THURSDAY, DECEMBER 23, 1880

## THE FOGS OF LONDON

LAST week Mr. Scott Moncrieff described in our columns a method of all but entirely eliminating smoke from the atmosphere of London, and thus abolishing that most venerable of our institutions—Fog. And in a recent number Dr. Siemens showed how our existing grates could be made to give out a maximum of heat at a minimum of expense and an entire absence of smoke. It may therefore be of some interest to inquire briefly into the latest theories as to the causes and consequences of this hideous incubus which renders residence in London a terror to so many.

Fogs are supposed to form a constituent part of the climatology of the British Islands from which there is no escape; and in certain strictly local climatologies, such as that of London, where the aggregation of human beings is altogether unprecedented, they now and again acquire an extraordinary intensity and persistency, and are attended with consequences so disastrous and fatal as to press urgently on Parliament the necessity of legislation towards the mitigation of the evil.

In illustration of this, reference may be made to the influence on the mortality of London exercised by the fog which prevailed there from November, 1879, to February, 1880, which was so remarkable both for its denseness and protractedness, as to constitute it one of the most memorable fogs on record. The question has been investigated by Dr. Arthur Mitchell, and the results recently published in the *Journal* of the Scottish Meteorological Society.

The increase in the death-rate was truly enormous, as these figures, giving the whole mortality for each of the seven weeks ending February 21, show—1754, 1730, 1900, 2200, 3376, 2495, and 2016; in other words, several thousand persons fell victims to the disastrous fatality of this great fog. An examination of the figures in the Registrar-General's Reports shows that no approach to so large an increase in the death-rate showed itself in any of the other British large towns, and in none of these did fog of a noteworthy character occur. Of all diseases, asthma was most directly influenced in its fatality by the fog; for as the density of the fog increased so did the deaths from asthma, and as the fog abated, relief came at once to the asthmatic, and the death-rate instantly fell. Thus the mortality rose to 220 per cent. above the average during the week of densest fog, but as the fog gave way the mortality fell to 40 per cent. below the average. Bronchitis, pneumonia, pleurisy, and other lung diseases appeared also with an enormously increased fatality, the mortality from bronchitis rising during the week when the fog was at its worst to 331 per cent. above its average. In the case of these diseases however the relief did not come instantaneously with the cessation of the fog, but injuries of a more permanent nature appear to have been sustained which kept the death-rate at a high figure for some time after the fog had finally disappeared. Whooping-cough exhibited these characteristics in even a still more pronounced manner. The pernicious effects of the fog lingered still longer in the system; so that while the death-rate rose during the worst week of the fog to 182 per cent. above the average, four weeks thereafter it had fallen no lower than 74 per cent. above the normal mortality of whooping-cough. It is singular, and particularly to the medical profession profoundly interesting, that deaths from croup, diphtheria, and rheumatism did not show any distinct relation to the fog. As regards the other diseases, the deaths from which are registered, they equally did not appear to show any steady connection with the fog's varying denseness and persistency.

This pernicious and deadly character of fog on persons suffering from these diseases is not due to fog as such, but to the noxious qualities imparted to it by our large towns. Dr. Angus Smith has shown that the air of Manchester during an extremely dense fog contained 20·85 per cent. of oxygen, or one-tenth per cent. less than the normal quantity. The pernicious character of fog however is to be traced not so much to this slight diminution of atmospheric oxygen as to the presence of positively deleterious substances.

The smoke which issues from our dwelling-houses contains, in addition to solid soot, also gaseous carbonic acid, sulphurous acid, carbon monoxide, sulphide of ammonia, and sometimes minute traces of arsenic. Moreover the soot does not consist of particles of carbon only, but carbon saturated with tarry matters, sulphur and ammonia compounds, &c. Smoke from manufactories is usually more completely burned than that from dwelling-houses, and is therefore less deleterious. In many cases however manufactories pour out into the air their own specific hurtful gases. Of these gases the more pernicious are mineral acids, especially sulphuric and hydrochloric acids, sulphuretted hydrogen, sulphur dioxide, and oxide of arsenic. Gases rising from decaying animal and vegetable matter in waste heaps and in faulty sewers also lend their aid in the contamination of the atmosphere of towns. In the neighbourhood of various manufactories solid impurities crowd the air, resulting in a denseness of fog in these restricted localities with an accompanying suffering and fatality elsewhere unknown.

In February last we drew attention (NATURE, vol. xxi. p. 355) to the question of fogs and the general atmospheric conditions under which they are generated, when the importance in discussing the question of fogs of a careful study of the anticyclone and its accompaniments was adverted to. Indeed it is in the highest degree probable that all our memorable great fogs are intimately connected with the anticyclone, being found towards their outskirts or rather in the debatable region between the cyclone and the anticyclone. They arise from the diffusion of the vapour brought up by the cyclone outwards and through the colder and drier air of those parts of the anticyclone contiguous to it, where it is condensed into immense breadths of fog stretching several hundred miles in length.

The two features of the anticyclone to which more special attention is directed are these: (1) the calmness or comparative calmness of the air; and (2) the *slow downward general movement of the atmosphere over the region covered by the anticyclone*, and a general outward movement in all directions towards surrounding regions as we near its outskirts.

Consider now this feature of the anticyclone in its

relation to the vast quantities of deleterious matters which are vomited into the atmosphere from the chimneys of London. The horizontal movement of the air is at a minimum, and thus altogether insufficient to sweep these noxious matters out into the surrounding country. The impurities therefore ascend into the air over London; and when no longer buoyed up by the warmer air with which they began the ascent, they fall under the influence of the general downward movement of the atmosphere; and this downward movement is accelerated by the solid impurities becoming saturated with condensed aqueous vapour, coal-oil, and tarry substances. Hence the specially noxious fogs of large towns settle near the surface, are no more than a few fathoms in depth, and are at the maximum where chimneys are planted thickest, the situation low-lying and confined, and where consequently the horizontal circulation of the air is absolutely arrested.

If we would then overcome, or in any way mitigate, the terribly fatal effects of our city fogs, it can be done in no other way than by Parliament interposing with a legislation which will not only effectually stop the emanation of deleterious exhalations from manufactories, but also compel the combustion of the smoke arising from ordinary fires in dwelling-houses. As regards the latter, where the real difficulty in legislating lies, it may be stated that we already have appliances for thoroughly burning coal, the use of which would be attended with an immense saving of money to the community, as well as the prevention of the painful recurrence of periods of such widespread sickness and mortality as London passed through in the beginning of the present year. But it is of little use in science showing how this terrible evil may be cured if the authorities make no attempt to put her hardly obtained results into practice; it would cost little to give both Dr. Siemens's and Mr. Moncrieff's methods a fair trial on something more than a miniature scale. But what are some of the obstacles to such a practical course may be seen from our correspondence columns to-day.

