-fangled "evolution theory," which draws support "from the existence of savages and the supposition that they are descended from 'hairy quadrupeds,' . . . for it shows, as to one of the greatest bodies of savages, that they are descended from the most renowned and civilised people of antiquity." Certainly these are weighty conclusions, which, if established, would fully justify the further inference that "this discovery is more important on the whole than that of the Assyrian or Euphratean inscriptions deciphered of late with such marvellous ingenuity."

By "Oceanic" the writer understands all the languages except the Australian current in the Indo-Pacific insular world. These he evidently regards as constituting a single linguistic family, the Malayo-Polynesian, "comprising the Malagasy, Malayan, Polynesian, and Melanesian, better called the Papuan." His philology has thus not got beyond the days of Forster and Marsden, or the earlier writings of Prof. Whitney, all of whom are appealed to in support of this now exploded theory. The readers of NATURE need scarcely be reminded that from the Malayo-Polynesian must henceforth be detached all the strictly Papuan and Melanesian tongues, as constituting a fundamentally distinct order of speech, itself doubtless embracing many stock languages. Hence the same reasoning process that establishes the identity of Semitic and Oceanic would also establish the identity of Semitic with any other stock languages wherever spoken. The process thus proves too much, that is, proves nothing.

Although Semitic is here compared generally with the whole of the heterogeneous "Oceanic" group, it is remarkable that Efatese is taken as the chief point of comparison, not that this is claimed to be a typical member of the Oceanic group, but merely because it happens to be the dialect with which the writer is most familiar. Now in Efate, a small island about the centre of the New Hebrides, there is a good deal of linguistic confusion, strictly Polynesian (Sawaiori) dialects being

spoken at the Polynesian settlements of Mel and Fil, while Melanesian idioms prevail elsewhere. But from the examples adduced, and especially from such agglutinating forms as *mitángu*, *mitáma*, *mitána* = my, your, his, eye (*máta* = eye), it is obvious that the Efatese in question is not an Oceanic (Malayo-Polynesian) dialect at all, but a strictly Melanesian tongue affected by Oceanic influences. The language on which the author mainly relies is consequently useless as a point of comparison between the Semitic and Malayo-Polynesian families.

The actual relation between these two families is again stated to be "that of an ancient to a modern language, as Latin to French, Saxon to English. This implies that we shall find the Oceanic, as compared with the Semitic, characterised by phonetic and grammatical decay, &c." Doubtless there is in Oceanic, as in all linguistic groups, abundant evidence of decay. But, as compared with the Semitic, it must be regarded not as a modern, but as an almost infantile, form of speech. Semitic stands in some respects on a level with, if not even on a higher footing than, Aryan itself, as regards its grammatical evolution, whereas in Malayo-Polynesian the verb is not yet clearly differentiated from the noun. Thus even in Samoan most of the so-called verbs are merely nouns modified by detached relational particles, and, like the adjectives, forming reduplicate plurals. Compare *nofo* = to sit, pl. *nonofo*, with *tele* = great, pl. *tetele*. This instance alone will satisfy the ordinary linguistic student of the prodigious gulf that separates the Oceanic from the Semitic with its highly complicated system of verbal conjugation.

And how does the writer propose to bridge over this gulf? Mainly by a string of words taken without method from any given Oceanic language, and compared with any member of the Semitic group to which it may happen to bear some faint resemblance in sound if not in sense. No attempt is of course made to establish some general preliminary system of "lautverschiebung," without which all such comparisons are absolutely destitute of any scientific value. They resolve themselves mainly into onomatopœic forms, the common property of all articulate speech, or into some of those numerous etymological curiosities which can always be found by the diligent seeker, but which are such terrible pitfalls for the unwary.

Most of the Hebrew terms themselves are moreover taken either in secondary and later forms, or else in secondary and later meanings, forms and meanings which are consequently useless for the purpose of comparison between the *organic* Semitic and Oceanic languages. Thus the Efate *mitaku* = to fear, is compared with the Hebrew *dag*. But this *dag*, or rather *dāag* (דָּאַג, Jer. xvii. 8), is a comparatively modern form of an older *dāab* (דָּאַב), which primarily means *to melt*, and which neither in sense nor sound shows any further resemblance with the Melanesian *mitaku*. This is only one instance from among many. The further back these supposed parallelisms are traced, the more divergent become the lines, until at last they fade away into parabolic curves, and leave the gulf between these linguistic systems more impassable than ever.

Mr. Macdonald does not expressly mention the "lost tribes." But it is on these flimsy grounds that, in a slightly incoherent concluding sentence, he claims to have rediscovered in the South Seas a lost Semitic people, "their language full-orbed and in all its living vigour"!

A. H. KEANE

AMERICAN WHEAT[1]

THIS is a pamphlet issued by the Chemical Division of the Department of Agriculture, U.S., and is further specified as *Bulletin* No. 1. It may be described as an elaborate monograph upon the composition of American wheat, and the subject is handled with great thoroughness, although the value of the result obtained falls considerably short of being startling. It is a specimen of painstaking analytical work which may form the basis for generalisations of value in the hands of able agriculturists and statisticians.

The variation in the composition of the wheat grain itself as affected by climate is rendered evident, and a comparison is instituted between the composition of European, American, Egyptian, and Australian wheats. The author in the first place produces elaborate tables of analysis, showing the composition of numerous varieties of wheat. Secondly, he considers the composition of the typical or average wheat of each of the American States. Lastly, he compares American wheats with those produced in other quarters of the globe. Among this mass of analyses it is difficult to arrive at conclusions, and there is some danger of falling into error. Mr. Clifford Richardson finds that American wheats are drier than European wheats in the proportion of 10·27 to 14 per cent. of moisture. The percentage of dry matter is consequently much higher, and the grain is proportionately more valuable. The carbohydrates average 72 per cent. instead of 68 per cent. as in the case of English wheat for example. The amount of fibre is also less in American wheats. The ash constituents are most abundant in wheat from newly cultivated tracts, and on old worn out lands both the ash constituents and nitrogen are considered to have diminished.

American wheat is, however, deficient in albuminoids to a degree which appears to disconcert Mr. Richardson more than we think it need. In American wheat we evidently have a small grain, specially free from fibre (bran), peculiarly dry, very rich in carbohydrates and oil, but deficient in albuminoids. European wheats sometimes contain 19·5 per cent. of albuminoids, and ordinarily 13 per cent. American wheats contain upon an average 11·95 per cent. of albuminoids, but in Oregon and on the Pacific coasts only 8·6 per cent. Mr. Richardson seems to overrate the importance of this fact. He appears to be in doubt as to the true importance of the albuminoids when he says, "The albuminoids are regarded, *and probably rightly*, as the most valuable part of the grain." He might, however, have been led by his investigations to doubt how far a high percentage of albuminoids is the best indication of quality in wheat. First, Australian and Egyptian wheats are both somewhat deficient in albuminoids, and are yet known to be remarkably fine. He also notices that while Oregon and Californian wheats contain comparatively low amounts of albuminoids, the grains are large and handsome. He further points out that the proportion of albuminoids in spring wheats is higher than in winter wheats, although he fails to notice that all wheat-growers know that winter wheat is better than spring wheat. Having concluded that American wheat is at fault in this particular, he endeavours to explain why such is the case with a view to remedying the defect. So far from being a fault, the richness of American wheats in starch, and the comparatively smaller proportion of glutin, appears to us as indicative of its high quality. "Tail" corn contains more glutin than "head" corn, and badly matured grains are usually rich in this important constituent. A little consideration as to the constitution of a grain of wheat will show that the glutin is not the best criterion of value. The outside layers of the grain contain the glutin, and then honeycomb cells inclose the starchy interior. This outer portion of the kernel is the first to ripen while growth still continues along the axis and in the centre. The fully matured grain, in fact, becomes like a well-packed trunk, thoroughly stuffed out, and this with starch grains. If we are correct in this view of the maturing of the grain, the percentage of glutin must diminish in proportion as starch is

[1] "An Investigation of the Composition of American Wheat and Corn." By Clifford Richardson, Assistant Chemist. (Washington Printing Office, 1883.)

deposited, and increases in relative weight. We are disposed to think that the carbohydrates, and not the albuminoids, must be taken as the true criterion of quality in wheats, and that, judged by this test, the Americans have no need to fear that their wheats are inferior to those of Europe.

The author finds a difficulty (p. 33) in accounting for the small proportion of water in American wheats. Any agriculturist would have been able to tell him that well-developed, thoroughly matured, and well-harvested wheat always contains a less proportion of moisture than wheat in an opposite condition. It is due partly to simple drying, but also to the fact that good wheat is thoroughly filled up with starch cells (carbohydrates), and that there are no fissures left for moisture or air to lurk in. Well-fed meat contains less water than badly-fed meat for the same reason, viz. the thorough filling up of the internal spaces with fat cells. A little attention to the structure of the wheat grain would have enhanced the value of Mr. Richardson's monograph.

The fact that unripened and badly matured wheat is often rich in glutin is well known to chemists, and we are disposed to think that the richness of European wheat in this constituent is partly due to the fact that it is often defectively matured.

After treating exhaustively upon the composition of American wheat, the author proceeds to treat of flour and bread, and lastly of other cereals and maize. The pamphlet certainly repays the trouble of perusal, and indicates the vast pains which is now being taken by the United States Government in order to bring scientific knowledge to bear upon its most important industry. The wheat production of each State is watched with minute care, and the quality of the produce is subjected to analysis. It is gratifying to notice that Canadian wheat is in all respects equal to that grown in the United States.

JOHN WRIGHTSON

College of Agriculture, Downton, Salisbury

THE REMARKABLE SUNSETS

SINCE our last number appeared the view that the recent wonderful sunrise and sunset phenomena have really been due to the terrible eruption of Krakatoa in August last has been confirmed in the most definite manner. Material brought down by rain in Holland and snow in Spain has on microscopic examination proved to be identical with actual products of the eruption brought from Krakatoa in the ordinary manner.

The following letter to the *Times* from Mr. Joseph McPherson, an eminent geologist now in Madrid, must be read in connection with the letter from Holland given below:—"Desirous of obtaining positive proof of the brilliant theory put forth in your columns relative to the cause of the remarkable appearances at sunrise and sunset which have for many days excited public attention, I have this day analysed some fresh-fallen snow with the following results, namely, that I have found crystals of hypersthene, pyroxine, magnetic iron, and volcanic glass, all of which have been found in the analysis lately made at Paris of the volcanic ashes from the eruption of Java."

This being so, every fact connected with the displays instead of losing really gains an additional interest, and now that we know we are in presence of the work of the upper currents each date becomes of great importance.

The extraordinary fact now comes out that before even the lower currents had time to carry the volcanic products to a region so near the eruption as India an upper current from the east had taken them in a straight line *viâ* the Seychelles, Cape Coast Castle, Trinidad, and Panama to Honolulu, in fact very nearly back again to the Straits of Sunda! The 5th of September is now fixed from two sources as the date of the first appearance of the strange phenomena at Honolulu.

Mr. Bishop thus writes to the *Saturday Press* (published at Honolulu, September 22), which has been forwarded to us by the courtesy of the Hawaiian Consul at Glasgow:—

"I first noticed these peculiar appearances on Wednesday the 5th inst. at 7 p.m., so long after sunset that ordinarily no trace of colour remains on the western sky. The sky, from south-west to west, was then covered with a lurid red and dull yellow glow, much resembling that produced by a distant conflagration. This extended to an altitude of 15° or 20°. I continued to distinguish the light till 7.25."

He then proceeds:—

"I would note three peculiarities of the phenomenon, distinguishing it from ordinary sunset reflections, and unlike anything I remember to have observed before: (1) It appears to be a reflection from no cloud or stratum of vapour whatever. (2) The peculiar lurid glow as of a distant conflagration, totally unlike our common sunsets. (3) The very late hour to which the light was observable—long past the usual hour of total cessation of twilight. To this may be added (4) that the centre of brilliancy was more or less to the south of west."

Mr. Bishop at once ascribed the phenomena to Krakatoa dust, and suggested more vivid appearances along the line Honolulu, Ladrones, Manila, Sunda. Of course he knew nothing of the line Panama, Trinidad, Cape Coast Castle, Seychelles, Sunda.

In a subsequent communication Mr. Bishop tells us that the after-glow remained brilliant for some time, being very brilliant on September 30. The haze stratum was visible as a continuous sheet at a height far above that of the highest cirrus, a slight wavy ripple being noticeable in its structure, always perfectly transparent and invisible except under certain conditions. A conspicuous circle of 15° to 20° radius was observed during several days, "a misty, rippled surface of haze, with faint crimson hue, which at the edges of the circle gave a purplish tint against the blue sky."

He states that Capt. Penhallow, of the *Hope*, observed these phenomena in lat. 24° N., 140° 29′ W., on September 18.

The following notes as to the eruption itself we take from the *Straits Times*, as dates and times are mentioned:—

"In the afternoon of Sunday, August 26, a rumbling sound was generally heard at Batavia, coming from the west, like that of far distant thunder varied by strong detonations, the concussion from which shook and rattled doors and windows on all sides . . . especially when on the night between August 26 and 27 these phenomena steadily became more violent until 1 a.m., when a detonation was experienced which brought about such a concussion that the gaslights here were all as it were extinguished at the same moment. Many persons, anxious for their wives and families and for life and limb, hence forbore to sleep and awaited the morning in great excitement. Morning broke, but the sun, instead of shining with that clear brightness which characterises the morning hours in the East, concealed itself, and the whole sky seemed overcast. At 7 a.m. on that day, August 27, the first shower of ashes was noticed here, from which it was inferred that whatever might be the volcano at work in the neighbourhood, the outburst must assuredly be appalling when ashes in showers could be noticed even in distant Batavia. The ash showers fell heavier, and before the hour of midday had struck the whole of Batavia was enveloped in thick darkness. From the lack of sunlight the temperature fell several degrees. People shivered with cold, their discomfort being heightened by anxiety, especially when lamplight had to be used at midday. Like a mountain a great sea wave came rushing on along the whole coast of West Java, forced its way into the rivers, thus causing them instantly to rise several yards and overflow their

banks. Indescribable was the confusion into which prahus, steamboats, and tambangans were thrown in the lower city, and no pen can depict the confusion in old Batavia, resulting in especially the natives and Chinese seeking safety by a general flight. To give some idea of the tidal waves which agitated the sea and rivers, we need only say that at Tanjang Priok, in particular, the water rose ten feet within a few minutes, that it not only wholly overflowed a portion of Lower Batavia quite suddenly, but also bore fully laden prahus of twenty-five lasts and even more capacity ashore like straws. This phenomenon was repeated at 2 p.m., but not so violently. However great was the force exerted by this heavy flow, there came a moment, after it had raged its utmost, when the water in masses of immense height suddenly ebbing away vanished, and left the river beds and sea bottom a while dry. Meanwhile, the thick, heavy, and oppressive atmosphere, charged with sulphurous fumes, began to clear up somewhat in spite of the cold. It became lighter, and by the increasing light people beheld a sight seldom certainly witnessed here in the course of centuries. The streets, or rather the roads, the trees, and the houses, were covered with a wholly white layer of ashes, and presented in the land of the sun a genuine Dutch winter scene. In the meantime, when, later in the day the distant detonations had ceased and rumbles had become fainter, no one had yet the least idea of the havoc wrought by this strange natural phenomenon. By that time Anjer had been flooded and devastated by tidal waves; with few exceptions its inhabitants had been drowned in a moment of time, and on its site in the course of that disastrous Monday nothing but an extensive muddy morass could be seen." EDITOR

We have received the following communications:—

EARLY in the morning, on December 13, between four and five o'clock, a violent tempest from the north-west arose. The temperature in the course of the morning was rather low, viz. 4° C., and, especially between six and seven, the wind was accompanied by showers of rain, intermingled with hail. This rain was of a peculiar nature, every drop, after having dried up, leaving behind a slight sediment of grayish coloured substance. This was most distinctly to be seen on the panes of windows turned towards the west or the north-west; the spots with which these panes were dotted did not leave the least doubt about their having been caused by the fallen rain.

The streamlets of rain, having evaporated, left on the whole surface of the windows the said grayish matter behind, so that there can be no doubt but the rain itself had conveyed from the upper air the above dust.

The magnificent "cloud-glow" which, on several previous evenings, had also been observed hereabouts, and which has been attributed by meteorologists—with good right, no doubt—to the volcanic ashes due to the catastrophe of Java, made us suppose that the substance observed by us on the windows could not but be of the same origin. We took it for granted that whirlwinds, when the storm set in, had brought the dust down to the lower regions of the atmosphere, where it mingled with the falling rain. Consequently we proceeded to examine microscopically the sediment, in order to compare it with original ash from Krakatoa, which had been sent to the Agricultural Laboratory at Wageningen to have its value as plant-food ascertained. The result of this examination was that both the sediment and the volcanic ash contained (1) small, transparent, glassy particles, (2) brownish, half transparent, somewhat filamentous, little staves, and (3) jet black, sharp-edged, small grains resembling augite. The average size of the particles observed in the sediment was of course much smaller than that of the constituents of the ash. These observations fortify us in our supposition, expressed above, that the ashes of Krakatoa have come down in Holland.