## *WHAT IS CIVILISATION?*

*The Past in the Present. What is Civilisation?* By Arthur Mitchell, M.D., LL.D. 8vo. pp. xvi. and 354. (Edinburgh: David Douglas, 1880.)

THIS interesting volume, as may be inferred from the title, embraces two cognate but at the same time somewhat diverse subjects—the one the survival, or possibly the reintroduction, of objects and customs, which are usually regarded as primitive, among the civilised nations of the present day; the other the nature and origin of civilisation.

As Rhind Lecturer on Archæology Dr. Arthur Mitchell selected these two subjects as the topics on which to enlarge, and devoted six of his lectures to the first and four to the second; and these lectures, illustrated by nearly 150 excellent illustrations, form the body of his book, to which is added a long appendix and a detailed analytical table of contents.

The facts brought forward in the first portion of the work, though for the greater part by no means new to most archæologists, are of considerable general interest, and will appear sufficiently striking to the ordinary reader. The peregrinations of the author in the remoter districts of Scotland and the neighbouring groups of islands have brought him in frequent contact with those among whom ancient customs are most likely to have survived, whose domestic appliances are often of the same simple character as were those of their ancestors generations and generations ago, and whose ordinary life has also been but little affected by the advance in material civilisation of their fellow-countrymen. To these objects and customs so persistently surviving from the Past into the Present the term "neo-archaic" has been applied by Prof. Rolleston; and it is precisely these objects that a practised archæologist declines to regard as ancient, unless the circumstances of their finding justify him in so doing. Foremost among them is placed the whorl and spindle, an appliance for spinning still in use in parts of Scotland, as it is throughout the whole of the continent of Europe; and which indeed is never likely to be entirely supplanted by the spinning-wheel or other machinery, so long as the use of the spindle can be combined with an out-of-doors occupation, such as tending sheep or cows. All will agree with Dr. Mitchell that the mental power of those Scotch women who still use the spindle and whorl need not be a whit inferior to that of those who do not use it, and some will go farther, and place the shepherdess who spins in a higher rank than the one whose hands are idle all the day long. That a spindle should be made of a form to do without a whorl, or that a potato should be substituted for the latter, are regarded by the author as signs of the art of spinning by hand having reached a state of degradation; but if producing the greatest effect with the least possible trouble is any sign of progress, such an opinion is questionable.

In all such cases the external circumstances of a family or group of families must be taken into consideration; and if it be cheaper or more easy to employ articles of the simplest and rudest character than to purchase, it may be from a distance, the appliances of modern art, the simple methods and appliances will survive. Netting and knitting by hand will thrive by the side of netting and knitting by machinery, as the long hours of a winter's evening, which might otherwise be wasted, can thus be utilised at practically no cost; and it seems more remarkable that the simple form of narrow loom for webbing, of which Dr. Mitchell gives a figure, should have become almost extinct, than that it should have survived.

A flint for striking a light may be cheaper and in some respects more convenient than lucifers; and the "knockin'-stane" and mallet are not less effective for their purpose than the most expensive pestle and mortar. The earthenware "craggans" are as cheap and as well adapted for the ends they serve as pots thrown on the wheel; and in countries where carriage is difficult or extensive water power scarce, the quern or hand-mill and the little Norse-mill may still hold their own; as they did in St. Alban's in the fourteenth century, when they competed with the high charges for multure at the Abbey mills. The survival of the black houses and beehive houses in the Hebrides may also probably be reduced to a question of cost. Perforated or grooved stones are cheaper than plummets of lead as sinkers for nets and lines; and for working in water a pivot and socket of

stone is probably both cheaper and more durable than one of metal. The existence of sockets and other working parts formed of stone in our best clocks and watches can hardly be regarded as an instance of low civilisation, or of those who use them being in the Stone Age.

In all these remarks Dr. Mitchell will perhaps agree, and if the object of his lectures were merely to inculcate caution in accepting such objects as those he describes as belonging of necessity to any remote antiquity or to an absolutely rude and barbarous people, most archæologists would fully endorse his views. But there is throughout these lectures a more or less evident intention that they should apply not to any minor questions of archæological classification, but to the far greater question of the progress of the human race. Though accepting the ordinary division of antiquities into those of the Stone Age, of the Bronze Age, and of the Iron Age, he does not regard the use of stone, bronze, or iron as in any way indicative of the culture and capacity of those who used them. No doubt many of those who use iron and steel are mentally barbarians, and certainly the instances the author brings forward of the superstitious beliefs still prevalent in Scotland show how deeply rooted are such relics of early beliefs, and how little material civilisation has done to elevate the mental culture of the mass of the population. The distinction Dr. Mitchell draws between culture and civilisation is one which is well illustrated by the continued existence of such low forms of belief; and all his readers will agree with him that it is an error to suppose that in this or any other civilised country the mass of the people can be spoken of as highly cultured. Civilisation he defines to be nothing more than a complicated outcome of a war waged with Nature by man in society to prevent her from putting into execution in his case her law of Natural Selection.

Such a view of mankind being to a certain extent exempt from the operation of that law has already been held by many; but even if accepted does not appear to contradict the opinion that the human race may have been evolved from some lower form of mammalian life. For on such an assumption it is, as Dr. Mitchell insists, impossible that man in isolation could become civilised, while, on the other hand, it is evident that until he had become sufficiently intelligent or cultured to enter into association with his fellow men, he would remain subject to the law of Natural Selection in the same manner as any members of the brute creation. Nor even when the stage of association was reached can we expect that there should have been at once any great development of mental power; for there is a long interval between the banding together of a certain number of human units, and any one of them being in that position of ease and leisure which is so necessary for mental culture.

It is perfectly true that so far as osteological evidence is concerned there appears to be no tangible difference between the earliest known remains of man and the human frame of the present day. But it is by no means certain that all the skulls which have been attributed to the Quaternary Period actually belong to so remote an antiquity; and it is worth while to remember that among the coolies of China and some of the Pelew islanders, while the weight of the brain is singularly great, it is balanced by a marked deficiency in the number and depth of the secondary convolutions and by a want of depth in the grey matter.

Dr. Mitchell's view, though we believe nowhere clearly expressed, appears to be that during the whole period of the existence of the human race there was in some part of the world a state of civilisation in existence, which would imply that those among whom it prevailed were possessed of the same average mental capacity as any people or nation of the present day. "May it not happen," he says, "that dealing with the human race as a whole, there never has been a time in its history when there did not occur among men states both of high and of low civilisation? Is it not also possible that there may have never existed a time in the history of mankind as a whole when there were not among those composing it persons potentially as good—persons exhibiting as high a capacity—as any among those who now go to make up mankind?" Were the history of our race confined to the last five or six thousand years it might be hard to answer these questions otherwise than in the affirmative; but who that appreciates the vast antiquity of man as established by recent geological discoveries will admit that such a term forms more than a small fractional portion of the period of man's existence upon the earth, or that there is any parity of reasoning between the circumstances of the beginning of the human period and of the comparatively recent times of Egyptian or Assyrian civilisation?

Granted even that the potential mental capacity existed, of what use could it have been to those who were daily on the brink of starvation, who were unacquainted with writing, and with metal, and had not even succeeded in domesticating any of those animals which now seem almost necessary for human existence?

This however is not the place to enter into a long discussion as to the origin and progress of civilisation. Those, and they are many, who are interested in this subject will do well to read Dr. Mitchell's book, and even should they not agree with all his conclusions, will feel that his cause has not suffered from the treatment it has received at his hands.

They will also find in his Appendix much valuable matter extracted from the writings of Mr. Alfred R. Wallace, Mr. Herbert Spencer, and Mr. Bancroft. To the antiquary pure and simple the illustrations of the "neo-archaic" objects still in use in Scotland will be attractive and valuable; and should some stray politician take up the volume some of the reflections on the dangers to civilisation which may arise from over-legislation, as set forth in the last of the lectures, may profitably be studied.

## AUSTRIAN MYRIOPODS

*Die Myriopoden der österreichisch-ungarischen Monarchie.* Von Dr. Robert Latzel. Erste Hälfte: Die Chilopoden. 8vo. pp. xv. and 228, plates i-x. (Wien: Alfred Hölder, 1880.)

THE centipedes, millipeds, and their allies have hitherto not only been neglected by English naturalists, but practically by Continental workers, until the present generation. Our countryman, Newport, indeed (of whom it may be said with justice, that he touched nothing that he did not elucidate and adorn), has secured a permanent

place in the annals of the class referred to; but it is to the brothers Koch, Meinert, and the Italians Fanzago and Fedrizzi, with the Bohemian naturalist Rosický, and some few other writers of less importance, that we have had to look in recent times for anything approaching serious or continued work upon these creatures. In America, Wood and A. S. Packard, jun., have also done good service. The writer of the book now under notice (Professor of Natural Sciences in the Imperial Franz-Joseph Gymnasium at Vienna) has by this sterling treatise at once assumed a place in the front rank of authorities. We are not aware of any prior writings of his on the subject, beyond one or two of trifling local interest; but, from his five years' study and collection of material in various parts of Austria and in Western Hungary, it is clear that he is qualified for the task of monographing the species of his country, especially as he has examined nearly all the exponents in Austrian collections and museums. As he says, no work on the *Myriopoda* of Europe, or even of Germany and the Austro-Hungarian Empire, exists; so it is to be hoped that the present instalment towards such a desideratum may be from time to time succeeded by others of more extended area.

As regards the preparation, &c., of specimens, Dr. Latzel recommends the use of small well-corked glass tubes, containing spirits of wine. Pinned examples are of no use.

Adopting the *Myriopoda* as a separate class (Packard seems alone nowadays in uniting them with the *Insecta*), the following classification is proposed: Orders I. CHILOPODA; II. SYMPHYLA, Ryder (for the *Scolopendrellidæ*); III. DIPLOPODA, with sub-orders *Chilognatha*, *Colobognatha* (for the *Polyzoniidæ*), and *Heterognatha* (for the *Pauropodidæ*); IV. MALACOPODA (*Peripatidæ*).

The present part discusses the *Chilopoda* only, the flat centipedes, with large sternum, and whose first pair of thoracic feet is transformed into foot-jaws. The common thin yellow *Geophilus*, which sometimes gives out a phosphoric light, is a type of the order. Thirty-one genera are recognised, whereof fifteen are European, one American (*Notiphilides*), and one European (*Stigmatogaster*) being described as new, and *Opisthemega*, Wood, renamed *Megopisthus*. Sixty-seven Austrian species are described (*Lithobius*, the largest, with thirty-seven), including many new ones.

It is not within our scope to analyse the specific characters of such a work; Dr. Latzel seems to have performed his task conscientiously and exhaustively, giving the varied stages of development in each case where known ("juvenis," "adolescens," "pullus," and "fetus"), and combining biological and anatomical aspects with the purely descriptive accounts.

The *Myriopoda* have always afforded material for the comparative anatomist, as evidenced quite recently by MacLeod's researches upon the poison-bearing glands of various Chilopods (in the *Bulletin* of the Belgian Academy of Sciences, 2nd series, vol. xlv. p. 781 *et seq.*), and Voges's scheme for the classification of *Tracheata* (in Siebold and Kölliker's *Zeitschrift für wissenschaftliche Zoologie*, vol. xxxi. p. 143), &c. Dr. Latzel recognises the importance of this element, and gives some remarkably well-executed lithographs (from his own designs) of such organs as are of general morphological importance, in addition to details illustrative of specific structure. Were it not for the general excellence of Continental work in such matters, we should congratulate Messrs. Hölder upon the result of their part in this matter.

## OUR BOOK SHELF

*Die Ethnographisch-Anthropologische Abtheilung des Museum Godeffroy in Hamburg. Ein Beitrag zur Kunde der Südsee-Völker.* Von J. D. E. Schmeltz und Dr. med. R. Krause. (Hamburg: L. Friederichsen and Co. 1881.)

THIS catalogue of the anthropological section of the Museum Godeffroy in Hamburg is a model of its kind, and from the exhaustive manner in which it is treated the publishers are quite justified in calling the publication as they do in their prospectus a "Handbook of Ethnography and Ethnology of the South Sea Tribes." The Godeffroy collection is probably unique and unrivalled as representing the area to which it is confined, and is another example of what private munificence can accomplish for scientific ends; and though the great merchant house may no longer have their collectors scattered throughout the South Seas, the town of Hamburg now possesses by their exertions the anthropological material which this somewhat bulky volume of 687 pages with 46 plates is found not too large to enumerate. However, this catalogue is not merely an enumeration, but contains much valuable geographical information, and some most useful bibliographical notes, which, in the present absence of any anthropological record compiled in the method and way of our zoological work, is, if not perfect, much to be commended, and not too critically received. The arrangement is geographical, and therefore ethnological in its true sense, as followed in most large museums, the Pitt-Rivers collection being of course a brilliant exception, which is rather designed to exhibit evolution in culture.

The first part, "Ethnographische Abtheilung," is written by Dr. Schmeltz, and naturally occupies the largest portion of the volume. Australia is treated first, and then "Oceanien," commencing at New Guinea and terminating with the Sandwich Isles, including not only so large and well known an area as New Zealand, but also amongst others the smaller and much less known Exchequer Isles and Futuna. Of the last-named we are told incidentally that the fauna and flora is allied to that of Samoa. The Gilbert, Marshall, and Caroline Islands are then dealt with, the last very fully. This ethnographical portion concludes with Alaska and a few other various localities, thus showing that in the most special of museums the usual few outside elements obtrude.