Wageningen, December 14 M. W. BEYERINCK
J. VAN DAM

WITH every spare cranny in NATURE filled with volcanic dust, and the whole discussion in far abler hands than mine, I should be loth to trouble you, were there not one point in connection with the recent optical phenomena which has, as far as I know, escaped observation, and which may possibly be worthy of consideration. I allude to the connection between the sky-glows and the phenomenon commonly known as "*Rayons de Crépuscule*."

To the latter phenomenon I have incidentally had my attention much drawn, having been for many years engaged in a set of cloud observations for a special purpose. This appearance has already been described, and to some extent discussed, in the pages of NATURE and elsewhere. Several other phenomena, some of them occurring while the sun is above the horizon, seem to have been confounded under the same name. That of which I now write consists of red rays converging to a point near the horizon opposite to the sun's position, usually at between fifteen and fifty minutes after the sun has set or before it has risen. On rare occasions I have seen these belts in the evening extending past the zenith so as to converge towards the position of the sun beneath the western horizon. The interspaces of these rays (which, as has long ago been explained by Mr. Lockyer, are the shadows of hills or clouds beyond the visible horizon) are often of a complementary blue-green. The colour of the rays is similar to that reflected at an earlier hour in the evening, or at a later in the morning, from the most elevated cirri. This phenomenon seems to be in itself almost entirely independent of any weather conditions, occurring under utterly diverse states of the atmosphere. It possesses one remarkable characteristic. It is far more common in Europe in the month of November than at any other period of the year, although the prevalent state of our November skies is scarcely such as to favour its visibility. To this characteristic I called the attention of some scientific friends several years ago, amongst whom I may mention the name of Robert H. Scott, F.R.S. I have thought that the "*Rayons de Crépuscule*" were somewhat more common in the years when the November meteors were most abundant. But if this prove to be the rule the exceptions are numerous. There are long periods during which there are no "*Rayons de Crépuscule*," or in which if they occur our view of them is entirely obstructed. I have always supposed that the fall of meteoric dust determines the condensation and congelation of the vapour which exists in those strata from which these red rays are reflected, just as London smoke determines the formation of spherules of fog. The solar rays are thus reflected from ice spiculæ suspended in the atmosphere, rather than, as I understand Prof. Brücke to imply, from the atmosphere itself. Are there any reasons for doubting the possibility of the existence of much water vapour at a far greater elevation than this stratum? This would ordinarily remain in the vapour state, being above the ordinary range of the *pulverised* meteorites.

Now the same orange-red glow in the east, from ten to twenty minutes after sunset, by which I have usually been able to predict the appearance of "*Rayons de Crépuscule*," has been almost constantly visible at that hour throughout the present period. Further, this has been followed slightly on one, and vividly on two, of those evenings when the succeeding glow was most remarkable, by the "*Rayons de Crépuscule*" themselves. And the rays of red light emerging on several occasions from the effulgent glow in the west appear to me closely to resemble western continuations of very elevated "*Rayons de Crépuscule*."

Ecce iterum. Here we come back to Krakatoa. Granting the distance to which the vapour and dust were ejected from the bowels of Krakatoa to have been so great that the more rapidly rotating surface of the earth brought Panama under this vapour and dust in the space of less than a week, we have a gigantic pepper-box capable of condensing and congealing vapour which had long remained undisturbed in its serene heights. We do not need to call in the known currents of the atmosphere to explain the dispersion Poleward and therefore eastward of the volcanic matter, gravitation alone accounting for the transmission of the particles down the inclined isobaric planes.

To my theory of ice spiculæ it has been objected that these ought to produce halos. So, whenever the recent phenomena have been most strikingly developed, they have done. Yesterday was the third occasion during this period when, from 2.15 to 2.50 p.m. the sun was surrounded by a remarkable halo, the sky at the time being totally devoid (in the neighbourhood of the halo) of any visible upper clouds whatsoever. Cumuli passing the halo appeared green. The halo was followed by a splendid glow in the evening, and again this morning.

December 15 W. CLEMENT LEY

IF you are not yet suffering from a plethora of letters on this subject, I should like to add a few remarks to those which have been already made.

On Thursday, December 6, I witnessed one of these gorgeous sunsets in company with a friend, from the top of Rusthall Common, near Tunbridge Wells. Like Mr. Rollo Russell, I noticed that the peculiar *lasting* glow came from a lofty stratum of pale, fibrous, nearly transparent cirriform haze, which was almost invisible as the sun set, but afterwards came gradually into view, at first white in colour, and then gradually changing to orange, pink, and finally red, the change to pink occurring at 4.25 and to red at 4.45.

We also observed a strange reactionary effect produced by this glow, viz., that long after the red tints had faded from the ordinary cirrus in the western sky and from some snow-shower cumuli in the east, they were both relighted by the glow which had meanwhile increased in the west.

On Friday, this reflection *on to low clouds all over the sky* from the undoubtedly lofty stratum in the west was more noticeable, and it at once struck me that persons who had not observed the entire process of the extinction of the real reflection of the sun by these clouds, and their subsequent reillumination by reflection from the *upper* glow (as Miss Ley terms it), might erroneously be led to attribute this secondary illumination to their reflection of direct sunlight. On this ground alone, I should be rather inclined to accept with a little hesitation the observation on which Prof. Helmholtz bases his calculation, viz., that the clouds which were illuminated by the sun were 45° *above the horizon two hours after sunset.*

Nothing that I saw on either Thursday or Friday at all favoured such a fact. On the contrary, there was some positive evidence in favour of the reflecting medium being situated at a much more moderate altitude. In the first place, judging by an eye often engaged of late in taking vertical angles with a theodolite, I should say that on both days (when the sky was very clear and the stratum which emitted the glow was unusually well defined) the maximum height of the glow-stratum was not more than from 10° to 12° above the horizon.

Moreover the interval between when the ordinary cirrus ceased to glow and this upper stratum began to glow corresponded very much more with a height of from ten to thirteen miles than with such an enormous height as forty miles.

Miss Ley has, I believe, already calculated the height of the stratum to be thirteen miles, and I think this height is far more probable than one of forty miles. Besides, can we imagine either vapour, or volcanic dust, or a mixture of both, to be capable of remaining in suspension in air of such tenuity as must exist at such an altitude? Moreover, I think it must be admitted that whatever be the cause, whether meteoric dust, or impalpable pumice carried over by the upper anti-trade currents from the Java eruption, the reflection arises from a definite stratum and not merely from an atmosphere filled throughout with such dust. Possibly, as Mr. Edmund Clark suggests, the dust may act as a nucleus for the condensation of any vapour that may exist at such a high level, and it is possible that just as we find certain definite positions at which condensation occurs, and therefore clouds float, at lower altitudes, so there may be some particular height at which condensation is determined in these upper regions, thus accounting for the definiteness of the reflection and the presence of the cirrus haze to which it apparently belongs.

Thus, Dr. Vettin of Berlin has recently shown that the clouds have a marked tendency to float at certain defined levels, which can only be supposed to result from the action of certain physical causes regarding whose nature we are at present entirely ignorant.

The name of the cloud and the corresponding elevation in feet are as follows :—

Name of stratum	Height in feet
Lower cloud	1,600
Cloud	3,800
Cloudlets	7,200
Under cirrus	12,800
Upper cirrus	23,000

Now we see that these heights increase very nearly in a geometrical ratio, with 2 as the common factor, so that we might anticipate a tendency for cloud to be formed (assuming that the empirical relation held good) at an elevation of about 46,000 feet, or a height of nearly nine miles. It would be at least interesting to find that the average height of the reflecting layer in these recent sunsets lay at about this elevation.

Another circumstance which favours the notion that the dust would be carried from the tropics, and float above, and not below, this level is that, while at all lower elevations the polar currents predominate, it is just about this same level that the equatorial or southerly air-currents begin to exceed those which have a northerly component in strength and frequency. Thus, according to Vettin, the following figures represent the relative volumes (?) [1] of air carried by the equatorial and polar currents at different altitudes over Berlin :—

Equatorial	Polar	Height in feet
305	226	From 41,000 feet up to the extreme limits of the atmosphere.
253	228	41,000
206	222	23,000
164	212	12,800
108	131	7,200
92	118	3,800
83	158	1,600

This table, I think, makes it easier to understand how the dust should have been transported over to extra-tropical regions from the neighbourhood of Java, and why it should appear only in the *very high strata.*

E. DOUGLAS ARCHIBALD

GILBERT WHITE of Selborne, in one of his letters (lxv., to the Hon. Daines Barrington), describes the "amazing and portentous phenomena" observed in the summer of 1783. "The sun at noon looked as blank as a clouded moon, and shed a rust-coloured ferruginous light on the ground, particularly lurid and blood-coloured at rising and setting. The country people began to look

[1] I have not the copy of the *Zeitschrift* by me just now, and am only quoting from memory. I cannot therefore be sure whether it is volumes or frequencies. For the purpose in hand either would do equally well.

with a superstitious awe at the red lowering aspect of the sun; and indeed there was reason for the most enlightened person to be apprehensive, for all the while Calabria and part of Sicily were torn and convulsed with earthquakes, and about that juncture a volcano sprang out of the sea off the coast of Norway."

Those who are familiar with the letters and poems of Cowper will remember his references to the same phenomena in that year, as in "The Task," Book ii.—

> "Fires from beneath, and meteors from above
> Portentous, unexampled, unexplained,
> Have kindled beacons in the skies; and th' old
> And crazy earth has had her shaking fits
> More frequent, and foregone her usual rest."

Mrs. Somerville, in her "Physical Geography," traced the origin of these atmospheric phenomena to the great eruption of Skaptar, one of the volcanoes in Iceland, which broke out May 8, and continued till August, sending forth clouds of mingled dust and vapour, which spread over the whole of northern Europe. Mr. Henderson, in his work on Iceland, and Dr. Daubeny in his work on volcanoes, also describe this eruption, and the enormous quantities of volcanic dust sent by it into the atmosphere.

Mr. Norman Lockyer ascribes the recent abnormal sunrise and sunset phenomena to the clouds of volcanic dust from the great eruption of Krakatoa on September 2. The different effect caused by a tropical eruption and one in northern regions would be such as Gilbert White observed, and what we have lately witnessed. In the eruption of 1783 the stratum of dust and vapour must have been at a low level compared with that of 1883. We know in a general way the course of the circulation of the atmosphere, as we do that of the ocean: the flow of currents from the Poles to replace the ascending volume of air in the equatorial zone, which gradually diffuses itself in the upper regions of the atmosphere. But of the direction and velocity of these lofty strata we know little in detail; just as we have variations and unexplained diversions even of oceanic currents, but in the atmosphere to far greater extent. From Humboldt and Arago we have been taught to believe that the pumice and vapour clouds from volcanoes are raised to enormous altitudes, and the dispersion of these may be too irregular to admit of calculating the exact time after a tropical eruption when atmospherical phenomena would appear in particular localities. The fact remains that abnormal atmospheric effects have resulted from the presence in upper regions of the air of pumice dust in unusual quantity.

In some regions of the earth these phenomena have been frequently observed, as on the coasts of Peru, where we would expect a large amount of volcanic dust to be present. In Ellis's "Voyage to the Sandwich Islands," he describes just such appearances as we have been recently seeing. "Towards evening and in early morning I have seen clouds of every hue in different parts of the heavens, and such as I had never seen before: for instance, rich and perfect green, amber, carmine; while the hemisphere round the rising and setting sun has been one blaze of glory." Similar sunlight effects are described by Bishop Heber in his narrative. "Besides tints of crimson, flame-colour, &c., there were large tracts of translucent green in the immediate neighbourhood of the sinking sun, and for some time after sunset; with hues such I have never seen before, except in a prism, and surpassing every effect of paint or glass or gem." These effects were such as aqueous vapour alone could not have produced, and were doubtless due to foreign matter in the upper regions of the atmosphere.

In the meteorological observations of Luke Howard there are several records of similar abnormal sunlight effects when the sky was "deep blood-red after sunset, with hues passing through crimson and a gradation of lighter reds and orange and flame colour." Whether these appearances can be connected with particular volcanic disturbances or not, they seem to have been due to the presence of foreign matter in the upper strata of the air; and there are rarely periods when some volcanic region is not in active eruption.

On more than one evening in December the metallic-green colour of the moon attracted general notice. This was not due to the laws of complementary colour, for it remained when not a vestige of red or crimson could affect the vision. Mr. Edward Whymper states that the peculiar hue recalled to him the same appearance as witnessed by him in South America when the atmosphere was charged with volcanic dust.

JAMES MACAULAY

IN 1880, when travelling in Southern Algeria, I was talking with some colonists about a simoom, when a Frenchman present exclaimed "C'est la première fois que j'ai vu le soleil bleu." Upon interrogation I was assured by the whole company that the sun, seen through the fine dust of a Sahara wind, had a decidedly blue colour. I do not know whether this is always the case when a storm is blowing from the desert; but the fact, even if not a regular one, throws some light upon the East-Indian green sun. It confirms evidently the opinion that the green colour and the remarkable weakness of the sun's light, as observed in India, were due to volcanic dust from Krakatoa. An eruption like that of August must throw up into the highest layers of the atmosphere dust not only in enormous quantities but also of extraordinary fineness. And I see no difficulty in assuming that this dust, transported by air currents over Africa and Europe, was the cause of the "remarkable sunsets," the more so, as the latter phenomenon is evidently a wandering one. At Constantinople the first remarkable sunset was observed on November 20 (splendid), and subsequently we saw the same glow of the heavens in the morning and evening of the first five days of December, though partially masked by clouds. Afterwards the observation was rendered impossible by bad weather.

Constantinople, December 12 DR. BUDDE

I HAVE read with great interest the accounts of the extraordinary sunsets we have had lately. I have watched all the effects most carefully for the last fortnight, and it may be of some interest to you to hear my account. The first time I noticed anything very odd was on the evening of the 24th. I was then calling on a friend who lives on this lake, and it was dark enough to have candles, when on looking up at his studio window I saw three or four masses of cumuli piled up against each other, and all of unusual, or rather I should say unnatural, colour. I said to my friend, "Well, I never saw such a sky or clouds, it is exactly like an old master picture, like a rich Titian sky." . . . I said this because what *ought* to have been blue sky was quite a rich green, and some of the clouds rich amber, others red brick colour, and others a yellow green. There was a high wind; these clouds were in the north, or nearly opposite the sunset, and very near. I was startled, because I knew some of the colours to be unnatural, especially at that time of day (4.30); it was not a green or an amber I had ever seen, and I have watched the sky very carefully for many years. Then, about a week ago, I saw the same effect again, and on looking round towards the sunset my eye caught the crescent moon; it was of a *pale blue green*. Two evenings before this, I was startled on looking up from my book (and some time after candles had been brought in) to see quite a red glare behind the "Old Man"; as it was almost night, I thought it was some large fire, but on going out I saw that it was merely a glare from the sunset; and more to the east near the horizon there were lurid masses of red cloud very far off

showing through bars of nearer gray cloud. I thought of running into Ruskin's study and telling him to look, and went as far as his door, but then deemed it better not, as the effect was of so lurid and awful a nature, I thought it might put him off his work! My next scene was one morning; finding the room very dark, I suddenly discovered the maid had shut the shutters; I got up to open them, and to my astonishment saw Coniston *Old Man all red*, but with no shadows! I was all the more astonished because it was still much too dark for any light on the "Old Man" at all! and I can assure you it really looked *alarming*. I have of course often seen the mountain red and orange, but never before sunrise. I concluded that this glare was caused by some very bright reflection from the rising sun on the sky above, and bright enough to make the mountains all red. I watched this more or less until nine o'clock, when at last the usual shadows appeared, the mountain getting I suppose some real sunlight. Then my last effects have been two extraordinary after-glows a few evenings ago. It seemed to me that about half an hour before sunset the sun began to shine through some extraordinary vapour capable of being illuminated *very much* more than the ordinary atmosphere, so much so that we had faint *cast* shadows from it on our lawn; there was no sign of the sun or even where he was, as this vapour was so *equally* illuminated. It lasted long; and when candles had been in some time, there was still a band of *intense rose* colour on the western horizon.

ARTHUR SEVERN

Brantwood, Coniston, Lancashire, December 9

THIS atmospheric phenomenon still continues morning and evening to excite admiration. Its effects, however, on the colour of the sky disappear at an earlier hour than has hitherto been the case; on the morning of Wednesday, the 5th inst., the southern heavens were resplendent with richest and most brilliant colours, to attempt the description of which would be somewhat puzzling. It seems as if of late the grandest displays occur before sunrise. The afternoon effects were remarkable less for richness of coloration than for the lustre of the light which arose in the west after sunset and for the predominance over the whole sky of opalescent white colours. The reflection of the light on church towers and buildings brought out the architecture in strong and startling relief. There was, however, at 4.15 p.m. a colour display, and on this occasion the moon for a short time was again changed to a hue of emerald green. On the 6th, before sunrise, the phenomenon reappeared in a mantle of lurid red colour. The display passed through the usual changes of colour and disappeared when the sun rose. In the afternoon the glow at 4 p.m. reappeared, followed by the usual brilliant radiance; the colours were, however, sea-greens, opaline whites, and bright grays till 4.30 p.m., when a blood-red colour overspread the western sky. The glow faded sooner than usual. The morning of the 7th though splendid was less grand in character than the display of the previous morning. At 4 p.m. a rosy hue suffused a few light clouds that rested on the sky. At 4.15 pearly whites and mauves and grays prevailed. Just at this time an irregularly shaped vaporous mass of an exquisite tint of lake formed in the west 45° above the horizon, and gradually spread to a point near the horizon. At 4.30 the usual orange-coloured arc appeared in the west, and for a few moments the light emitted was almost dazzling. The display was somewhat evanescent. On the 8th, before sunrise, the sky was enriched with various hues of red, carmine, green, and yellow. At 3 p.m. there was a detached cloud canopy coloured with a deep rose, but changing to an orange hue; 5 p.m. dense cloud canopy with red radiance visible through the clouds. On the 9th a dense cloud canopy shut out observation. At 4 p.m. a bright yellow glare coloured the horizon of the western sky. This was followed by the orange-coloured radiance, but the display was fugitive. The morning and afternoon of the 10th were unfavourable for observation owing to a dense cloud canopy, but a yellow-coloured light in the sky was perceptible. On the 11th the sky before sunrise was brilliant with colours pink, blood-red, yellow, and green. At 8 a.m. for a few moments the sun appeared of a green colour. This afternoon's effects were very beautiful. At 3 p.m. a yellow glow prevailed: this gave way to a remarkable streak of a vivid green colour extending along the horizon from north-west to south-west; above this was a vaporous mass reaching to within a few degrees of the zenith. Beyond this mass and overspreading the zenith the colour was mauve. In the eastern sky the colours were reds, mauves, and blues. This evening the moon again shone with a green light. The glowing arc of orange-coloured radiance which evening after evening shone in the western horizon seems to have ceased to be apparent here. The effects of the splendid sky coloration in causing the flame of gas lamps to appear white, or rather in fact to resemble the electric light—noticed by Mr. Sydney Hodges at Ealing—was at this place a striking feature of the displays. A destructive hurricane from the north-west set in at 11 p.m. on the 11th inst., and was of greater violence than any that has occurred here from that point for these forty years. The night was moonlight, with flying scud. In the night, between one and two o'clock a.m., during the height of the hurricane, the phenomenon of paraselene or mock moon was visible. The false disk was well defined, equalled the moon in size, but was less brilliant, and was some 4° or 5° from the true moon; prismatic halos were visible during the night. The wind blew in terrific gusts, striking houses and buildings almost with the force of a battering ram. Before sunrise on the 12th a red glare suffused the sky, and at half-past eight a.m. the sun appeared of a dark green colour, and remained of this colour for several minutes. The violence of the hurricane subsided towards four a.m. During the lulls of the storm there were on one or two occasions tremors that I could not connect with the vibration of the house from the effect of the wind, and which seemed to me to be earth tremors. In the afternoon the glow appeared in the west in the shape of a mass of a luminous yellow body some 25° above the horizon, which sank gradually below the horizon, and left a clear sky. On the morning of the 13th the only colour visible was a deep yellow, and that colour prevailed in the vicinity of the sun throughout the day. Thermometer again rose to 50°, barometer falling. In the afternoon of that day, cloud obscuration shut out observation.

December 14.—At sunrise, owing to the denseness of the prevailing cloud canopy, observation was not possible. At 10 a.m. the canopy broke up and dispersed, and, except along the eastern horizon, the sky became blue and clear. At 11 a.m. a broad, colourless stream of remarkable moving vapour or cloud haze, and rayed, nebulous cirri of a very filmy structure, issued from a point occupied by a few clouds of the stratus type on the western horizon, and travelled across the zenith eastwards. The motion of the vapour and cirri was rather fast as it swept across the sky. The quick-changing forms were most astonishing, some being of a leaf structure, some pointed rays, some curled, others horizontal bars. The forms of both haze and cirri were most fantastic. The stream continued to flow till after 2 p.m. I have never before observed anything like it. At 3.15 p.m. there was a wide-spreading green sky space about 20° in altitude on the western horizon. Above it gradually in the clear sky, a rich russet glow, with no definite outline, became developed, and continued to prevail. A 4 p.m. a pink glow coloured some clouds resting on the western sky and flushed the entire horizon. Towards 5 p.m. the russet colour gave way to a smoky yellow tint, and soon afterwards the light disappeared. Cloud-forms during the day took the most weird and fantastic forms. Imagining that the phenomenon was on the wane, I was surprised

to witness a display so brilliant and imposing. On this day the thermometer rose to 54°. At 8 p.m. there was a rather broad band of green light round the disk of the moon. It seemed to me that neither the sun nor the moon during the days and nights of the 12th, 13th, 14th, and 15th gave the usual light.

December 15.—The sunrise this morning was of a most impressive character. From just before sunrise till 8 a.m. the eastern sky was flushed with blood-red colour. At 8 a.m. the sun again shone with a most beautiful green light for a few minutes. The room in which the observations were made has two windows, one facing east, the other south, and the marvellous spectacle was witnessed of a flood of crimson glare filling the east window, while through the south window poured a volume of dazzling green light. This afternoon there was a thick cloud canopy, and rain fell, but a yellow glare penetrated the clouds on the south and west. At 4 p.m. through a cloud rent could be seen the bright pink, russet green, and yellow colours of the glow. The thermometer registered 44°.

December 16.—The glare was visible this morning, but no colour other than smoky yellow was visible. Afternoon the glare very powerful, but at 3.45 pale yellow was the only colour. This, however, prevailed in the west, but extended round the whole horizon. The spoked ray feature, however, was greatly developed.

The steel coloured radiance which glowed in the western sky at 3.30 p.m. at the time of closing my letter was followed from 4 till shortly after 5 p.m. by the fiery glare which has been a marked feature of the red sky displays during their prevalence. The sky effects were much the same as on the previous afternoon, except that the nebulous matter was traversed by fan-shaped pointed rays, and its structure presented a billowy appearance.

December 17.—Glare at sunrise as on other mornings of late, the coloration less grand and brilliant. During the morning a stream of filmy cirri issuing from the point in the heavens occupied by the sun and travelling across the zenith till after midday. 3.30 p.m.—Steel coloured glare, followed at 4 p.m. by the development of the usual fiery glow in the western sky, traces of which remained till 6 p.m.

In the "Notes" in NATURE for the 6th inst. (p. 135) is a record of a fall, on the night of Nov. 17, at Storelvdal, Norway, of layers of gray and black dust. This was the day of the date of a fall of discoloured rain near Worcester. Recent accounts announce the visibility of the phenomenon in America, where its cause is ascribed to meteoric dust. Reports of falls of ashes on land and shipboard tend rather to strengthen the volcanic dust theory. According to the "Annals of Philosophy," vol. ii., the sun appeared of a blue colour in April of the year 1821 in England. It seems from other sources that there were in February of that year a violent volcanic eruption in the island of Bourbon, and in June of the previous year a destructive outbreak in Gunung Api.

Worcester, December 17 J. LL. BOZWARD

THE following observations of the remarkable "glow" that has lately been attracting such universal attention at sunrise and sunset may be of use for comparison with similar phenomena observed in other parts of the world. They relate to the phenomenon as observed at sunrise on those occasions when the atmospheric conditions and other circumstances have been favourable for obtaining good observations, though I may state that, even when cloudy, and no clear blue sky visible, the red glow has frequently made itself apparent through the clouds.

December 4.—6.40 a.m. The whole eastern sky between the east-north-east and south-west, for an altitude of 15°, was of a pale pink; at 7.15 it had increased in altitude to 45°, and near the horizon was of a deep crimson. At 7.30 it began to fade away, changing to a yellowish pink, and at 7.45 it had disappeared, excepting a slight crimson haze having an altitude of about 10°, and confined to that portion of the horizon at which the sun was about to make his appearance.

December 12.—6.30 a.m. A narrow belt of brilliant crimson clouds about 5° wide skirted the horizon between the north-east and south-south-east; at 7 it had considerably decreased in brilliancy, and reached an altitude of 15°, and at 7.30 it had become of one uniform pink colour, and now reached the great altitude of 60°. It now began gradually to fade away, changing to a yellowish pink, and rapidly decreasing in altitude until by 7.45 it had entirely disappeared, leaving a clear blue sky, which at 7.50 became tinged with the ordinary sunrise tints.

December 13.—6.50 a.m. A bright yellow glow having an altitude of 15°, appeared on the horizon, extending from the east-north-east to the south-east; at 7.20 it had increased in altitude to 60°, the upper portion being of a pink colour, giving to the blue sky immediately adjoining a sickly green tint. At 7.50 the pink glow near the zenith had disappeared, and the yellow glow near the horizon had changed to pink; it had now decreased in altitude to 10°, and extended no further than between the east and south-east points of the horizon. As the sun rose above the horizon it again changed to yellow.

December 17.—7.15 a.m. The clouds which up to this time had overcast the sky cleared away, although a very brilliant display of the "glow" was to be seen. The entire eastern sky between the east-north-east and south-south-east for an altitude of 75° was of a beautiful pink, excepting immediately on the horizon, where it was yellow. At 7.45 the glow disappeared, leaving a clear blue sky until 7.55, when the usual sunrise tints made their appearance.

From the foregoing remarks it will be seen that the "glow" in this locality has generally made its appearance 1h. 20m. before sunrise, and excepting in one instance (December 4) it has disappeared ten minutes before the sun has made his appearance above the horizon.

Dalston, E, December 18 B. J. HOPKINS

I HAVE observed the "after-glow" here (Madrid) since November 30, when it first came under my notice. The effect was particularly fine on the 2nd inst., the atmosphere being perfectly clear, and the moon (new, two and a half hours behind the sun) quite brilliant, as also the stars. At 4.24 (Madrid time) the sun went down, and we had a fine, but not unusual, golden sunset effect which lasted about fifteen minutes. At 5 the sky was gradually lit up again, say 100 miles north and south of sun point on the horizon, and some 45° of arc above, the colour varying from pink-red to crimson, less intense on high, but with a defined semicircular boundary against blue sky, which at this period assumed a *greenish* tint, as did also the moon without losing her brilliancy. But I did not observe any "streaks of Polar auroral light," mentioned in Mr. Bozward's letter; the crimson fan (shall I say?) was uniform, and maintained its intensity till six o'clock, though it gradually receded; the moon at the same time recovering her silvery appearance; and at 6.15, that is one hour and forty minutes after sunset, all was over. At 6 p.m. the barometer (4-inch height aneroid by Ladd) marked 705·50 mm. (say 27·80 inches; Madrid is 655 metres above the sea), and the thermometer (Casella, K.O., No. 9538), sheltered, 4 metres above ground, stood at 10° Cent.

On the 3rd inst. the effect was somewhat different, owing to slight haziness, coupled with delicate ripples of cirrus above, a few streaks of heavy cloud down on horizon, and slight breeze from south-west; but the

whole phenomenon on the 4th inst. was the most instructive. These are my notes:—

4.34 p.m. sundown; usual sunset effect, golden; massive horizontal streaks of neutral tint cloud, from 5° to 20° above horizon, with intervals, coloured Indian red; cirrus above light crimson. 4.50, all over, clouds no longer illuminated, sky on horizon dull yellow. 5 p.m., yellow band turned *pale green; low clouds remaining quite dark* (not illuminated), upper transparent cirrus pink or light purple. *gradually* fading off into blue atmosphere, which remained *decidedly blue* although the moon and haze circle round her (= four moon diameters) were decidedly *greenish*. 5.15, purple fan receded or contracted somewhat, and more crimson in colour; green tint on horizon fainter. 5.25, upper purple tint quite gone; light down on horizon bright red like conflagration (or iron heated to redness); moon greenish; *heavy cloud streaks quite dark;* and here I will say that although I noticed in Madrid a very slight breeze from north-west, *all* clouds remained to all appearance perfectly stationary from beginning to end. 5.35, at this moment the lower clouds (say to 20° above horizon) were *reilluminated as at sunset* from beneath (Indian red), after remaining forty-five minutes in total shade. At 5 45 this new illumination began to fade, and the red glow on the horizon had risen somewhat, and was dusky. 5.50, only a few red streaks under the clouds; glow as before, apparently more intense, owing to increasing darkness. 6.0, glow dull, and low down on horizon, nearly all on the north side of the sun's setting point. 6.15, all over. Barometer 702 mm. (say 27·65 in.); thermometer 12° C.

Since December 1 the whole phenomenon, without losing intensity, has become reduced in extent, *i.e.* the fan of light (so to speak) is getting smaller, especially in the direction of its length on the horizon. Yesterday (5th) I noticed the same *reillumination* of cloud; to-day we had heavy clouds and rain at the time, and barometer 699 mm. and thermometer 6° 5 at six. F. GILLMAN

Quintana 26 (Barrio Arguelles), Madrid, Dec. 6

THERE has been a very fine "glow" this evening, with the delicate rose tint which is so unusual. I observed the bands at C and D very strongly marked, and also a faint band at about *a*, and another about half way between C and D. This is the best marked evening glow that we have had here since about the end of last week.

Dublin, December 14 J. P. O'REILLY

SIGNOR DENZA, Director of the Central Observatory at Moncalieri, writes that these sunsets were seen from November 25 to December 1, and again from December 4 to December 7, throughout the whole of Italy from the Alps to the extremity of Calabria, and everywhere with great intensity. A vast number of reports have been received at the Central Observatory, generally to the same effect. So vivid was the glow, that by many observers it was taken for an aurora borealis, the prevailing colours oscillating between red and deep orange, and afterwards passing through all the tints to the most delicate pink. During the evenings of November 28 and 29 nearly the whole sky was lit up, and the phenomenon was followed first by storms, fogs, and rain, and later on by snow. Observed with the spectroscope, the light presented nothing but the usual absorption lines of the vapour of water, but very intense. Before dawn and after sunset the zodiacal light was seen very distinctly.

Numerous letters have appeared in the *Times* on the sunsets during the past week:—

MR. G. J. SYMONS sends the following extract from the Meteorological Report from Adelaide Observatory, South Australia, for October, 1883:—"On every clear evening during this month, and the last fortnight of September, a peculiar phenomenon has been apparent in the western sky. Shortly after sunset a red glow will make its appearance, at an altitude of about 50°, being very faint at first, but as the brightness of the sky near the horizon dies away with the receding sun, the red glow will expand downwards, becoming at the same time more brilliant, until at last the whole western sky will be lit up with a beautiful light, varying in colour from a delicate pink to a most intense scarlet, and the spectacle presents a most brilliant appearance. The upper part will then gradually fade away until the colour is noticeable only 7° or 8° above the horizon, at which time the light is at about its brightest. Afterwards, a secondary glow will sometimes make its appearance at an altitude of about 50°, and gradually spread downwards until the sky is again lit up. In the secondary phenomenon the colours are generally more delicate. The whole thing will fade away about 8 p.m. This phenomenon has been noticed all over the south-eastern portion of this continent, from Port Augusta (lat. 32° S.) to Melbourne; and in India the sun has at times presented a most peculiar appearance, being green at rising, then gradually changing to a blue at noon, and inversely from noon to sunset. Various theories have been started to account for the phenomena."

COL. STUART-WORTLEY states that in 1862 he spent a year in South Italy on purpose to study the formation of clouds by the aid of photography. "During that time I spent some time at Naples while the great eruption of that year was going on, and was struck with the unusual colours of the sunsets during and after the eruptions. I still have photographs of both sunrises and sunsets indorsed with memoranda as to unusual and exceptional colours." Four years ago, while sailing in the Pacific, Col. Stuart Wortley was much struck with the fact that very frequently the whole vault of heaven was overspread with magnificent and glorious colouring, and that in the higher regions of the air colours were found that were never seen at the horizon or below a certain height. "Now, this exceptional magnificence and peculiarity of colouring only occurs in certain latitudes and in well-defined belts, and I venture to suggest that, seen in the light now thrown on the subject by Mr. Norman Lockyer and others, the constant stream of volcanic matter thrown out by the great volcanoes in the mountain ranges of South America, and possibly from elsewhere, form an almost permanent stratum of floating matter, carried in certain directions and kept in certain positions by alternating currents in the higher regions of the air, and that to this stratum of volcanic matter much of the exceptional colouring found to be associated with sunrises and sunsets in portions of the Southern Pacific Ocean is due."