The second part, "Anthropologische Abtheilung," is the joint production of Messrs. Schmeltz and Krause, the first author treating the photographs and original drawings, whilst Dr. Krause enumerates and describes the osteological specimens. The cranial measurements are most desired by physical anthropologists, and it is to be hoped that some of our own provincial museums which are still behind in that respect, though possibly containing but few crania, will yet, where such can be authentically localised, have the same at once properly measured, and for a method, the lately-published Catalogue by Prof. Flower will supply all that anthropological science requires. Such Catalogues as the one under notice, taken with those of Prof. Flower and General Pitt-Rivers, are in themselves real manuals of anthropology.

W. L. D.

*On the Digestive Ferments and on the Preparation and Use of Artificially Digested Food.* By Wm. Roberts, M.D., F.R.S. (London: Smith, Elder, and Co., 1880.)

THIS little volume contains the three Lumleian Lectures delivered before the College of Physicians, London, for the present year. The subject is treated in a manner worthy of the reputation of the author. He gives a summary of what is known on the subject of digestion as a function common to animals and plants, treats of the general characters and properties of the digestive juices and their ferments, with an account of the action of each on food material. After many trials the author adopts three solutions for the preservation of his solution of animal ferment, full details of the preparation of which are given. The researches of Musculus and O'Sullivan as to the transformation of starch are given, with the very recent researches on the same subject by Brown and Heron. The subject of the digestion of starch is excellently handled, and any dyspeptic reader would do well to consider the facts and reasonings here so well and clearly given. The second lecture chiefly relates to pepsin and the digestion of proteids; digestive proteolysis; the milk-curdling ferment. The third lecture is devoted to the effects of cooking on food, preparation of artificially-digested food, peptonised materials, the clinical experience of the use of peptonised food, and on the use of pancreatic extract as an addition to food shortly before food is taken. These lectures, though at times technical, may be understood by the ordinary reader, who would often derive advantage from a general knowledge of their contents. As long as man must live on food so long will the proper digestion of that food be of extreme importance to him.

*The Niger and the Benueh: Travels in Central Africa.* By Adolphe Burdo. From the French by Mrs. George Sturge. (London: Bentley, 1880.)

THERE is a good deal that is interesting in M. Burdo's lively story of his voyage up the Niger and Benueh, partly in the company of Bishop Crowther. He gives many details of the various towns and villages he visited on the banks of the two rivers, and of the appearance and habits of the people he met with, all welcome information in a region on which our information is even yet comparatively meagre. M. Burdo's journey was made in 1878.

## 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 ensure the appearance even of communications containing interesting and novel facts.*]

### Smokeless London

I HAVE read the letter of Mr. Scott Moncrieff in NATURE, vol. xxiii. p. 151, with much interest, and am satisfied that his data and conclusions are substantially accurate. This conviction is based on some experience in the commercial distillation of coal.

One difficulty will arise which should at once be foreseen and provided against, or it may be exaggerated into a big bugbear by that class of self-styled "practical" men who oppose to every innovation the inertia of their own self-sufficient stupidity. The semi-coke remaining in the retorts, when only one-third of the volatile constituents of the coal has been run off, will be highly inflammable, and display this property by a great outburst of lurid flame and dense smoke when the retort doors are opened for discharging, and unless the withdrawn charge is immediately quenched there will be a veritable Inferno where it falls. This is merely a matter of practical detail admitting of easy remedy where there is ability and willingness to grapple with it.

A more serious difficulty is likely to arise in London from the peculiar position of the gas companies. They are suffering from commercial congestion due to a plethora of prosperity, and receiving no stimulation from wholesome competition, they display very low commercial vitality. The public welfare is no business of theirs.

It is otherwise in those towns that are sufficiently advanced in civilisation and have abolished the gas and water joint-stock monopolies. There the public are helping themselves, and control the management of the Corporation gas works by their election of the members of the Corporation. Many of these towns are foggy and smoky enough for the experiment, and in these such a boon as that offered by Mr. Moncrieff will probably be appreciated, and, being appreciated by those most interested, will be at once practically tested. Birmingham, for instance, is likely to try it. I was there a few weeks ago and saw how they have eclipsed our electric lamps on the Embankment by the gas lamps around their town-hall.

If it succeeds in any one of these towns our companies will surely follow, or if not, so much the worse for the companies.

Stonebridge Park, Willesden, December 17 W. MATTIEU WILLIAMS

I HAVE read with great interest Mr. Scott Moncrieff's scheme for "Smokeless London" propounded in your last issue. I would ask however—Is he satisfied that the coke would be smokeless when only 3333 feet of gas per ton has been extracted from the coal?

London, December 20 E. R. F.

### Climates of Vancouver Island and Bournemouth

I THINK it very probable that your correspondent Capt. Verney is right about the climate of Vancouver's Island. My only sources of information were maps of isothermals in Keith Johnston's and Phillips' Atlases, which show the *mean* temperature about the same as that of the south of England, while the *winter* temperature is shown as being decidedly colder, and it was to this I more especially referred. The mainland of British Columbia is undoubtedly colder than that of Western Europe, but Vancouver's Island itself and the adjacent sea may be really milder; and if so it is another proof of the great power of the returning Japan current.

I shall be very glad of Prof. Haughton's criticisms on my hypothesis; and in the mean time will only say: 1. That unless Bournemouth is *never* cooled by north and north-east winds, any amelioration of the climate of the Polar regions would certainly benefit it. 2. That as by my hypothesis the entrance of two new gulf-streams into the Arctic Ocean would entirely prevent the formation of ice; the return currents that would undoubtedly be produced would *not be cold currents* in the sense in which they are now, as they would probably be always considerably above the freezing point. ALFRED R. WALLACE

### Geological Climates

IN relation to the discussion as to the importance to be ascribed to the distribution of certain trees and plants in the determination of geological climates, it may interest Prof. Haughton and Mr. Duncan to know that a specimen of the Australian *Araucaria Cunninghami* is now growing on one of the slopes of the Marlstone Hills near Belvoir Castle, in North Leicestershire, a position it has occupied for upwards of forty years. It has attained a height of about thirty-five feet. Having survived (without other protection than that afforded by the wooded heights about it) the cold of the winters of 1860 and 1879, its capability to withstand a greater degree of cold than is ever experienced in our southern counties may be with confidence asserted.

Masses of a true and very characteristic bamboo, *Bambusa metaké*, are now growing vigorously and spreading rapidly on the same estate, the long elegant and slender canes and the delicate green foliage of this variety of bamboo not having suffered in the slightest degree from the severe frost of last winter or the early and equally trying severity of this. *Arundinaria falcata*, the bamboo found as high as the snow-line in the Himalayas, has also proved hardy at Belvoir, but it has been displaced as an ornamental plant by *B. metaké*. *Arundo donax*

often throws up clustering bunches of canes that reach a height of sixteen feet in one season. Associated with *Arundo conspicua* and *Gynecium argentum*, the above interesting and handsome plants give quite a tropical aspect to some of the hill-sides of this northern county.

WILLIAM INGRAM

Belvoir, December 20

### The Appulse of Jupiter to a Fixed Star on November 20

REFERRING to a request appearing in NATURE, vol. xxiii. p. 158, I may say that the approach of Jupiter to B.D. + 2°97 was well observed here, and I found that the star, when perpendicular to the belts, was 4′·05 distant from the northern limb. The definition was good, and the measure, I should say, pretty exact.

It was a strange and beautiful sight, Jupiter appearing with *five* satellites, though, at the same time, the different aspect of the star compared with that of the moons was very striking. The light of the former was however very sensibly affected by the glow of the great disk near it, and it looked no more than 10 magnitude.

JOHN BIRMINGHAM

Millbrook, Tuam

### British Earthquakes

MAY I ask leave to offer a few remarks on the leading article on British Earthquakes which appeared in NATURE, vol. xxiii. p. 117. The author brings out very strongly the apparent connection between great lines of jointing or faulting and earthquake movements, and points out the great fault which traverses Scotland from sea to sea as a case in point. Now I had this same question before the British Association this year, and exhibited a map illustrative thereof. I had further, following up a theory submitted by me to the Royal Irish Academy, on the Correlation of Coast-Line Directions, and published by that body, drawn up on a Geikie's Geological Map of Scotland certain of those correlated lines, and on a smaller map of the British Isles had indicated both the lines in question and the localities wherein earthquakes have been noticed in later times, more essentially since 1860. One of those lines crosses the district about Comrie, and at the moment (August, 1880) could hardly be pointed out as in any notable way supporting the connection sought to be established between coast-line directions and earthquake localities. But the recent earthquakes in the north of Ireland and in Scotland go far to do this, as the direction shown by me both agrees with the great fault mentioned by the author of the paper on British Earthquakes in direction, and also fairly shows the direction of the earthquake band or zone, which apparently extends from Londonderry across Scotland. This direction is exactly at 40° with the coast-line direction between Carnsore Point and Wicklow Head, as shown on the accompanying map.

I may add that having had occasion to examine Prof. Höfer's memoir on the "Erdbeben Kärntens und deren Stosilinien," and to compare his lines with those given on the map of Europe exhibited by me at the British Association meeting of this year, I find some very remarkable concordances as regards directions, which, having submitted to him, he quite recognised. I consider therefore that this memoir, Prof. Geikie's very remarkable article on the Volcanoes of North-Western Europe, and this late article on British Earthquakes, all point more and more distinctly to the importance of jointing and fissuring in connection with volcanic and earthquake action, and so far go in support of the theory submitted by me.

J. P. O'REILLY

Royal College of Sciences, Dublin, December 14

### A General Theorem in Kinematics

I AM very much obliged to Prof. Everett and Mr. J. J. Walker for having taken the trouble to point out that the theorem which I communicated to NATURE is, *so far as it relates to uniplanar motion*, already known. I am indebted to Prof. Unwin for more complete information on the subject. He tells me that the theorem (for the uniplanar case) has been employed by German engineers in the discussion of stresses produced in moving pieces —exactly the use of the theorem which naturally presents itself. Moreover, the theorem (for the uniplanar case) will be found in § 198 of Collignon's "Cinématique," as well as in other foreign books, but not, so far as my information goes, in the work of any English author. None of your correspondents or of mine are however able to say that the *general* case was previously known.

The simple method of proof given by Prof. Everett is that which I had used nearly a month ago in a paper which I wrote (and have since read) for the London Mathematical Society.

I may mention in connection with this subject a kinematical theorem which Mr. Kempe communicated to NATURE some time back. I find that this theorem comes properly under a general theorem which holds for the areas of roulettes. It can be easily proved that the areas of the most general kinds of roulettes follow exactly the law of circular transformation which Steiner proved to hold good for the areas of pedals. For this theorem of Steiner's see Williamson's "Integral Calculus," p. 202, third ed.

Mr. Kempe's theorem (as also Holditch's) is an immediate consequence, since every possible uniplanar displacement of a body can be produced by epicycloidal motion. Mr. Williamson, justly describing Mr. Kempe's as "a singularly elegant theorem" (*ibid.* p. 210), arrives at it quite differently.

GEORGE M. MINCHIN

Royal Engineering College, Cooper's Hill, December 13

### A Correction

IN NATURE, vol. xxiii. p. 44, Prof. Young has published some experiments proving that the thermo-electric power of a platinum-iron couple is to be observed in vacuo as well as in air; this fact is said to be contradictory to the results given in my papers. I presume that some error has caused this statement, as I never and nowhere asserted that the thermo-electric power is dependent on the surrounding gases. I have, on the contrary, stated (*Phil. Mag.*, October 1880, p. 294) that no such influence has been hitherto observed. Thus the experiments of Prof. Young do in no way contradict my views.

University of Vienna FRANZ EXNER

### Jelly Fish

ON November 3, in the B.I.S.N. Co.'s steamer *Arcot*, Capt. Stevenson, while in lat. 16° 50′ N., long. 55° 45′ E., with the Kuriyan-muriyan islands to the north, thirty to forty miles and three days out from Aden to Karachi, we passed through a vast quantity of brown anemones, the ordinary bell-shaped jelly-fish and strange worm-like (apparently) jelly-fish, floating on and just below the surface. These were first noticed about five in the afternoon, and we were still amongst them when we went below to dinner at six, the vessel steaming about eight knots. The anemones were only peculiar in that they appeared to be rounded at the base and without the ordinary flat surface for adhering to rock or stone; they were in vast numbers and had the feelers expanded. The worm-like or centipede-like jelly-fish were from six to eight feet long and as thick as a man's wrist. They appeared sometimes singly, sometimes many twisted together; they were in slow feeble snake-like motion. All agreed that they were ribbed in appearance; but there was a difference of opinion as to the colour. It was described by some as that of the sea, by others as violet, brown, or purple. Each apparent rib was divided from those next it by a bar of lighter colour.

At night the sea was bright with many phosphoric lights of many shapes, so we were perhaps still passing through the mass. There was a dead calm at the time.

The captain has read this account and stated it to be fairly correct.

F. C. CONSTABLE

Karachi, Sind, November 8

## *MR. PLIMSOLL'S CURE FOR COLLIERY EXPLOSIONS*

LET us suppose a person actuated by very powerful motives, who desires to solve the most difficult mathematical problem of the day, and who, after having neglected to acquire the most rudimentary knowledge of his subject, and after having contented himself with seeking the company of land surveyors, and trying to entrap civil engineers into conversations about it, suddenly startles the world with the cry of Eureka! Eureka! Eureka! should we, or should we not, be inclined to regard his solution with respect?