MR. W. H. PREECE writes:—"I think I can add one link to Mr. Lockyer's chain of reasoning. If we assume that the mass of volcanic matter projected with such force into the atmosphere in the Straits of Sunda was highly electrified, then it must have been electrified with the same sign as that of the earth—viz. negative. Therefore, when the force of projection had exhausted itself, the cloud of matter would be subject to two other forces besides gravity—the repulsion of the electrified earth, and the self-repulsion of each particle of electrified dust. The first would determine the tenuity of the cloud, for the lighter the particles the further they would be repelled, and the heavier the particles the quicker they would descend. It is quite possible to conceive that they might be so minute and so highly electrified as to reach the utmost confines of our atmosphere, where they would remain as long as they remained electrified. The second repulsive force would cause the particles to spread out continuously in a horizontal plane until they would cover an area determined only by their quantity. When we take into consideration the movements of the atmosphere and the rotation of the earth, I see no reason to doubt that an immense cloud of highly electrified matter, projected into the atmosphere in Java, could spread itself in

the higher regions of the atmosphere over an area equal to that of Europe. That this is not fanciful is proved by the behaviour of smoke. I have often watched when at sea, on a still, calm day, the black smoke of some passing steamer rise to some determined height, and then gradually spread itself at an equal and constant distance from the sea like a great flat pall. I have also seen on land the smoke from some manufacturing shaft blown gently by the wind follow the curves of the land, remaining always at the same distance from the ground, but gradually spreading outwards in every direction. I have also seen two lines of smoke refuse to coalesce, but repelling each other exactly as they ought if they were similarly electrified. That smoke is, therefore, negatively electrified I firmly believe, though I have never tested it. Now, that this wonderful atmospheric disturbance was accompanied by extraordinary electrical disturbance was shown, not only by Capt. Watson's observations near the spot, but by Prof. Smith's records at Madras, and hence it requires no great stretch of the imagination to conceive electricity playing a great part in the recent gorgeous display of atmospheric effects."

IN reference to Mr. Preece's letter, Mr. Crookes writes:—"In a paper read before the Royal Society in 1879 I showed that at a rarefaction of the millionth of an atmosphere two pieces of electrified gold leaf repelled one another at a considerable angle for thirteen months without loss of charge. Therefore at a rarefaction of a millionth (corresponding to a height above the earth's surface of about sixty-two miles) air is a perfect non-conductor of statical electricity, without interfering with the mutual repulsion of similarly electrified particles. When we bear in mind that the specific gravity of gold is five or six times that of the rock whose disruption formed the dust in question, and that the size of the individual particles of dust is certainly many thousand times smaller than my gold leaves, there is every reason to believe that electrified dust, once projected fifty or sixty miles above the earth's surface, might remain there for many years."

BISHOP BROMBY, writing to the *Times*, says that in a letter from a member of his family at Hobart, Tasmania, the writer speaks admiringly of "the loveliest after-glow which was spread over the sky on the other side of the water where the sun had set." This was written on October 12 by one who was ignorant that similar phenomena had been observed in other parts of the world.

ANOTHER correspondent of the *Times* states that in a letter dated "Duem, September 24, 1883," Hicks Pasha wrote:—"By the way, have you in England noticed a large black spot on the sun? To-day, when it rose, it was of a pale green colour, and we saw through our glasses an immense black spot on the lower half of it. What does this portend? I feel sure there must be some notice of it in the papers in England."

SHERIFF RAMPINI of Lerwick, Shetland, writes that the sunsets have been observed in these northern islands.

MR. G. F. BURDER of Clifton sends the following extract from a letter from a passenger travelling from San Francisco to Sydney, three days after leaving Honolulu. The writer says:—"On Wednesday, September 5, we witnessed a most curious phenomenon. The sun set perfectly blue, and next morning it rose a flaming ball of blue. The blue light was reflected in our cabins."

ON November 30, at 4 p.m., another remarkable sunset was observed in Stockholm. A correspondent states that the western sky became covered with an intense purple after-glow, having the appearance of an enormous distant conflagration, which nearly reached the zenith, and lasted for an hour, even after it was dark, and the stars were visible. On the morning of December 1 a similar intense light was observed at sunrise. The colour was, however, then more yellow. The phenomena have also been observed in the north of Sweden, in Gothenburg, in Christiania, and in Copenhagen.

THE KRAKATOA AIR-WAVE

ON Thursday last Mr. R. H. Scott communicated a paper to the Royal Society giving a map and tabular statements concerning certain barometric disturbances observed towards the end of August last.

The obvious correspondence of the forms and times of occurrence of the barometric disturbances, described in Mr. Scott's paper, at once suggested to General Strachey that they were due to a common origin, and the great volcanic eruption at Krakatoa in the Straits of Sunda appeared to supply a probable efficient cause. General Strachey therefore took up the question from this point of view, and at the same meeting communicated a paper, of which the following is an abstract:—

"Any shock of sufficient violence might be expected to produce an atmospheric wave, advancing from the place where it was caused in a circular form round the globe, at first expanding until it had got half round the earth, and then again contracting till it was again concentrated at the antipodes, from which again it would be thrown back, and so pass backwards and forwards till it was obliterated. It might have been expected that such a wave would travel with the velocity of sound, being probably of the same nature as that which causes sound, though the vibrations had not the peculiar character that affects our organs of hearing. It has, however, been suggested to me that the wave may rather have had the character of a solitary wave produced in a liquid, the velocity of which in the air would not materially differ from that of sound.[1]

"A rough examination of the facts at first made known by the observations recorded in Great Britain indicated that there was *primâ facie* strong evidence in support of this view, and that the phenomena would be approximately explained by the passage round the earth of a series of waves travelling at the rate of about 700 miles an hour in opposite directions from the place where the volcanic eruption occurred. The records since procured from other places, and the more careful examination of the facts, have quite confirmed this conclusion.

"Although we may expect to obtain additional data from other parts of the globe, which will make the investigation of this somewhat remarkable phenomenon more complete, yet those we now have are sufficient to justify an attempt being made to bring the more important facts before the Royal Society without further delay.

"The following table shows the stations from which the records have been received of which use has been made in this discussion, with certain particulars of their geographical position, and of their distances measured on great circles, from Krakatoa, the place of eruption:—

Place	Longitude	Latitude	Distance from Krakatoa, measured on a great circle	
			From west to east.	From east to west.
	° ′	° ′	° ′	° ′
Toronto	W. 79 15	N. 43 40	142 15	217 45
Valencia	,, 10 18	,, 51 55	249 31	110 29
Coimbra	,, 8 24	,, 40 13	247 58	112 2
Armagh	,, 6 39	,, 54 21	252 17	107 43
Falmouth	,, 5 4	,, 50 9	252 15	107 45
Glasgow	,, 4 18	,, 55 53	253 57	106 3
Stonyhurst	,, 2 28	,, 53 51	254 34	105 26
Aberdeen	,, 2 6	,, 57 10	255 25	104 35
Kew	,, 0 19	,, 51 28	255 27	104 33
Greenwich	,, 0 0	,, 51 29	255 39	104 21
Paris	E. 2 20	,, 48 50	256 49	103 11
Brussels	,, 4 20	,, 50 51	258 17	101 43
St. Petersburg	,, 30 20	,, 59 56	272 3	87 57
Krakatoa	,, 105 22	S. 6 9		

[1] The log of a surveying ship at the north of Borneo, since received, shows that the explosions were heard there on the morning of August 27, at a distance of 1200 miles from the volcano; and it has been also stated that these sounds were heard in Ceylon, at a distance of about 2000 miles.—R.S.

"As the earlier disturbances, on August 27 and 28, extend over several hours, it became necessary to fix on certain sufficiently well defined points in the curves representing the barometric pressure, from which to measure the epochs of the passage of successive disturbances. The *first* and *second* of the series are, in almost all the curves, well defined and generally similar in form, commencing with a distinct rise, which is again followed by a distinct fall, the fall being shorter than the rise. These features are followed by a less definite rise succeeded by a shallow fall, after which there is again a rise, which gradually passes into the more regular trace.

"The *third* and *fourth* of the disturbances can be traced in all the curves, but they no longer exhibit the same characters, and are usually nothing more than a sudden sharply defined rise, though in front of some of these there is a more or less distinct trace of a hollow.

"The *fifth* and *sixth* of the series become less distinct and are lost at several stations, being usually rises; while a *seventh* faint disturbance, as a shallow hollow, can be traced in a few of the curves, after which nothing can be distinguished.

"By a comparison of the time intervals between the first and third, the third and fifth, and the fifth and seventh disturbances, and assuming (which the facts seem to justify) that the velocity of the wave has remained unchanged in its passage from east to west, it would appear that the first well-defined rise in the first of the series corresponds to the rises which are prominent in those succeeding it. And the same conclusion has been drawn from an examination of the second and fourth compared with the fourth and sixth of the series.

"Adopting these conclusions, the times of the successive passages of the initial rise have been measured from the curves, suitable allowance having been made where the rise was difficult to trace, or, as sometimes happened, a hollow appeared corresponding in position with the hollows in the earlier form of the disturbances. There is, of course, some doubt attaching to these measurements, but their general consistency seems to indicate that they may be accepted as fairly representing the facts under discussion.

"The following table gives the results of these estimates of the times at which the successive waves passed the several stations, reckoned from midnight of Aug. 26, in Greenwich mean time:—

Place	Times of passage of wave.						
	I.	II.	III.	IV.	V.	VI.	VII.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Toronto	16 55	25 10	55 10	61 30			
Valencia	13 55	26 30	50 50	62 5	87 55	96 10	124 25
Coimbra	13 50	26 55	50 30	62 40			
Armagh	13 30	26 45	50 40	62 15	87 45	96 20	124 30
Falmouth	13 25	27 0	50 25	62 15	...	97 45	124 30
Glasgow	13 30	27 0	50 35	62 20	87 35	97 30	
Stonyhurst	13 20	26 50	50 25	62 25	87 40	97 30	124 5
Aberdeen	13 20	27 5	50 30	62 30	87 20	98 30	
Kew	13 15	27 15	50 15	62 30	...	98 0	124 5
Greenwich	13 15	27 15					
Paris	13 15	27 30	50 0	62 50			
Brussels	12 35	27 45	50 0	62 55	86 45	98 40	
St. Petersburg	11 15	28 40	48 30	63 50	84 40		

"From these figures are deduced the intervals between the successive passages of the waves from east to west, and from west to east, respectively, or of the times of travelling round the earth, which are shown in the next table, for all stations excepting Toronto.

"From the results thus obtained it would follow that the wave travelled round the earth from east to west in 36h. 57m., being at the rate of ·1026 hour for one degree of a great circle of the earth, and from west to east in 35h. 17m., being at the rate of ·098 hour for one degree. From the velocities thus determined the probable time of the origin of the wave has been calculated from the known distance of each place from Krakatoa, the time occupied in the passage of the wave from Krakatoa to the place of observation, and the observed time of the passage of the waves.

"The mean value thus obtained from the waves moving from east to west for the time of the origin of the disturbance at

Intervals occupied in travelling round the earth.

Place.	From east to west.				From west to east.		
	I. to III.	III. to V.	V. to VII.	Mean.	II. to IV.	IV. to VI.	Mean.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Valencia ...	36 55	37 5	36 50	36 57	35 35	34 5	34 50
Coimbra ...	36 40	...	...	36 40	35 45	...	33 45
Armagh.....	37 10	37 5	36 45	37 0	35 30	34 5	34 48
Falmouth ...	37 0	37 3*	37 3*	37 2	35 15	35 30	35 22
Glasgow ..	37 5	37 0	...	37 3	35 20	35 10	35 15
Stonyhurst	37 5	37 15	36 25	36 55	35 35	35 5	35 20
Aberdeen ...	37 10	36 50	...	37 0	35 25	36 0	35 43
Kew	37 0	36 55*	36 55*	36 57	35 15	35 30	35 23
Greenwich	36 45						
Paris	36 45	...	...	36 45	35 20	...	35 20
Brussels.....	37 25	36 45	...	37 5	35 10	35 45	35 28
St.Petersbrg.	37 15	36 10	...	36 43	35 10	...	35 10
Mean excluding Toronto	37 4	36 54	36 48	36 57	35 24	35 9	35 17

Krakatoa is 2·52h. Greenwich mean time, or 9·53h. local time, that is 9h. 32m. a.m. of August 27.[1]

"In like manner the waves travelling from west to east gave results which were exhibited in another table.

"The mean value of the time of the origin of the disturbance obtained from the waves moving from west to east is therefore 2·20h. Greenwich mean time, or 9·21h. local time, that is, 9h. 13m. local time.

"The mean between the two values obtained from the waves travelling against the earth's motion of revolution, and those travelling with it is 2h. 24m. Greenwich mean time, or 9h. 24m. local time, August 27.

"The velocity of the waves in miles will be for those which travel from east to west 674 miles per hour, and for those passing from west to east 706 miles per hour. The velocity of sound is for a temperature of 50° F. 757 miles an hour, and for 80° F. 781 miles an hour. With a temperature as low as zero F. the velocity will only be reduced to 723 miles an hour, which is still considerably in excess of the greater of the observed velocities. The excess of the velocity of the waves which travelled in the same direction as the earth's motion of revolution, that is, from west to east, over that of those which passed in the opposite direction, is about 32 miles an hour, which might be accounted for by the circumstance that the winds along the paths of the waves would, on the whole, be from the west, which would cause an increase in the velocity of the one set, and a diminution in that of the other, so that the observed difference of 32 miles would correspond to an average westerly wind of 16 miles an hour, which is not improbable.

"It should be observed that the path of the wave which passed Toronto approached very near to the North and South Poles, and that the velocity in both directions appeared to be somewhat less than in the waves which passed over Central Europe. The wave which passed northwards over Asia travelled at the rate of about 660 miles an hour, or about 15 miles an hour slower than the wave which passed over Great Britain from east to west. This reduction of velocity seems to be within the limits of what might be due to the low temperature of the regions.

"The wave travelling from east to west having been perceptible on the barometer traces at several of the stations until about 122 hours after its origin, and its velocity having been 674 miles an hour, it had travelled before its extinction more than 82,200 miles, and had passed 3¼ times round the entire circuit of the earth.

"It is further worthy of notice that during August 30 and 31 and September 1, a very severe cyclonic storm was crossing the North Atlantic, and that the wave coming from the westward early on the 31st, No. VI. of the series, must have passed on in front of the cyclone, and that its next transit would have carried it into the very centre of the cyclone near the British Isles on the afternoon of September 1. This perhaps ac-

* At these stations the fifth transit cannot be traced.

[1] It has not been thought necessary to give *in extenso* the table showing the separate values deduced from the several observations, but they differ from the mean by in no case more than a few minutes.

counts for no trace of it being found, though the wave coming from the eastward on the morning of that day, just before the cyclone had arrived, No. VII., was discernible.

"There is no definite statement, so far as I am informed at present, of the true time of any particularly severe shock or explosion at Krakatoa excepting that which is contained in the letter of Mr. Watson (published in NATURE, December 6, 1883), whose ship was within a few miles of the volcano on the morning of August 27. He refers to an unusually severe explosion as having occurred at 11h. 15m. a.m. local time, which is nearly 45 minutes later than the time, 9h. 32m., arrived at in the foregoing discussion. The point of the disturbance (as indicated by the barograms) which has been taken as the front of the wave is the highest point of the first abrupt rise of the trace, and is perhaps, on an average, not far from one hour after the first signs of disturbance, the increase of pressure having been very rapid during the interval, but broken into two or three steps or oscillations. During the following half hour there is usually a large decrease of pressure, succeeded by another abrupt rise lasting about half an hour. Then follow a fall of about an hour, then a rise of an hour and a half, and then a fall of an hour and a quarter. The whole length of the disturbance on the time scale is between five and six hours, corresponding to an actual distance of between 3500 miles and 4000 miles. The length of the first main wave of the disturbance is about one hour on the time scale, or about 700 miles in length over the earth's surface.

"In the present position of our knowledge of the facts, it can only be surmised that the shock of 11h. 15m. a.m. of August 27, observed by Mr. Watson, corresponds to the second main feature of the disturbance. That the wave which forms the first feature would have originated at 11h. 15m. a.m. is apparently inconsistent with the observed velocities, which it has been shown are remarkably consistent, and indicate without much doubt an origin at 9h. 32m. a.m.

"The barometric disturbance at Mauritius noted by Dr. Meldrum is said to have begun soon after 11 a.m. local time. The distance from the volcano to Mauritius being about 3450 miles, the wave at the rate of 674 miles per hour would have reached the island in 5h. 7m. Taking the great shock at 2h. 32m. Greenwich mean time, as before reckoned, the wave would reach Mauritius at 7h. 39m. Greenwich mean time, or adding the allowance for difference of longitude, 3h. 50m., the local time would be 11h. 29m., which agrees satisfactorily with the facts as recorded.