Mr. Plimsoll has done for the mining world exactly what our suppositious person would have accomplished for the mathematical one. In an article contained in the December

number of the *Nineteenth Century*, under the title of "Explosions in Collieries and their Cure," he lays before the readers of that magazine an account of the praiseworthy motives which impelled him to seek some means of preventing these horrible disasters; he tells them plainly that he knows little or nothing about the subject, and he recounts what steps he took for the purpose of supplying the want of that knowledge to some extent. He says:—"In my hope that the resources of chemistry might supply a solution of the problem which has so long perplexed everybody, I have made it my business from time to time to seek the society of practical chemists as well as of purely scientific men whose business it is to teach chemistry. I have seen several amongst the former who are engaged in calico-printing works, lead-works, &c., and have sought, by getting them to talk about chemistry, and by so to speak lying in wait myself for some hint in their conversation, for something which might supply the missing link."

Mr. Plimsoll then gives an account of how he travelled over the painfully disappointing road of trying to "unmask" the fire-damp, to "make it visible to the eye like smoke or steam," and to indicate its presence by means of a collodion balloon filled with the light carburetted hydrogen and put into a vertical recess glazed in front where it "would float upon the stratum of common air because filled with the lighter gas, but would remain at the bottom of the stratum of gas because kept down by the weight of the envelope inclosing it."

He says of the fire-damp indicator:—"A delicate instrument has been invented, constructed on the principle of the diffusion of gases; but as this would require the application and careful observation of anybody using it, and as all it shows can be equally ascertained by watching the elongation of the flame on the safety-lamp, I pass it by."

He next asks, "Can this gas be absorbed?" and gives an example of what he means by describing the strong affinity which quicklime has "for hydrogen in the form of water"; and lastly, he puts the question: "Supposing all these branches of inquiry to result unsatisfactorily, whether this gas should be loaded or neutralised in some manner that should render it non-explosive?"

We will pass over the incentives which our author brings forward with the view of stimulating men of science to undertake the work of discovery. That these incentives are strong enough in all conscience we who heard the dreadful sound of the explosion at the Naval Steam-Coal (Penygraig) Collieries as we lay awake shortly after midnight on Friday last can testify from experience. A few hours later we breathed the fatal after-damp in a sufficiently diluted form to produce only headache and nausea: we looked upon the blackened remains of the victims as they lay or knelt on the ground, some having been hurled from a distance and having nearly every bone in their bodies broken, others having their coats tightly drawn over their necks and mouths and their faces buried in the dust, and still others actually kneeling, having their knees drawn more or less closely up under them, their hands pressed on their mouths and their faces also in the dust. We saw nine fine horses that had been struck down where they stood in their stable never to rise again; one that had started off at a mad gallop, and been arrested in six yards by a fall of roof due to the blast which startled him, his legs and his whole body in an attitude of fierce action resting on the top of the fall, and his head laid gently on one side; two others lying on their backs with their legs in the air; another that had turned round in his shafts by some extraordinary convulsion, so that he faced the load he was drawing, while his body, with head erect, was twisted in between two props at the side of the road; and, lastly, a little donkey denuded of harness and tossed like a rag on to a heap of rubbish. We saw many of the bodies carried to the bottom of the shaft and sent to the surface, and others being carried from the pit to the homes where they lately dwelt; we heard the weeping of the bereaved ones; we saw one little knot of mourners from our very window, and since we began to write, as they gathered at the end of a row of houses, were joined by others bearing a coffin on their shoulders, and proceeded slowly down the road and out of sight, while the plaintive Welsh hymn that never fails to accompany such a procession rose and fell on the ear, and died away fitfully amongst the hills.

If any one can see and hear all this and more and remain unmoved, his natural affection is dead, and Mr. Plimsoll's appeal will be made to him in vain. Happily there are many whose hearts are wrung when they see or hear of the sufferings of their fellow-men, and who are always ready and willing to respond to such a cry.

We will now turn to the second part of Mr. Plimsoll's article, where we find his account of the manner in which he proposes to prevent "half, or it may happily prove even more than half, the number of explosions." He describes it in the following words:—"I do not propose to alter anything in existing arrangements in the suggestion I am about to offer, but only to supplement them. Let the present system of ventilation remain as it is in all its vigour, but in regard to the gas which escapes it, gets behind it, and accumulates in the upper and the waste portions of the pit, can we not go arm in arm with Nature in this matter, as we do in the others, and follow the gas whithersoever it goes and thus, in Lord Bacon's words, by obeying Nature learn how to conquer her?

"It goes to the highest part of the pit, therefore into the exhausted spaces. I would work with this tendency, and, as in the case of water, a large hole is dug called a 'sump,' to collect the water at the bottom of the pit and so facilitate its removal by the pumps, so I would make a hole or sump for the accommodation of the gas; but as the water is heavy and lies upon the floor, and has the sump for it made in the floor, so my hole or 'sump' to gather the gas should be in the roof of the mine, and that in the highest accessible places.

"If it were certain that the water will run into the hole or sump dug for it in the floor or the lowest part of the pit, then it is equally certain that the light carburetted hydrogen would rise in the 'sump' or hole dug for it in the highest part of the workings of the pit.

"I would then place a vertical tube with an open trumpet-shaped mouth, something like the funnel or chimney of a locomotive, in this place, and of such a length that the open mouth (which should be protected with a louvre covering or cap to keep out the dirt) should reach up very near to the roof; the bottom end of this pipe or tube I would continue to the bank of the pit; and as in the case of water you proceed to remove the accumulation by a water-pump, so in this case I would pump out the accumulation of light carburetted hydrogen by means of an air-pump; probably a small fan like that used in foundries would do as well, or even better.

"This air-pump or fan could easily be worked by a strap from the winding-engine, or by hand. It would require assistance during the daily drawing out of the pipe the atmospheric air which would fill it when the gas was exhausted from the mine. I ask your common sense, could you not as certainly in this way draw off every cubic foot of gas in the mine as you now can certainly remove the water from it?"

Mr. Plimsoll summarises in the following manner:—

"1. Is it not a fact that the light carburetted hydrogen does and will seek the highest place of refuge open to it in the pit? 2. Is it not a fact that at this moment there is scarcely a coal-mine which has not gas in its goaves and highest parts? And 3. Is it not clear that by thus tapping the highest places it can as surely be drawn off as water can be pumped out of a pit?"

It would be impossible to controvert all the statements that Mr. Plimsoll makes regarding the properties of fire-damp, its tendency to rise to the highest point, and so on; he has supplied himself with all the knowledge necessary to understand its behaviour when it is found in easily manageable quantities. But what are we to think of his proposal when we come to deal with such quantities as 1000 and 2000 cubic feet per minute? Two hours after the explosion at the Naval Steam-Coal (Penygraig) Colliery we estimated the amount of fire-damp coming up the upcast at 1100 cubic feet per minute, and this is doubtless the normal quantity when the colliery is at work. Dinas Colliery, which adjoins the last-named one, always produced about 1000 cubic feet per minute for some years before the explosion on January 13, 1879; Llwynypia Colliery, which adjoins the Naval Steam-Coal Colliery on the other side, produced 2000 cubic feet per minute for some years, but its output of coal is now less, and consequently its production of gas has decreased.

But where does this gas come from, and how is it disposed of? In following one of the subdivisions of the air-current from the point where it leaves the main intake air-current to the point where it returns to the main return air-current we observe the following phenomena. On reaching the first working place the air is still apparently as pure as it was when it left the surface; about the fifth or sixth place it begins to show the first symptoms of gas on the small flame of a glass safety-lamp (it is still invisible in a Davy lamp); at the tenth place the cap is quite apparent even to the unpractised eye; at the fifteenth place it is say $\frac{3}{16}$ of an inch in height, and at the twentieth place it is a $\frac{1}{4}$ of an inch. This is enough, and the current returns towards the upcast shaft without passing through any more places. At the point of its junction with the main return air-current its cap remains exactly the same as it was when it left the last face. We have ourselves verified these observations hundreds of times in different mines. The number of places through which the air must pass in order to obtain a given proportion of gas varies according to the rate at which gas is produced in the mine in question, and the volume of air passing along the faces.

In the most fiery mines we can generally follow the air-current from the surface, and return with it again to the surface after having passed along the working places without having seen the least accumulation of explosive gas. This is the rule; a cavity left by a fall of roof and containing explosive gas is the exception, and not only is no work allowed to be carried on near it, but means are taken to ventilate it as quickly as possible.

How then could Mr. Plimsoll's method be applied under these circumstances? Should we slacken the ventilation in order to give the gas time to rise to the roof, and after it got there to give it a chance of finding its way to a sump excavated for it somewhere or other? If so we should have streams of explosive gas travelling along the roof of the working places, and our dangers would be increased a thousandfold. We do not know what kind of mines those are in which Mr. Plimsoll has seen a stratum of explosive gas along the roof of the airways, but we should prefer not to have anything to do with them, even were his method applied for the purpose of drawing off the gas.

Let us take the explosion that has just occurred in the Rhondda Valley as an example. About ten months ago the two shafts, which are about 1111 yards apart, and over 400 yards deep, were connected together by an approximately straight heading, which is driven nearly level in coal from each shaft for say 520 yards, and descends the slope of a fault for 60 yards. The coal in one shaft is 30 yards below the level of that in the other shaft, and the surface of the ground at the top of the former shaft is 188 feet higher than at the latter. The fault forms a natural boundary between the workings of the two shafts, and, except for purposes of ventilation and communication, they were treated as distinct collieries. The workings are ranged on each side of the straight heading, there being four districts at the lower level (three on the right hand and one on the left, looking towards the higher shaft), and one district at the higher level (on the right hand side, looking in the same direction). The natural direction of the air-current is from the lower to the higher shaft. The natural air-current gives a volume of about 30,000 cubic feet of air per minute at the present moment, and we are informed that when the fan was at work the volume was between 60 and 80,000 cubic feet. The envelope of the fan was destroyed by the explosion, and the natural ventilation had to be depended on for the explorations so far as they have been carried.

Soon after midnight on the morning of Friday last there were somewhat over one hundred men and boys busily employed underground: five were at the bottom of the upper shaft, four at the bottom of the lower shaft; seventeen or so were on the straight heading about half-way between the fault and the upper shaft; twenty-four were in the left-hand workings of the lower shaft; several gangs of from three to six were in each of the other three small districts of the lower workings; fifteen or so were in the right-hand workings constituting the only district in the upper pit; some were cutting coal, others were blasting down roof, some were filling rubbish, others were stowing it into empty places, and here and there a horse and his driver were proceeding along the roadways with short trains of full or empty waggons.

No explosive accumulation of gas is said to have been found in the mine when it was examined a few hours previously, and two men, who came up only a few minutes before the explosion, had not heard of any unusual occurrence. The mine is a very dry one, and there is abundance of very fine coal-dust to be found everywhere on the roadways.

A sudden shock was felt; a veritable hurricane swept through every passage and every open space communicating with the air-ways; a "darkness that might be felt" ensued for an instant, then a gleam of brilliant light accompanied by a shower of molten and red-hot dust, then darkness again, and all was still.

During the interval between the raising of the dust and the passage of the flame some of the men, who evidently knew what had occurred, pulled their coats over their necks and mouths and staggered outwards, but fell after they had gone at most six or eight yards; others, as we have said, knelt down, covered their faces with their hands, and buried their mouths in the dust and small coal on the floor; the terrified horses made a few mad plunges, and then the Angel of Death breathed upon them all, and they remained transfixed in the positions they had assumed at that fatal moment. Only five men who were engaged in workings close to the downcast shaft escaped alive. They were rendered insensible by the after-damp, but recovered consciousness before the exploring parties reached them, having been revived by the fresh air which immediately flowed into the downcast shaft after the explosion was over.

We ask now where was the fire-damp accumulated that could produce so widespread an explosion, and at what part of the colliery would Mr. Plimsoll have placed his apparatus for the purpose of pumping it out?

The flame ramified into every district of workings both in the upper and lower pit, and left unmistakable tokens of its presence in the form of crusts of coked coal-dust on the timber, on the coal, and on some of the men's bodies.

It is evident that Mr. Plimsoll has remained unnecessarily ignorant that many men have been engaged in working out the problem he has attempted to solve. Let him go back to the many volumes of Parliamentary evi-

dence for information that will enable him to avoid all his useless work in trying to find means of "unmasking" or absorbing the gas; let him take up Faraday and Lyell's report on the Haswell Colliery explosion of 1844, and he will find his own proposal described in every essential detail, as well as a hint thrown out that coal-dust has much to do with explosions; let him peruse the copy of the report addressed to the United Committee of the Coal Trade by the Special Committee appointed to take into consideration Faraday and Lyell's report, and he will find the opinion expressed by the practical men of that day regarding the very plan he now brings forward as original.

But why should he labour through all that mass of reading and more than we have named, when he can find all that is of any value on the subject condensed in that most admirable dissertation, entitled "Rapport de M. Haton de la Goupillière (Ingenieur-en-chef des Mines, Professeur d'Exploitation des Mines à l'École des Mines), au nom de la Commission d'Étude des Moyens propre a prévenir les Explosions du grisou" (Paris: Dunod, Editeur, Quai des Augustins, No. 49, 1880). In that volume he will find an account of all his own plans and those of many others, as well as much valuable information that will prove of inestimable value to him if he should decide to pursue this subject to its legitimate conclusion, as we most earnestly hope he will.

Mr. Plimsoll wrongs the scientific and mining sections of the community when he charges them with so much indifference. In England, in France, and in Belgium there is at present a Government Commission considering the subject of his article, viz. "Explosions in Collieries and their Cure," and collecting evidence which will be of great value in enabling us to approach nearer to the mark we are all aiming at.