"In conclusion, it may be noticed that the sea-waves produced by this volcanic disturbance, assuming the time of its occurrence to have been 2h. 32m. Greenwich mean time on August 27, were propagated with an approximate velocity of 480 miles an hour to Mauritius, of 430 miles an hour to Port Elizabeth near the Cape of Good Hope, and 420 miles to Galle, and a somewhat slower rate to Aden. The details of the occurrence of these waves on the coasts of India will shortly be laid before the Society by Major Baird, who has informed me that the velocity of the wave between Galle and Aden was 378 miles an hour, and the lengths of the great waves from 287 to 630 miles."

"P.S.—December 15. Since the above was read before the Royal Society a copy of the barometric trace from New York has been received, which shows disturbances very similar to those recorded at Toronto, and at times which are quite in accordance with the general conclusions stated in the paper."

NOTES

IN connection with the resignation of Prof. Sylvester of his Chair in the Johns Hopkins University, we find that it was resolved at a meeting of the trustees held October 1, "That as this resignation is doubtless the result of mature reflection on the part of Prof. Sylvester, it is hereby accepted, but that in doing so the Board of Trustees cordially extend to him its hearty thanks for the invaluable services which he has rendered to the University, and also its profound sense of the great ability, the conscientious fidelity, and untiring energy with which he has discharged the arduous duties of his Chair, thereby elevating the science of mathematics to its proper plane, not only in this institution but in this country." It was also resolved "That Prof. Sylvester be appointed Professor Emeritus in the Johns Hopkins University."

IT may be remembered that at the recent Geodetic Congress the French delegates opposed the adoption of Greenwich as the universal meridian, though M. Faye was in favour of the adoption of Greenwich time. At the meeting of the Paris Academy on December 3, M. Faye, whilst supporting the proposal that the universal time should be that of Greenwich, stipulates for the civil hour instead of the astronomical hour, and for the counting of longitudes from oh. to 12h. positive towards the east and negative towards the west, instead of from oh. to 24h. reckoned towards the east, but leaving it to astronomers and navigators to employ at discretion for the universal time that according to civil or astronomical reckoning, as may seem best.

A MEETING was held in Sheffield last week for the purpose of carrying out, in connection with Firth College, a proposed technical department having reference to the trade of the district. Among those who spoke were Mr. Mundella and Dr. Sorby, and we need not say that all agreed as to the desirability of establishing such a department, and the necessity of educating our captains, as well as our privates, of industry, in the principles of their crafts. For that, Mr. Mundella insisted, is the true technical education. He gave the experience of a friend who has just been visiting the United States, and inspected the means for technical education existing there; the distinct conclusion was "that there is more skill and intelligence in American industrial pursuits than there is in our English industrial pursuits." It is much that we know our weakness and are taking means to remedy it. No doubt the Firth College will soon have a well equipped technical department.

THE Lecture Arrangements at the Royal Institution before Easter, 1884, are as follows:—Prof. Dewar, six lectures (adapted to a juvenile auditory) on Alchemy (in relation to modern science), commencing on Thursday next (December 27); Mr. R. S. Poole, two lectures on the Interest and Usefulness of the Study of Coins and Medals; Mr. A. Geikie, five lectures on the Origin of the Scenery of the British Isles; Prof. J. G. McKendrick, five lectures on Animal Heat: its Origin, Distribution, and Regulation; Prof. Ernst Pauer, six lectures on the History and Development of the Music for the Pianoforte, and its Predecessors the Clavecin, Harpsichord, &c.; Prof. Tyndall, six lectures on the Older Electricity, its Phenomena and Investigators; Prof. Henry Morley, six lectures on Life and Literature under Charles I.; and Capt. Abney, six lectures on Photographic Action, considered as the Work of Radiation. The Friday Evening Meetings begin on January 18, Prof. Tyndall on Rainbows. The discourses on the other evenings will probably be as follows:—Rev. T. G. Bonney, the Building of the Alps; Prof. Max Müller, Râjah Râmmohun Roy; Mr. G. J. Romanes, the Darwinian Theory of Instinct; Prof. Thorpe, the Chemical Work of Wöhler; Sir Frederick Bramwell, London (below bridge) North and South Communication; Prof. Hughes, Theory of Magnetism (illustrated by experiments); Mr. C. V. Boys, Bicycles and Tricycles in Theory and Practice; Mr. J. N. Langley, the Physiological Aspect of Mesmerism; Mr. Walter Besant, the Art of Fiction; Prof. O. Reynolds, the Two Manners of Motion of Water (shown by experiments).

EVERY one must wish well to the scheme for an Institute for East London, to the meeting in connection with which last Friday at the Mansion House the President of the Royal Society gave the benefit of his experience as an East End doctor forty years ago. The demand for such commodities as the Institute would furnish is strong enough; eminent men of science who have lectured in Whitechapel on their special subjects tell us

that the largest obtainable place of meeting in the district is invariably crowded.

A MEETING and *conversazione* will be held under the auspices of the National Association of Science and Art Teachers, in the Manchester Technical School and Mechanics' Institution on Saturday, December 22. Prof. Roscoe, F.R.S., will take the chair. It is expected that a large number of science and art teachers will be present, including visitors and delegates from the Liverpool, Birmingham, and Newcastle-upon-Tyne branches of the Association. It has been arranged on this occasion to bring together for exhibition a collection of apparatus, models, text-books, diagrams, and appliances of a new and interesting nature bearing upon the study of science and art. We have no doubt the meeting will be a successful one. The Association is calculated to be of great service to science teachers, and deserves encouragement. Prof. Huxley is president, and the secretary is Mr. W. E. Crowther, Technical School, Manchester.

AT the last meeting of Superintendents of National Education at Washington, Prof. Bickmore described the lectures on natural history which he now gives every Saturday to school teachers, and the first history of these lectures. The authorities of the Natural History Museum wrote to the Board of Education in New York suggesting that a select few of their teachers should come to hear an informal address upon the objects there exhibited. Sets of these lectures were attended first by those few, then by fifty, then by over one hundred teachers. They are now given to a full hall every Saturday. No continued systematic series of illustrations could be met with, so a photographer was employed to take transparencies of specimens and copies of various illustrations bearing upon the subject to be exhibited by the oxy-hydrogen light. Another lantern is also used to throw light upon the written lists and diagrams or upon objects which are arranged in pigeon-holes, upon each one of which exactly the lecturer can throw the light as it is wanted.

AFTER some interesting reflections upon the wonderful strides in population revealed by the last United States census, Dr. Harris pointed out to the same meeting how partial would be the value of any special technical education that might be given to a whole school. He urged that mechanical inventions were every day throwing out of work "hands" that had acquired manual dexterity. Education of the brain to directive intelligence is the great want. The large development of invention is set down to the study of natural science and of the phenomena of physical processes. On the other hand, the relish, by many students at least, for manual instruction leads the authorities at Boston to report that "manual training is so great a relief to the iteration of school work that it is a positive benefit rather than a detriment to the course in the other studies."

WE learn from Trondhjem that the starling has been seen for the last two winters in the north of the Trondhjem Amt, sitting on the roofs of houses at Christmas time, notwithstanding the cold, which was considerable for the season. In the present year some of the birds are again to be seen after their usual period of migration.

Naturen reports that Prof. Heiberg of Christiania has demonstrated the presence in the air passages and pulmonary substance of hares of a form of strongylus, both barren and charged with ova, which would appear to be the cause of an otherwise unexplained mortality among these animals in the autumn of last year in the district of Eidsvold in Norway.

SEVERAL Russian writers have of late been drawing attention to the fact that the Japanese seas harbour various species of fish which are poisonous. Dr. Sawtscherks even suggests that ships going to these waters ought to be provided with descriptions and representations of these suspected fish, of which twelve varieties would appear to belong to Tetrodon, *T. inermis*, the Japanese "Kanatuka," being reported as especially venomous. According to Dr. Guldrew, one Japanese fish, known as Fuku, is so poisonous that death follows almost instantaneously after eating only a moderate-sized bit of the flesh. The Japanese are forbidden by law to eat this fish, but it is nevertheless not unfrequently the cause of death among the lower classes, who believe it to be possessed of certain marvellous properties, on account of which they risk the danger of being poisoned.

IT is evident that we have much yet to learn respecting insects which habitually go through their early stages in *sea water*. In the current number of the *American Naturalist* (December, 1883) is a account by A. W. Pearson of the larva of the Dipterous family *Stratiomyiidæ* that was found by him beneath *Zostera* on the beach near the mouth of the Merrimac River. With a few exceptions all marine insects are either Coleopterous or Dipterous, and it is the latter order especially that shows itself the most diversified in point of larval adaptation to extraordinary conditions.

M. TILLO publishes in the last number of the *Izvestia* of the Russian Geographical Society the results of very accurate measurements he has made of the lengths of the rivers of Russia in Europe. The measurements have been made on the ten-versts-to-an-inch map of Russia, and present great differences with those which were published by General Strelbitsky in his work, "Superficie de l'Europe;" these last have been made on a map of a much smaller scale (sixty versts to an inch), and contain several errors. The figures of M. Tillo are, on the average, by 26 per cent. greater than those of M. Strelbitsky, showing thus the error which may ensue from measurements made on smaller maps; several rivers, as the Kama, Dnieper, Dniester, and Oka, are, in M. Strelbitsky's measurements, respectively by 200, 285, 300, and 315 versts too short; whilst the ten versts' map has given to M. Tillo a length of the Dnieper only by one-twentieth shorter than the three-versts-to-an-inch map. The chief rivers of Russia appear now with the following lengths: Volga, 2108 miles (the verst being taken equal to 0 663 miles), Ural, 1480 miles; Dnieper, 1329; Don, 1124; Kama, 1117; Petchora, 1024; and Oka, 915 miles.

IN the same periodical, M. Woeikof points out that the tea tree and the bamboo could be advantageously cultivated in Russian Transcaucasia. The most northern point where he has seen the tea tree in Japan is Akita, close by the western shore of Niphon, under 39° 45′ N. lat.; and he has been told that it is grown even at the frontier of Amovori, under the fortieth degree of latitude. The average temperature at Akita would be, according to meteorological observations at Niigata and Hakodade, about 11°·5 Cels. for the year, zero in January, 23°·5 in July, and 24°·5 in August. The tea tree grows very well also in the valleys at Ponevara, under 38° N. lat., 900 feet above the sea-level, where the average yearly temperature is no more than 12°, and that of January no more than 0°, whilst every year there falls a deep snow. As to the bamboo tree, it is cultivated under 39° 10′, 500 feet above the sea-level, on the western slope; and under 38° 35′, 400 to 450 feet above the sea-level, on the eastern slope. In the western parts of Transcaucasia, between Batoum and Tuapse, the average yearly temperature varies from 13° to 15°, and that of January is between 4°·5 to 6°·5. Both are thus higher than those of Japan. The summer is, perhaps, a little colder, but this difference would hardly exercise any influence. Even in the interior of the country, up to the Great Caucasus ridge, and east to that of Meakhi, the average temperatures at places up to 1000 feet above the sea-level would allow the culture of the tea tree. As to the rains, they are quite

sufficient in Western Transcausia, whilst in the eastern parts of the country irrigation would be necessary.

L'Astronomie states in its last number, in reference to a recent note in NATURE, that Admiral Mouchez has drawn up a memorial praying for the removal of the Paris Observatory from its present position, but that he has not yet presented it to the Council of the Observatory, but will do so at an early period. It is not the first time that the idea has been started. The proposal was made in 1868, and a Commission appointed to report on the matter. The scheme was objected to strongly by Leverrier, and finally rejected after a very sharp discussion.

THE Swedish frigate *Vanadis* has just started on a cruise round the world. King Oscar's second son participates in the cruise, as well as Dr. Hjalman Stolpe, who has been commissioned by the Government to collect materials for the nucleus of a National Ethnographical Museum in Stockholm. The frigate, whose mission is chiefly scientific, will call at many places of interest, as, for instance, the Straits of Magellan, the Marquesas and Sandwich Islands, the remarkable Malden Island, &c. A Swedish merchant, M. Fürstenberg of Gothenburg, has contributed 600*l.* for the purchase of objects of scientific value.

M. BOURDALOU, having published in 1864, in his work, "Nivellement Général de la France," that the average level of the Mediterranean is by 0·72 metres lower than that of the Atlantic, this result was received with some distrust by geodesists. General Tillo points out now, in the last issue of the Russian *Izvestia*, that this conclusion is fully supported by the results of the most accurate levellings made in Germany, Austria, Switzerland, and Spain, which have been published this year. It appears from a careful comparison of the mareographs at Santander and Alicante by General Ibanez, that the difference of levels at these two places reaches 0·66 metre, and the differences of level at Marseilles and Amsterdam appear to be 0·80 metre when compared through Alsace and Switzerland; the *Comptes Rendus de la Commission Permanente de l'Association Géodésique Internationale* arrive at 0·757 metre from the comparison with the Prussian levellings, whilst the fifth volume of the "Nivellements der Trigonometrischen Abtheilung der Landesaufnahme" gives 0·809 *viâ* Alsace, and 0·832 *viâ* Switzerland. The difference of levels at Trieste and Amsterdam, measured *viâ* Silesia and Bavaria, appears to be 0·59 metre. Each of these four results (0·72, 0·66, 0·80, and 0·59), having a probable error of 0·1 metre, their accordance is quite satisfactory, and we may admit thus that the average level of the Mediterranean is in fact lower by 0·7 metre than that of the Atlantic.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. J. L. Waldon; a Night Heron (*Nycticorax griseus*), European, presented by Mr. N. H. Fenner; two Barbary Turtle Doves (*Turtur risorius*) from North Africa, presented by Miss Stewart; four Ring-hals Snakes (*Sepedon hæmachetes*), a Hoary Snake (*Coronella cana*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Black-faced Kangaroo (*Macropus melanops* ♂) from Australia, a Broad-nosed Lemur (*Hapalemur simus* ♂) from Madagascar, an Exanthematic Monitor (*Varanus exanthematicus*) from West Africa, purchased.

OUR ASTRONOMICAL COLUMN

THE MASS OF SATURN.—Prof. Asaph Hall has communicated to the Royal Astronomical Society a note upon the mass of Saturn deduced from observations of the outer satellite *Japetus*, made with the 26-inch refractor at the Naval Observatory, Washington, in 1875, 1876, and 1877. The mean distance of the satellite from its primary, reduced to the mean distance of the latter (9·53885), was found to be 515″·522 from 128 observations. For the periodic time of *Japetus* Prof. Hall compared his own observations with one by Sir W. Herschel on Sept. 20, 1789, and with Sir John Herschel's observations made at the Cape of Good Hope in 1837. The resulting sidereal revolution is 79·3310152 days. Hence the mass of Saturn in units of the sun's mass is $\frac{1}{3482{\cdot}2}$. Bessel, from heliometric measures of the great satellite *Titan* obtained a value of $\frac{1}{3501{\cdot}6}$, which has been since used in nearly all calculations where the mass of this planet enters; Jacob, from observations of *Titan* made at Madras in 1856–58, inferred a mass of $\frac{1}{3487{\cdot}2}$, which it will be seen closely approaches that given by Prof. Hall. The value deduced by Leverrier from the theory of Uranus is $\frac{1}{3529{\cdot}56}$, and therefore is the smallest of all.

CLOSE DOUBLE-STARS.—M. Perrotin has published in the *Astronomische Nachrichten* further mea ures of double-stars made at the Observatory of Montgros, Nice, amongst which are some of the close binaries. In July last he thought 72 Ophiuchi (rather a problematical object) might be elongated in the direction 110°, but in the following month it appeared single under good conditions of atmosphere. Of the closer stars we find—

		Position	Distance
η Coronæ Borealis ...	1883·564 ...	156°·00 ...	0″·610
Σ 1938	——·595 ...	112·95 ...	0·750
ε Equulei	——·640 ...	285·57 ...	0·973
O.Σ. 395	——·667 ...	95·30 ...	0·690

PONS' COMET.—The following approximate places of Pons' comet are deduced from the provisionally corrected elements of MM. Schulhof and Bossert:—

At Greenwich Midnight

1883–4	R.A. h. m. s.	Decl. ° ′	Log. distance from Earth	Log. distance from Sun
Dec. 31 ...	21 39 4 ...	+23 54·9 ...	9·8263 ...	9·9585
Jan. 2 ...	21 53 26 ...	20 45·2		
4 ...	22 7 37 ...	17 22·8 ...	9·8098 ...	9·9409
6 ...	22 21 31 ...	13 49·5		
8 ...	22 35 3 ...	10 7·5 ...	9·8029 ...	9·9249
10 ...	22 48 9 ...	6 21·0		
12 ...	23 0 44 ...	+ 2 33·2 ...	9·8065 ...	9·9111
14 ...	23 12 45 ...	− 1 12·2		
16 ...	23 24 10 ...	4 52·7 ...	9·8201 ...	9·9002
18 ...	23 34 58 ...	8 24·9		
20 ...	23 45 8 ...	11 47·7 ...	9·8414 ...	9·8928
22 ...	23 54 41 ...	14 59·5		
24 ...	0 3 37 ...	17 59·9 ...	9·8678 ...	9·8894
26 ...	0 11 57 ...	20 48·2		
28 ...	0 19 44 ...	−23 25·1 ...	9·8966 ...	9·8901

The intensity of light is at a maximum in the middle of January. The comet will be nearest to the earth on January 9, distance 0·634, or rather less than two-thirds of the earth's mean distance from the sun. At its last appearance in 1812 it did not approach the earth within about 1·35.

TEMPEL'S COMET, 1867 II.—M. Raoul Gautier of Geneva is engaged upon a revision of the orbit of this comet, which, it may be remembered, experienced great perturbations from a near approach to the planet Jupiter during the revolution 1867–73. It may probably arrive at perihelion again about May, 1885. If there should still be unpublished observations of this comet, it would be desirable to communicate them at once to M. Gautier, that they may be brought to bear upon his investigation.

DE MORGAN'S FIVE-FIGURE LOGARITHMS.—There is a report that the five-figure tables of logarithms of numbers and trigonometrical functions published "under the superintendence of the Society for the Diffusion of Useful Knowledge," but which are usually known as De Morgan's Tables, are out of print, and that there is no present intention of a further issue. If this be the fact, it is much to be regretted: they are by far the most convenient five-figure tables that we possess, on the score of size and legibility, and have been widely utilised in astronomical calculations. Lalande's Tables, the stereotype edition of Firmin Didot, are good, and the same may be said of Gauss's, where it is of advantage to have two degrees on one opening; but we nevertheless unhesitatingly give the preference to "De Morgan."

PROBABLE NATURE OF THE INTERNAL SYMMETRY OF CRYSTALS

SOME studies pursued by the writer as to the nature of molecules have led him to believe that in the atom-groupings which modern chemistry reveals to us the several atoms occupy distinct portions of space and do not lose their individuality. The object of the present paper is to show how far this conclusion is in harmony with, and indeed to some extent explains, the symmetrical forms of crystals, and the argument may therefore in some sort be considered an extension of the argument for a condition of internal symmetry derived from the phenomena of cleavage.

If we are to suppose that crystals are built up of minute masses of different elements symmetrically disposed, it is natural to inquire in the first place what very symmetrical arrangements of points or particles in space are possible.

It would appear that there are but *five*, which will now be described.

If a number of equal cubes are built into a continuous mass (Fig. 1), a system of points occupying the centres and angles of these cubes will furnish an example of one of these symmetrical arrangements. In this system each point is equidistant from the eight nearest points, and if a number of equal-sized spheres be stacked on a base layer arranged so that the sphere centres when joined form a system of equal squares, a side of which bears to the diameter of the spheres the ratio $2 : \sqrt{3}$ (see plan *a*), the sphere centres in such a stack will also furnish an example of this first kind of symmetry (Fig. 2).

A second kind of symmetry will be presented if one-half the points in the first kind be removed so that we have only those at the cube centres, or only those at the cube angles. In this system each point is equidistant from the six nearest points, and if equal-sized spheres be stacked upon a base layer, arranged so that the sphere centres when joined form a system of equilateral triangles, a side of which bears to the diameter of the spheres the ratio $\sqrt{2} : 1$ (see plan *b*); and if the layers be so placed that the sphere centres of the fourth layer are over those of the first, those of the fifth over those of the second, and so on, the sphere centres in such a stack will also furnish an example of this second kind of symmetry (Fig. 3).

A third kind of symmetry will be presented if again one-half the points be removed, *i.e.* so that when cubes of two colours arranged in such a way that each cube is surrounded by cubes of the other colour are used (see Fig. 1), we have only the points at the centres of the cubes *of one colour*. In this system each point is equidistant from the twelve nearest points, and if equal-sized spheres be stacked upon a base layer in which the spheres are in contact, and whether they form a square pattern (see plan *c*), or a triangular one (see plan *d*)—provided that, if triangular-pattern layers be employed, the sphere centres in the fourth layer must be over those in the first, those in the fifth over those in the second, and so on—the sphere centres (the arrangement being the same in either case) will furnish a second example of the third kind of symmetry (Figs. 4 and 4*a*, the latter showing a stack with the angle removed to display the triangular arrangement).

A fourth kind of symmetry, which resembles the third in that each point is equidistant from the twelve nearest points, but which is of a widely different character from the three former kinds, is depicted if layers of spheres in contact arranged in the triangular pattern (plan *d*) are so placed that the sphere centres of the third layer are over those of the first, those of the fourth over those of the second, and so on. The symmetry produced is hexagonal in structure and uniaxal (Figs. 5 and 5*a*).

A fifth kind of symmetry, and this completes the number of very symmetrical arrangements possible, resembles the second kind of symmetry in that each point is equidistant from the six nearest points, and bears the same relation to the fourth kind (Fig. 5) as the second (Fig. 3) bears to the third (Fig. 4); that is to say, it may be regarded as produced by the insertion of additional points in positions midway between points arranged in the fourth kind of symmetry. It is depicted if triangularly constituted layers identical with those depicting the second kind of symmetry (plan *b*) are deposited in the following way (Fig. 6):—First place three layers as though to produce the second kind of symmetry; then place the fourth with its sphere centres over those of the second layer; then the fifth so that the third, fourth, and fifth, like the first, second, and third, are in the second kind of symmetry; then the sixth with its sphere centres over those of the fourth and second; and then the seventh, so that the fifth, sixth, and seventh layers are also in the second kind of symmetry; and so on. The symmetry produced is, like the last, hexagonal in structure and uniaxal.

The writer believes that every one of the various symmetrical forms presented by crystals can be shown to be consistent with the subsistence of an arrangement of the atoms of the crystallising compound in one or other of these five kinds of symmetry *at the time when crystallisation begins;* and proposes to show that a relation subsists between the atomic composition of very many bodies and their crystal forms in harmony with this conclusion.

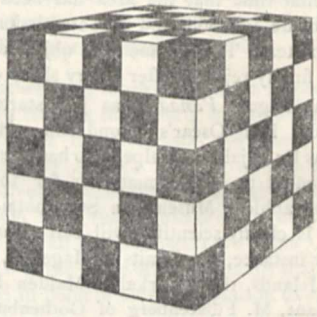


FIG. 1.

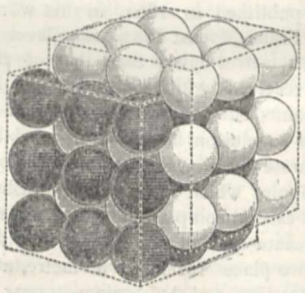
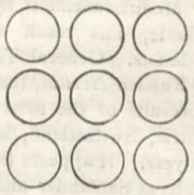


FIG. 2.



Plan *a*.

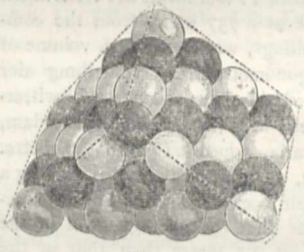
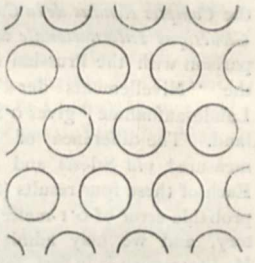


FIG. 3.



Plan *b*.

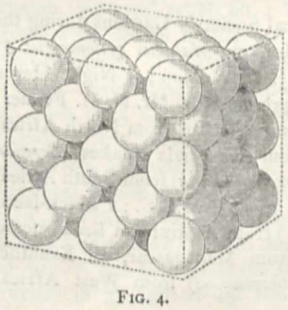
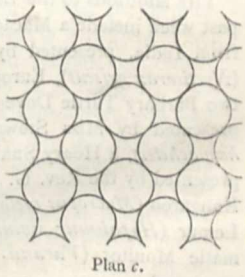


FIG. 4.



Plan *c*.

To proceed then to facts, we notice first that, as a rule, compounds consisting of an equal number of atoms of two kinds crystallise in cubes.

The following may be mentioned:—

Potassic chloride, KCl.

Potassic bromide, KBr (sometimes elongated into prisms, or extended into planes).

Potassic iodide, KI.
Sodic chloride, NaCl.
Sodic bromide, NaBr.
Sodic iodide, NaI (anhydrous above 40° C.).
Cæsi. chloride, CS. Cl.
Plumbic sulphide, PbS.
Argentic chloride, AgCl.

When we have named lithic chloride, crystallising above 15°

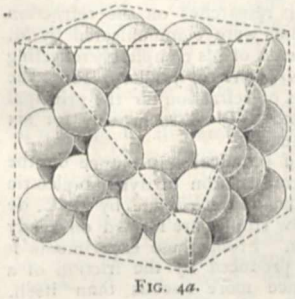
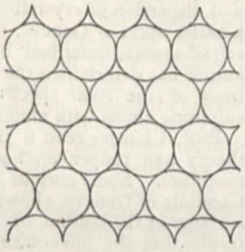


FIG. 4*a*.



Plan *d*.

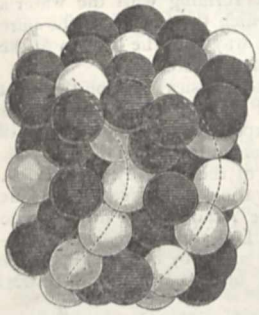
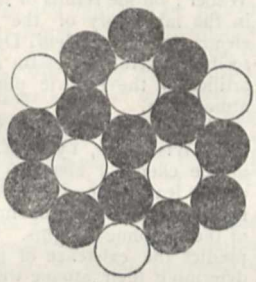


FIG. 5.



Plan *e*.

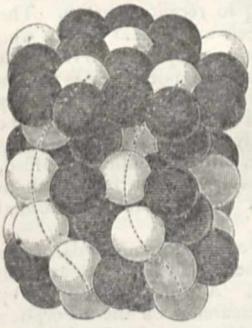


FIG. 5*a*.

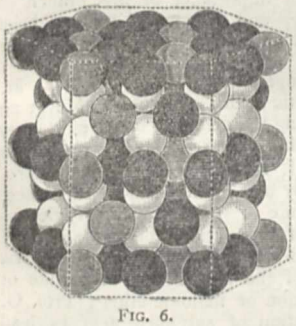
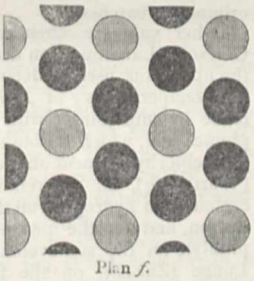


FIG. 6.



Plan *f*.

in octahedra, we have mentioned most of the compounds consisting of two elements in equal proportions known to us in a crystalline state.

Mercuric sulphide, Hg. S, which crystallises in six-sided prisms, is an apparent exception, but if we were guided by the gaseous volume of mercury in determining its atomic weight, we should have to write the compound Hg_2S.

Other apparent exceptions are :—

Zincic oxide, ZnO, crystallising in six-sided prisms.
Cadmium sulphide, CdS ; and
Glucina, GO, crystallising in minute six-sided prismatic crystals.

Now three out of our five possible kinds of internal symmetry have three axes or directions at right angles to each other, in reference to which they are disposed in the same symmetrical manner, and two kinds, the first and second, admit of a very symmetrical arrangement of two kinds of particles *in equal numbers* (see Figs. 2 and 3). Surely this coincidence is very significant, and at least suggests the probability that when a compound consists of two kinds of chemical atoms in equal numbers, these atoms are symmetrically placed according to either the first or the second kind of internal symmetry.

We observe next that the third and fourth kinds of symmetry (Figs. 4 and 5) readily lend themselves to the symmetrical arrangement of particles of two kinds present in the proportion 1 : 2. For, as already pointed out, these two kinds of symmetry may either of them be produced by piling up layers of spheres placed triangularly in contact (see plan *d*), and spheres of two colours present in the proportion of 2 : 1 can be arranged in a most symmetrical manner in layers of this kind (see plan *e*).

As to what varieties of position of bi-coloured layers of this kind with respect to one another are possible, consistent with great symmetry, we have concluded that, apart from the question of arrangement of colour, there are but two, viz. the third and fourth kinds of symmetry (Figs. 4 and 5); but taking colour into account a greater variety is possible. Thus a little consideration shows us that, while all the possible ways of depositing the second layer produce a practically identical result, a choice of six different equally symmetrical results is presented in depositing the third layer, in all of which the spheres of the less numerous colour form files of spheres in contact running through the layers, and three of which belong to the third kind of symmetry and three to the fourth.

To specify these : We may have the less numerous spheres of the third layer placed with respect to those in the second and first :—

(1) So that the three spheres of each of the files just above alluded to range in line, the lines joining their centres forming a series of parallel straight lines crossing the planes of the layers obliquely. This arrangement belongs to the third kind of symmetry.

(2 and 3) So that the centres of these three spheres, when joined, form a slightly obtuse angle ; a different result being produced as the angle is made to the right or to the left. This pair of arrangements belongs also to the third kind of symmetry.

(4) So that the less numerous spheres in the third layer are vertically over those in the first. This arrangement belongs to the fourth kind of symmetry.

(5 and 6) So that, as in (2) and (3), the triplets of spheres form a system of equal obtuse angles, but the angles now being very obtuse. There are here, as in (2) and (3), a right-handed and a left-handed arrangement. These belong to the fourth kind of symmetry.

The deposition of the third layer, by the necessities of symmetry, determines the deposition of succeeding layers, and it follows therefore from the above that six different equally symmetrical arrangements of spheres of two colours present in the proportion 2 : 1 are possible in the third and fourth kinds of symmetry.

As to (1) the parallel files of the less numerous spheres crossing the first three layers will extend through subsequent layers.

As to (2) and (3) every three continuous layers will display the less numerous sphere centres placed to form the same angles as are presented by the triplets in the first three layers, and consequently these sphere centres lie on spirals which are right-handed or left-handed as the case may be ; the less numerous spheres in the fourth layer being vertically over those in the first, those in the fifth over those in the second, and so on.

As to (4) the less numerous spheres in the fourth layer must lie vertically over those in the second, those in the fifth over those in the third, and so on ; and thus the files of spheres in contact running through successive layers form a series of similar zigzags.

As to (5) and (6) the sphere centres, as in (2) and (3), lie either on right-handed or on left-handed spirals ; in this case the less numerous spheres in the seventh layer being vertically

over those in the first, those in the eighth over those in the second, and so on (Figs. 5 and 5*a*).

When we inquire whether the symmetrical arrangements just traced are in harmony with the facts respecting compounds of two kinds of atoms in the proportions 1 : 2, we find some very important evidence.

Thus water, H_2O, crystallises in six-sided prisms or in rhombohedra; forms both of which are compatible with one or other of the above symmetrical arrangements.

And the following most interesting concurrence of facts indicates that the symmetrical arrangements in the fourth kind of symmetry above described (see Figs. 5 and 5*a*) are those of the atoms of quartz.

(*a*) Quartz consists of oxygen two atoms, silicon one atom; just the proportions in these arrangements.

(*b*) It has the property of circular polarisation, from which it has been proved that its molecules must have a *spiral* arrangement, and, since some crystals have the property of rotating in one direction, some in the opposite, that this spiral arrangement is right-handed in some crystals, left-handed in others.

(*c*) It crystallises in six-sided prisms terminated by six-sided pyramids, a form derivable, as we have seen, from the arrangements before us.

As to this last point, just a word of explanation why we must not look for the angles exhibited by our model arrangements to be identical with the angles made by the pyramid faces in quartz.

It is a matter of common observation that the process of crystallisation is generally associated with change of bulk, and if we suppose this change to arise from expansion, or contraction, generally expansion of the different kinds of atoms, and that these different kinds have *different degrees of expansion*, we see that a mass symmetrically arranged in the manner supposed will in crystallising expand or contract more in some directions than in others, and while we should look for a similar change in the direction of each of the three transverse subordinate axes of the crystal, we should look for a different change in the direction of the principal axis. And thus, supposing the mass when liquid immediately before it began to crystallise to have had the internal symmetry which has been depicted, it is evident that the unequal change of dimension in different directions might suffice to bring about such an inclination of the faces of the terminal pyramids to the sides of the prism as is actually found to exist.

In support of this explanation we have the fact that crystals not of the regular system have been found to expand unequally in different directions when subjected to heat.

Further evidence in support of the theories here submitted is found in the fact that, with scarcely any exception, the compounds we are now considering do not crystallise in the regular or cubic system.[1]

WILLIAM BARLOW

(*To be continued.*)

THE HELVETIC SOCIETY OF NATURAL SCIENCES

THE sixty-sixth session of this Society was held early in the month of August of the present year in the city of Zurich. The proceedings of the various Mathematical, Physical, Chemical, Zoological, Botanical, and Medical Departments are somewhat fully reported in the *Archives des Sciences Physiques et Naturelles*, Geneva, October 15. On August 6 a preliminary meeting was held of the delegates of the Cantonal Sections and Special Committees, and next day the session was formally opened in the Town Hall under the presidency of Prof. Cramer. The two ensuing days were devoted to the work of the several Sections, all of which were well attended by numerous Swiss and foreign savants, brought together by the double attraction of the Helvetic Society and the National Exhibition, which was also held this year in Zurich.

In the Mathematical Section, over which Prof. W. Fiedler presided, the chief papers were those of Prof. Geiser (Zurich), on surfaces of the third degree; of Dr. Rudio (Zurich), on the geodetic lines traced on surfaces of the second degree; of Prof. Fiedler (Zurich), on the intersection of equilateral hyperboloids revolving on parallel axes.

In the Physical Section, presided over by Prof. R. Clausius, M. F. A. Forel (Morges) communicated the result of his researches made to determine the limits of variation of temperature in the waters of Lake Geneva. According to his thermometrical soundings, the diurnal variation is perceptible down to a depth of from 10 to 15 metres; the summer variation from 60 to 100 metres. Exceptional winters like that of 1879-80 are felt as low as 334 metres. Since that year the temperature of the water at these great depths has been raised on an average about half a degree Centigrade.

Some preliminary results of his researches on the refraction and dispersion of crystallised alums were communicated by M. Charles Soret of Geneva. By means of his completely reflecting refractometer, described in the *Archives* for January, 1883, the author has determined the indices of refraction for the principal lines of the solar spectrum from *a* to G inclusively for six sulphuric alums with alumina base.

Prof. Clausius read a paper of practical importance on the theory and proper method of construction of dynamo-electric machines. Some curious experiments were made by M. C. de Candolle of Geneva, showing how ripples are formed on sandy surfaces at the bottom of the sea. From these experiments it results that the phenomenon is produced by the friction of a liquid mass against any substance more viscous than itself. Hence the sand may be regarded as forming with the water a viscous mixture, on the surface of which the friction of the pure liquid develops ripples in the same way that the friction of the air develops ripples on the surface of the water itself.

Amongst the other memoirs in the Physical Section the most noteworthy were those of Prof. H. F. Weber (Zurich) on liquids and gases as heat conductors; an experimental demonstration of the second principle of the mechanical theory of heat, by M. Raoul Pictet; on the determination of the ohm, by Prof. H. F. Weber; on the results of the observations and researches made in the laboratory of the Lausanne Academy on atmospheric electricity, by M. Henri Dufour of Lausanne. The author described several successful attempts made by him to reproduce artificially the electric phenomena observed in the terrestrial atmosphere.

The Chemical Section was opened, under the presidency of Prof. Wislicenus, by Prof. V. Meyer's memoir on the nature of the chemical elements according to recent research. The author leans to the views of Mendeleeff and Lothar Meyer, who regard the properties of simple bodies as the periodical functions of their atomic weights. The fact that Mendeléeff was able to predict the existence of gallium and scandium, and correctly determine their atomic weights, was adduced in support of the theory that all the elements are merely different compound forms of one primitive substance. Hence, although hitherto baffled, the attempts now being made to decompose them may result in the experimental determination of one absolute primordial substance.

Prof. F. Krafft (Basle) presented some higher alcohols of the series $C_nH_{2n}+2O$, accompanying them with some remarks on the synthesis of alcohols in general. A *résumé* was given by Prof. Louis Soret (Geneva) of his researches on the absorption of the ultra-violet rays by various substances of animal origin. The author dwelt on the great importance of this branch of spectral analysis to chemistry, and concluded with a brief description of the method and appliances used by him in his original researches.

Other valuable chemical papers were those of Dr. M. Cérésole (Lausanne), on acetacetic acids; of Prof. V. Meyer on the apparatus used in determining the densities of gases at very high temperatures; of Prof. Schulze, describing the researches made by him jointly with M. J. Barbieri on phenylamidopropionic acid, which is obtained by heating albuminoid substances with chlorhydric acid and chloride of tin; of Prof. Wislicenus (Wurtzburg), on the relation of the optical rotatory power of carburets of hydrogen, on the existence of an atom of asymmetric carbon, and on the products of the reaction of dichloride of phtalyle on the sodic combination of malonic ether; Prof. G. Lunge (Zurich), on the formation of sulphuric acid in lead chambers; Dr. Urech (Stuttgart), on a lamp fed by ether of petroleum. This lamp, constructed by C. C. Liliienfein, of Stuttgart, consists of a metallic receiver containing the ether of petroleum, and connected with a Bunsen burner slightly modified in consequence of the liquid nature of the combustible.

In the Zoological Section Prof. C. Vogt, president, the proceedings were opened by a communication from Prof. H. Fol (Geneva), on the physiological origin of the individual in the

[1] With regard to calcic fluoride (fluor-spar), which appears as an exception, it may be remarked that a different atomic weight for calcium which would enable us to write the compound CaF would enable us to get over a difficulty with regard to another compound of calcium, as we shall see presently.

higher animals. M. H. Goll of Lausanne, presented a contribution to the natural history of the sedentary and migratory coregones of Lake Neuchâtel. Memoirs were received on the Arachnidæ of Switzerland by Prof. Pavesi of Pavia; on the fauna of Guatemala, by Dr. Otto Stoll of Zurich; on some new species of Medusæ from the Red Sea, by Dr. Keller of Zurich; on the Pelagic fauna of the Swiss lakes, by Dr. Othmar-Emile Imhof of Zurich; and on the influence of the physico-chemical environments on the development of the tadpole of the edible frog, by M. E. Yung of Geneva. From experiments made by mixing marine salt in various proportions with the natural freshwater element, M. Yung arrived at the conclusion that, the more saline the water, the slower is the development of the tadpole, all transformations ceasing in solutions of 9/1000, and death following in a few hours in solutions of 10/1000.

In the Botanical Section, Prof. Cremer, president, valuable memoirs were received from Prof. O. Heer of Zurich, on the Glacial flora of Switzerland, and on the fossil flora of Greenland. These were the last pages contributed to science by the distinguished savant, who had scarcely finished the revisal of the proofs when he died suddenly at Lausanne, on September 27. A series of hybrids between the *Primula auricula* and *Primula viscosa*, showing an uninterrupted series of forms intermediate between these two species, was exhibited by Prof. Favart of Lausanne. He also showed that the *Cardamine fossicola*, Godet, hitherto classed with the *C. pratensis*, Lin., should be grouped with the *C. matthioli*, Moretti. Some remarks were made by Prof. Schnetzler of Lausanne on a monstrosity of the Chinese primrose, and on the relation between an aërial alga (*Chroolepus umbrinus*) and a lichen (*Pyremula* sp.) M. C. de Candolle described the results of his attempts to determine how far any light may be thrown on the disputed origin of the *Cytisus adami* by the anatomical structure of its leaves. This plant, which suddenly made its appearance in the nursery of Adam at Vitry, near Paris, early in the present century, and which is remarkable for producing red and yellow blossoms mostly on separate branches, is usually regarded as a cross obtained by grafting the *Cytisus purpureus* on the *C. laburnum*. But M. de Candolle concludes that it is not a hybrid, but simply a degenerate variety of the *C. laburnum*.

In the Medical Section, Prof. von Kölliker, president, Prof. Klebs of Zurich read a remarkable paper on the transformations of the human species, which he regards as mainly the result of pathological influences.

Valuable communications were also made on the centres of origin of the optic nerves and on their relation to the cerebral cortex, by Dr. C. von Monakow of St. Petersburg; on the relations existing between the excitability and vulnerability of certain muscular groups, by Prof. Luchsinger of Berne; and on the mechanism of the ruminating process, by the same author.

The report on the Geological Section was unavoidably postponed to the November issue of the *Archiv s.*

NOTES FROM THE OTAGO UNIVERSITY MUSEUM

IV.—*On the Structure of the Head in "Palinurus," with special reference to the Classification of the Genus*[1]

THE genus *Palinurus* was divided by Milne-Edwards into two groups or sub-genera—one, the "Langoustes ordinaires," containing species in which the antennulary flagella are short, the bases of the antennæ approximated, and the rostrum present; while the other, or "Langoustes longicornes" (*Panulirus*, Gray; *Senex*, Pfeiffer), contains species in which the antennulary flagella are short, the antennæ widely separated at their proximal ends, and the rostrum absent.

In this classification, which is still in the main adopted by systematists, no notice is taken of the stridulating organ, first mentioned, I believe, by Leach, in *P. vulgaris*, and described at length by Möbius, and later by myself, in the same species.[2] This unique sound-producing apparatus is present in all the "Langoustes longicornes" which I have yet examined, as well as in *P. vulgaris* and *P. trigonus* among the "Langoustes ordinaires"; while in all the remaining members of the latter group which have come under my notice (*e.g.* the common New Zealand species, *P. lalandii* and *P. edwardsii*) there is no trace of it.

There is also great diversity among the "Langoustes ordinaires" in the development of the rostrum, the true size of which can only be seen in a longitudinal vertical section of the head (see Fig. 1). In *P. lalandii* and other non-stridulating species, the rostrum (A, *r*) is well developed, and bears comparison with that of *Homarus*, while in *P. vulgaris* (B, *r*) it is a mere spiniform tubercle meriting special description only from its position. *P. vulgaris*, moreover, has no trace of procephalic processes, which are present, though small, in *P. lalandii* (A, *pc.p*).

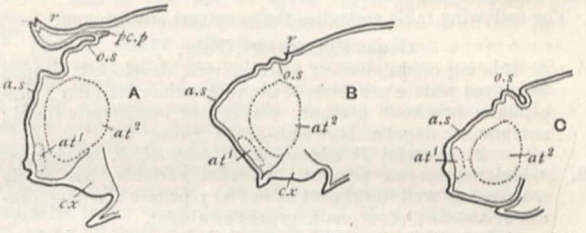


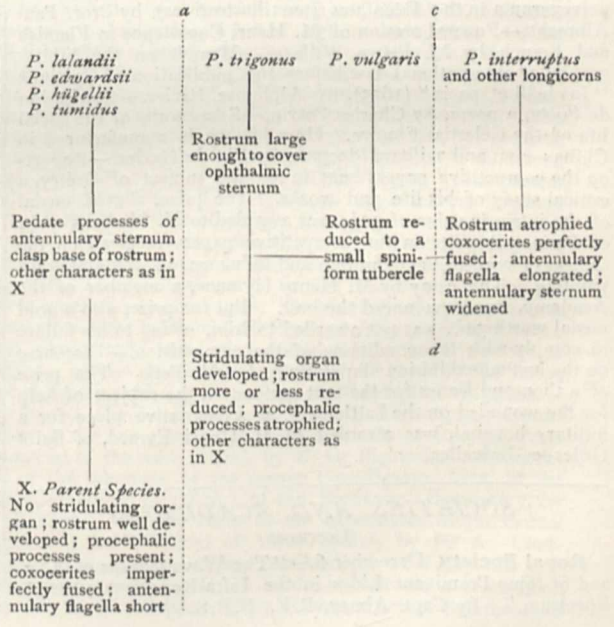
FIG. 1.—A, Longitudinal vertical section of the head of *Palinurus edwardsii*: B, of *P. vulgaris*: C, of *P. interruptus*. *as*, antennulary sternum; *at*¹, articular cavity for antennule; *at*², for antenna; *cx*, unanchylosed part of inner wall of coxocerite; *o.s*, ophthalmic sternum; *r*, rostrum; *pc. p*, procephalic process.

The woodcut shows that as regards both the rostrum and the antennulary sternum (the fixed part of the stridulating organ), *P. vulgaris* (B) approaches far more nearly to the "Langoustes longicornes," as represented by *P. interruptus* (C), than to the non-stridulating "Langoustes ordinaires," as represented by *P. edwardsii* (A).

On the other hand, all the brevicorn species examined agree in the imperfect fusion of the coxocerites or proximal segments of the antennæ. A transverse section taken immediately in front of the renal apertures shows that a small portion of the adjacent or inner walls of the coxocerites in *P. lalandii*, *P. vulgaris*, &c., are merely in apposition, whereas in the longicorn species concrescence is complete.

Assuming that the *Palinuridæ* are derived from an Astacoid or Homaroid ancestor through some such intermediate form as *Palinurellus*, one cannot but conclude that the species which have no stridulating organ, a well-developed rostrum, procephalic processes, and imperfectly fused coxocerites, come nearest to the parent stock, and that those in which the stridulating organ is developed, the rostrum and procephalic processes absent, and the coxocerites completely united with one another, have diverged most from that stock, and present us with the extreme of modification of the Palinuroid type.

This view is expressed in the following phylogenetic table:—



[1] Abstract of a paper taken as read at a meeting of the Otago Institute, September 12, 1883, and to be published in the next (16th) volume of the *Transactions of the New Zealand Institute*.

[2] Leach, "Malacostraca podophthalmata Britanniæ"; Möbius, *Archiv für Naturgeschichte*, 1867; T. J. Parker, *Proc. Zool. Soc.*, 1878, p. 442.

In a natural classification of the genus the most fundamental separation appears to me that along the dotted line *a b* dividing the non-stridulating from the stridulating species. This division once made, the stridulating species fall into two natural subdivisions, expressed in the table by the line *c d*, which divides the brevicorn from the longicorn forms.

I think the most convenient classification is obtained by dividing the species along the two lines *a b*, *c d* into three subgenera, one identical with the "Langoustes longicornes" of Milne-Edwards, the others formed by splitting up the "Langoustes ordinaires" into species with and species without a stridulating organ.

The following table embodies the proposed arrangement:—

Genus PALINURUS, Fabr.

A. Stridulating organ absent; rostrum well developed, clasped by paired pedate processes of the antennulary sternum; procephalic processes present; coxocerites imperfectly fused; antennulary flagella short (sub-genus *Jasus*, T. J. P.).
P. lalandii, *P. edwardsii*, *P. hügellii*, *P. tumidus*.

B. Stridulating organ present; rostrum variable, but rarely (? never) as well developed as in (A); pedate clasping processes absent; procephalic processes absent.

a. Antennulary sternum narrow below, bases of antennules being hidden, in a view from above, by bases of antennæ; coxocerites imperfectly fused; antennulary flagella short (sub-genus *Palinurus*).

α. Rostrum well developed, covering ophthalmic sternum. *P. trigonus*.

β. Rostrum reduced to a small spiniform tubercle; ophthalmic sternum uncovered. *P. vulgaris*.

b. Antennulary sternum broad below, bases of antennules being visible from the dorsal aspect; coxocerites perfectly fused; antennulary flagella long (sub-genus *Panulirus*, Gray; *Senex*, Pfeiffer).
P. interruptus, *P. fasciatus*, &c., &c.

Dunedin, N.Z., October 2 T. JEFFERY PARKER

SCIENTIFIC SERIALS

Bulletin of the Belgian Royal Academy of Sciences and Belles Lettres, October 4.—Obituary notices of the late M. Joseph Plateau, by MM. Duprez, Valerius, and Liagre.—Second communication on the discovery of the fossil iguanodon at Bernissart, by P. J. Van Beneden.—Researches on the absolute force of the muscles of the Invertebrates; Part I. Absolute force of the adductor muscles in the lamellibranch molluscs (four illustrations), by M. Félix Plateau.—Note on a new optical illusion, by H. Valerius.—Remarks on the action of lightning conductors constructed on the Melsens system, by H. Valerius.—Arithmetical and algebraic theorems, by E. Catalan.—Note on the pelvisternum in the Edentates (ten illustrations), by Prof. Paul Albrecht.—Funeral oration of M. Henri Conscience in Flemish and French, by M. Pierre Willems.—Memoir on the bibliography of international law before the publication of Grotius's "Jus belli et pacis" (1625), by Alphonse Rivier.—Confession de Poète, a poem, by Charles Potvin.—Some traits of the social life of the Celestial Empire. How history is manufactured in China; civil and military decrees, by Ch. de Harlez.—Reports on the competitive papers sent in on the subject of Grétry, a critical study of his life and works. The prize, a gold medal of the intrinsic value of 32*l*., was awarded to M. Michel Breuet of Paris.—Reports on the competitive papers received on the subject of realism, its definition and influence on contemporary painting. The essay by M. Henry Hymans, a member of the Academy, was pronounced the best. But the prize, also a gold medal worth 32*l*., was not awarded to him, owing to his failure to comply with the conditions of the competition.—Discourse on the annual exhibition of paintings, by M. Fetis. The prize of a thousand francs for the best cartoon on the subject of help for the wounded on the battle-field, as a decorative piece for a military hospital, was awarded to M. Henri Evrard, of Saint Gilles-lez-Bruxelles.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 6.—"The Wave-lengths of A, *a*, and of some Prominent Lines in the Infra-Red of the Visible Spectrum." By Capt. Abney, R.E., F.R.S.

M. Fievez has recently sent the author a map of the solar spectrum from C to A ("Annales de l'Observatoire Royal de Bruxelles," nouvelle série, tome v.) inclusive, and as part of this region is one which he is measuring, he examined the new publication with great interest. Photography and eye measurements do not coincide in the detail of the grouping of the little *a* group, or from there as far as A, and A itself is shown by M. Fievez's map as wanting in some details which appear in the photographs. The wave-lengths of the different lines from above "*a*" to A are not tho e given by Fievez, when comparison photographs o the 1st order of the red with the 2nd of the ultra-violet weref taken on the same photographic plate, or when the 2nd order of the red is compared with the 3rd order of the green taken in a similar manner. Prof. Rowland's concave gratings were employed for this comparison. Cornu's map was used as a reference for the ultra-violet wave-lengths, and Ångström's map for those in the blue and green.

Description of line	λ from comparison of 1st and 2nd orders	λ from comparison of 2nd and 3rd orders	λ according to Fievez	Remarks
"*a*"	7184·4 7185·4	7184·5 7185·4	7197·7 7198·7	This is shown in Ångström's map as a single line λ 7184·9.
Most refrangible edge of A.	7593·6	7593·7	7600·0	Ångström gives 7604 for the centre of this line; which of the bands he took as A is not clear. Langley gave 7600·9 for this edge.
Centre of 6th pair of lines in the flutings following A.	7644·2	7644·33	7652·2	

The determination of A has been made by Mascart, Smythe, and others, besides Ångström and Langley, with discordant results. The above may be taken as accurate, as are Cornu's and Ångström's maps.

The following are wave-lengths of some of the principal lines in the infra-red. The scale numbers refer to the author's map of the infra-red, which is published in the *Phil. Trans.*, Part II., 1880:—

Scale number	Description	Wave-lengths
1046	This line is a double, of which the components have the accompanying wave-lengths.....	8226·4 8229·9
1441	.....	8496·8
1509	.....	8540·6
1685	.....	8661·0
2175	A double line, the components of which have the accompanying wave-lengths	8986·2 8989·5
2638	" " "	9494·5 9500·1
3161	.....	9633·8

Mathematical Society, December 13.—S. Roberts, F.R.S., vice-president, in the chair.—The following were elected members:—Messrs. A. B. Basset, H. Fortey, R. T. Glazebrook, F.R.S., G. Heppel, J. J. Thomson, H. H. Turner, and Prof. W. Thomson, Cape Colony.—The following papers were communicated:—The form of standing waves on the surface of running water, by Lord Rayleigh, F.R.S.—A method of finding the plane sections of a surface and some considerations as to its extension to space of more than three dimensions, by Mr. W. J.

C. Sharp.—On a deduction from the elliptic-integral formula $y = \sin(A + B + C \ldots)$, by Mr. J. Griffiths.

Linnean Society, December 6.—Sir John Lubbock, Bart., president, in the chair.—H.H. Maharajah of Travancore, and Messrs. C. A. Barber, E. Bostock, H. Friend, J. Hannington, J. S. Hicks, J. Richardson, R. Tate, and H. Tisdall were elected Fellows of the Society.—Mr. B. Daydon Jackson exhibited a specimen of "Mexican whisks," known also in the London market as "chien-dent," which are now imported in considerable quantity from the vicinity of La Puebla in Mexico. It is believed to be derived from a species of *Andropogon*, but is in bulk coarser than the similar material from Southern Europe from *Andropogon gryllus*, and finer than the species of *Panicum* used in India for brushes.—Mr. Arthur Bennett exhibited a specimen of *Carex ligerica* gathered by Mr. Cunnack on the Scilly Isles (Cornwall), and believed by him to be a sterile form of *C. arenaria*, but identified as *C. ligerica* by Prof. Babington, and therefore new to science. Mr. Bennett also drew attention to locally so-called "vegetable hedgehogs," these being agglomerated larch leaves (having some resemblance to a rolled hedgehog) found in the Shropshire meres.—A large number of Lepidoptera from the district of Georgetown, Colorado, and a few from Missouri were exhibited by Mr. Ernest Jacob, who had collected them while engaged in the U.S.A. Geological Survey in the above districts, 1880-81.—A series of dried plants from Australia were shown on behalf of Mr. James Robertson.—Mr. Charles Darwin's paper on instinct (noticed in our last week's issue) was then read by the Zoological Secretary, and an important discussion followed, in which Mr. Wallace, Profs. Huxley, Allman, Mivart, Foster, Lankester, Mr. McLachlan, Mr. Seebohm, and others took part.

Zoological Society, December 4.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. Philip Crowley, F.Z.S., exhibited and made remarks on an egg of a Bower-bird from Southern New Guinea, supposed to be that of *Chlamydodera cerviniventris*.—Sir Joseph Fayrer, F.Z.S., exhibited a shed deer-horn, apparently gnawed by other deer, and made remarks on this subject.—Mr. Sclater exhibited, on the part of Dr. George Bennett, F.Z.S., four skins of a species of Paradise-bird of the genus *Drepanornis*, obtained in the vicinity of Port Moresby in Southern New Guinea. Mr. Sclater considered this form to be only subspecifically different from *D. albertisi* of North-eastern New Guinea.—Mr. W. Burton, F.Z.S., exhibited a supposed hybrid between a male blackcock and a hen pheasant.—Mr. R. Bowdler Sharpe gave descriptions of some new species of Flower-peckers, viz.:—*Dicæum sulaense*, from the Sula Islands; *D. pulchrius*, from South-eastern New Guinea; and *D. tristrami*, from the Solomon Islands. The author added some critical notes on other species of *Dicæum* and *Prionochilus*.—Mr. J. B. Sutton read a paper on the diseases of monkeys dying in the Society's Gardens, on which he gave many interesting details. Mr. Sutton called special attention to the prevalence of the belief that monkeys in confinement generally die of tuberculosis, and showed that such is not really the case.—Mr. H. O. Forbes, F.Z.S., read a paper describing the peculiar habits of a spider (*Thomisus decipiens*) as observed by him in Sumatra.—A second paper by Mr. Forbes gave an account of some rare birds from the Moluccas and from Timor Laut. To this the author added the description of a new species of Ground-Thrush from Timor Laut, which he proposed to call *Geocichla machiki*, in acknowledgment of services rendered to him by Dr. Julius Machik in Sumatra.—A communication was read from Prof. J. von Haast, F.R.S., containing notes on *Ziphius* (*Epiodon*) *novæzealandiæ*, in continuation of a former paper read before the Society on the same subject.—A second communication from Prof. Haast gave a description of a large Southern Rorqual (*Physalus* (*Balænoptera*) *australis*) which had been washed ashore dead on the New Brighton beach about five miles from Christchurch, New Zealand. Prof. Haast was doubtful as to the distinctness of this animal from *Balænoptera musculus* of the Northern Atlantic.—Mr. G. French Angas, C.M.Z.S., read some notes on the terrestrial Mollusca of Dominica collected during a recent visit to that island.

Mineralogical Society, December 11.—The Rev. Prof. Bonney, president, in the chair.—The following papers were read:—On some specimens of lava from Old Providence Island, by the President.—On the evidence of the occurrence of nickel iron with Widmanstätten's figures in the basalt of North Greenland, by Prof. K. T. V. Steenstrup.—Note on a new mode of occurrence of garnet, by H. Louis.—A chemical examination of the Greenland telluric iron (translated from "Medelelser fra Grönland," Heft 4, 1883), by Joh. Lerenzon.—At 9 p.m. (pursuant to notice) the meeting was made special, and the members of the Crystallographical Society were elected members of the Society, a portion of the rules relating to election being for the time suspended.

Dublin

University Experimental Science Association, Nov. 13.—Prof. V. Ball in the chair.—On the magnetophone, by Prof. Fitzgerald. A new form of the instrument was exhibited by W. V. Dixon. In this a diaphragm removed from a telephone is placed in close proximity with one extremity of a bar magnet, at the other extremity of which small masses of soft iron fixed radially on an axle are rotated. A note is produced at the diaphragm.—On the phenomena attending pressure on sensitive plates, by W. Hogg. Experiments confirmatory of those described by Capt. Abney were made, and enlarged photos of the developed marks shown. Similar experiments on sensitive albuminised paper were described by P. M. Crosthwaite; the use of paper allowed of considerable pressure being applied.—On compound locomotives, by F. Trouton.—On the identification of minerals by means of their specific heats, by J. Joly.—On the deposition of metallic copper in cracks, by N. M'J. Falkiner.—Experiments gave results similar to those obtained by Becquerel.

Manchester

Literary and Philosophical Society, November 27.—H. E. Roscoe, F.R.S., president, in the chair.—On the fungus of the salmon disease—*Saprolegnia ferax*, by H. Marshall Ward, M.A., Fellow of Christ College, Cambridge.

Paris

Academy of Sciences, December 10.—M. Blanchard, president, in the chair.—Note on a new compound of rhodium, by M. H. Debray.—On the quantities forming a group of nonions analogous to the quaternions of Hamilton, by M. J. Sylvester.—Summary report on the geological, botanical, zoological, and anthropological work accomplished by the French mission to Cape Horn, by Dr. Hyades. In the southern islands of the Fuegian Archipelago the prevailing rocks were found to be schists and granites greatly weathered wherever unprotected by vegetation. The dwarf Antarctic beech is limited to an altitude of 400 metres, the *Fagus betuloides* to 300, forming with the Drimys and Berberis a forest zone with a humid soil poor in vegetable humus, and covered with mosses, heaths, and a considerable variety of small plants. The marine flora abounds in all kinds of algæ (the most common being the *Macrocystis pyrifera*), affording a shelter to numerous zoophytes, Annelidæ, mollusks, Crustaceæ, and migratory fishes of eight or ten species. Of the shell-fish, which abound on most of the seaboard, all the large species are edible. Although poorer than the marine, the land fauna includes several species of Coleoptera, Lepidoptera, Arachnidæ, some forty species of birds, but no reptiles or frogs. The mammals are represented only by one species of fox, two rodents, and an otter, besides the domestic dog. The natives all belong to the Tekeenika stock of Fitzroy, called Yahgans by the present English missionaries. They speak an agglutinating language current from the middle of Beagle Passage to the southernmost islands about Cape Horn. About 1000 words of this language were collected, including some abstract terms, such as *tree*, *flower*, *fish*, *shell*. The numerals get no further than *three*, although the natives count also on the fingers. Over a hundred anthropometric observations were taken on individuals of all ages and both sexes. Good photographs were also obtained of a large number of Fuegians, besides numerous castings of all parts of the body, some skeletons, and a great variety of ethnological materials.—Note on the *Phylloxera gallicola*, by M. F. Henneguy.—Observations on the new planet 235 made at the Observatory of Paris (equatorial of the west tower), by M. G. Bigourdan.—Observation of the spectrum of the comet Pons-Brooks, 1812, at the 14-inch equatorial (0·378 m.) of the Bordeaux Observatory, by M. G. Rayet.—On the form of the expressions of the mutual distances in the problem of three bodies, by M. A. Lindstedt.—On the number of the permutations of n elements presenting s sequences, by M. D. André.—Note on a theorem of Liouville, by M. Stieltjes.—New demonstration of two theorems

of M. Bertrand, by M. Georges Ossian Bonnet.—Formulas giving the electric resistance of the circuit employed in the Edison system of electrical lighting, by M. G. Guéroult.—Observations relative to a method of studying earth currents, in connection with a communication recently made by M. Blavier, by M. F. Larroque.—Researches on the solidification of superfused sulphur (second part), by M. D. Gernez.—Determination of the equivalent of aluminium by means of its sulphate, by M. H. Baubigny.—On the formation of acetylene at the expense of the iodoform, by M. P. Cazeneuve.—New researches on the susceptibility of the eye to differences of luminous intensity, by M. Aug. Charpentier.—Cholera, small-pox, typhoid fever, and charbon amongst the coppersmiths of Villedieu, by M. Bochefontaine. Although the whole atmosphere of the place is, so to say, saturated with copper, nine of the inhabitants of Villedieu, all engaged in the copper industry, fell victims to cholera in 1849. Considering the difference of population, this would represent a mortality of 5700 in Paris. Nearly half of the population was attacked by small-pox in 1870, and a fatal case of charbon occurred in 1865.—On the existence and distribution of eleïdine in the bucco-œsophagian mucous membrane of mammals, by M. L. Ranvier.—On the genus Vesquia, a fossil yew found in the Aachen formations of Tournai, by M. C. Eg. Bertrand.—On a luminous phenomenon observed after sunset at Amiens on several evenings about the end of November and beginning of December last, by M. Decharme. The author feels inclined to attribute these effects to the aurora borealis. Details of similar manifestations observed in other places were quoted from a recent number of NATURE.

BERLIN

Physical Society, November 30.—Dr. Kayser placed before the meeting a concave grating sent by Prof. Rowland to the Physical Institute, explained the principle of this apparatus, and exhibited a photograph of the normal spectrum produced by help of the grating, as also a negative prepared by Prof. Rowland, on which Dr. Kayser was able with the naked eye to count between the two H lines over seventy fine lines, among which some appeared to form groups, so that by means of a microscope many more lines still would be distinguishable.—Prof. von Helmholtz next gave a minute report of the continuation of the experiments he had instituted with a view to explaining galvanic polarisation according to thermodynamic principles. Suppose that an electric current passed through a liquid completely free of gas, then would the gases generated by decomposition of the electrolyte be first absorbed by the liquid, and only after the latter was saturated to a degree corresponding with the pressure of gas resting on it would the development of gas begin. The previous solution of gas in the liquid was the expression of an attraction or of a molecular energy between the water and the gas, which acted in the same direction as did the electromotive energy which decomposed the electrolyte at the electrode. The absorption of the gas, therefore, agreeably with the teaching of the mathematical theory, increased the electromotive energy, and all the more so the less gas the liquid contained. This accorded with the experience derived from experiments that the convective current was so much the stronger by how much the less gas the fluid had absorbed. If the liquid already contained gas in solution, a part of it would escape at the surface by a kind of dissociation, and form above the liquid an atmosphere the pressure of which corresponded with that of the momentary saturation of the liquid. This dissociation of the solution represented a work which could reciprocally be applied to the conversion of gas to a liquid state; that is to say, supposing the conditions were such that the temperature of the system was maintained throughout unaltered, the whole process was a reversible one. With this consideration let one start from any normal condition whatsoever, from atmospheric pressure for example, then it was the teaching of the theory that the work was all the greater the less was the quantity of gas in solution, and in the case of very small gas volumes the work would be endless, that is to say, in every fluid were dissolved minute quantities of gas which could no longer be discharged. If the electrolytic fluid contained oxygen in solution, as in fact was regularly the case, the oxygen would be drawn by convection towards the oxygenous electrode, and there augmented by the oxygen which had been electrolytically separated, and after loss of its electricity become neutral. The gas would now begin to diffuse itself towards the other, the hydrogenous electrode, and this diffusion would produce the polarisation current which, just as much as the diffusion stream, was opposed to the electrolytic current and convection. The quantity of oxygen in the fluid and its diffusion might be illustrated by a curve which ascended from the hydrogenous electrode as its zero point rectilinearly to the oxygenous electrode, and so long as the electromotive force remained the same at the electrodes a state of equilibrium was maintained between electromotive force, convection, polarisation current, and diffusion; a state of equilibrium which was disturbed when the current was interrupted for however short a time. The theory of these processes taught, what experience confirmed, that a much greater electromotive force was required after the interruption to re-establish electrolysis than was before needed to continue the process. If the fluid were saturated with gas to a degree corresponding with the pressure of gas resting on it, the gases generated by electrolysis escaped. Seeing, however, that the degree of saturation was dependent on the pressure of gas, therefore, with the increase of gas pressure, the electromotive force which caused the development of gas would likewise have to be increased. It was now sought to ascertain the least electromotive force that was sufficient under a definite pressure to cause a development of gas, and the experiments made with this object in view showed that the development of the first bubbles had to overcome a considerable resistance, and therefore demanded intenser currents than were needed for later gas bubbles. When, by a definite current through an extended metallic wire, gas was developed in an electrolyte, by lessening the electromotive force it was possible to produce only single gas bubbles at one point of the wire. The same amount of electromotive force which was sufficient to produce this effect was not, however, equal to the generation of bubbles from the outset. To effect this latter result, a much stronger current would have to be employed. All these processes and relations here briefly indicated were mathematically calculated, and the results of the experiments invariably coincided with the teachings of the theory.

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