As usual the Royal Society travels in the van, and to our certain knowledge has given the sum of no less than 255*l.* within the last seven or eight years towards assisting in experiments which are being made with the view of throwing light upon the subject.

Similarly each of the Mining Institutes is eagerly canvassing every scrap of useful knowledge that may tend to lessen the risks of mining, and especially of explosions.

Lastly, in Germany we have also activity; and we can recommend a perusal of a pamphlet entitled "Die Verhüttung von Explosionen schlagender Wetter in Steinkohlenbergwerken," by Dr. Adolf Gurlt, Bergingenieur, Bonn: Verlag von Max Cohen und Sohn (Fr. Cohen), 1880. This pamphlet ends with the following words, in which it appeals to thoughtful miners. We would extend the same appeal to one and all:—

"So mögen denn alle denkenden Bergmänner ihre Kräfte vereinigen um dem verderblichen Feinde des Kohlenbergmannes, dem Grubengase, diesem Moloch, welcher noch fortwährend so viele frische Menschenleben verschlingt, in Zukunft seine Opfer nach Möglichkeit zu entreissen."

If really safe safety-lamps were introduced that could not under any circumstances ignite an explosive mixture of fire-damp and air; and if at the same time the use of an explosive or other agent that produced no flame were substituted for that of gunpowder or dynamite, we might be comparatively free from explosions.

Thus far however neither the one nor the other of these desirable consummations has been attained.

On the other hand, if we could entirely eliminate explosive accumulations of fire-damp and air from our mines we should expect, according to the most generally received opinions, to be able to use naked lights and to fire shots wherever we had a mind to do so. Naked lights we might use under these circumstances; but we should protest in the strongest terms against blasting in the presence of dry coal-dust alone. The *rôle* of that agent has not yet been officially recognised, at least to the extent of framing special regulations to assist in dealing with it; and until it is so recognised we venture to assert that explosions will continue, and that the same impossibility of explaining them, save by the assumption of simultaneous eruptions of fire-damp in different parts of the workings, will continue to be experienced.

That this is an illogical method of accounting for them may be gathered from the fact that the Risca explosion of July last required no less than three simultaneous eruptions to explain it. The Penygraig explosion would require one in each district; but we say this without prejudice to the evidence either direct or circumstantial that may yet be forthcoming to prove the existence of explosive accumulations in one or more places in the workings.

In conclusion we would say that the Penygraig explosion cannot be explained by the fire-damp hypothesis alone; explosive accumulations may have been accidentally ignited by a shot, or by a defective safety-lamp, and so have originated the explosion; but something else than fire-damp, something whose presence was entirely ignored, took up the flame, carried it to the innermost and to the most extreme limits of the workings, and was in all probability the cause of 90 per cent. or more of the deaths that ensued. Need we state our absolute conviction that that obscure agent was coal-dust?

W. GALLOWAY

## *COL. PRSHEVALSKYS' RECENT JOURNEY*

THE new number of the *Izvestia* of the Russian Geographical Society contains the long-expected letters from Col. Prshevalsky on his adventurous journey on the frontier of Tibet. We have already referred to Col. Prshevalsky's work; the following further details will be of interest:—His last news were dated from Hami, whence he proposed to go south-east to Tsaïdam. But it was impossible to find a guide: a Chinese, given for this purpose by the Hami authorities, left the expedition some fifty miles from the town, after having led the travellers into a region full of great ravines. M. Prshevalsky, confident in his eleven companions, resolved to find his way himself by sending every day two men on horseback for distances of thirty and fifty miles round to discover the best direction. The advance was very slow, and the travellers spent one month and a half in the mountains south of Sa-djeou, discovering the high mountain-ranges to which they gave the names of Humboldt and Ritter. After a march of 190 miles they arrived at Kourlyk in the Tsaïdam, but here also they were badly received, and could not find guides, owing to the secret influence of the Chinese. Finally M. Prshevalsky told the chief of Kourlyk that he would take him as guide to Tibet if another guide could not be found, and on the following day the guide was found.

On September 24 the travellers left Tsaïdam. Again the guide led them into impracticable tracts near to the Blue River, so that M. Prshevalsky's expedition was compelled again to seek its own way. After having crossed the Blue River at its sources, they climbed the high plateau of Tan-la, after having crossed the 16,800 feet high pass across the border-range, which was covered with snow in October. On the passage they were attacked by the nomad tribe of Egrays, but the companions of M. Prshevalsky gave them a hot reception, and the Egrays fled, leaving four killed and several wounded.

Descending from the Tan-la ridge, the expedition continued its way to Lassa, but at the Nabchou settlement, 160 miles distant from the capital of the Dalaï-Lama, they were met by Tibetians, who declared that the expedition could not be allowed to go further without a permission from the Lassa authorities; a thousand soldiers were assembled at Nabchou. M. Prshevalsky gave his consent to await an answer from Lassa, and stayed at

Nabchou, buying food from the Tangoutes, who consider themselves as under the rule of the governor of Sining. Twenty days later the answer arrived; a messenger from the Dalaï Lama, accompanied by seven officers, entreated M. Prshevalsky to return, saying that the whole population of Lassa was very excited against the strangers, as it was declared among the people that the expedition intended to steal the Dalaï-Lama himself and extirpate the Buddhist religion. A conflict with the inhabitants of Lassa being most probable, M. Prshevalsky was compelled to return. All December and January were spent on the road to Tsaïdam, the distance from Nabchou to Tsaïdam being 560 miles. Progress on this high plateau (14,000 to 16,000 feet) was very difficult; out of thirty-four camels twenty died, and the collections were conveyed on horseback; the men mostly went on foot. We need scarcely say that the scientific collections and observations are of a great value.

On March 20 M. Prshevalsky reached the Chinese town of Sining, close to Lake Koko-nor. After having received permission from the governor of the province to go to the Hoang-ho, however, without crossing it, M. Prshevalsky sent his collections to Alashan, and went east to the banks of the Yellow River, which are fifty-six miles distant from the town of Donkyr. He reached them at the Gomi settlement. The river, 450 feet wide, and 8000 feet above the sea-level, is rapid (5 feet in a second). Its valley cuts deeply into a great deposit of clay, gravel, and boulders, the abrupt walls of which, along the banks of the main river, being 1600 feet high, and no less than 1000 feet along the banks of numberless tributaries. The journey across these gigantic ravines with abrupt walls (quite like those of the loess in the lower parts of the Hoang-ho) was most difficult. After a journey of 130 miles up the Hoang-ho, M. Prshevalsky reached a lofty mountain-range, which is cut through by the river, and probably is a continuation of the Burkhan-buda range. Further advance along the banks was impossible, and M. Prshevalsky not having a guide for crossing the range was compelled to return and soon reached the town Gui-doni, situated on the left bank of the Hoang-ho, forty miles below Gomi. The natural history collections from the Upper Hoang-ho are very rich: 260 species of plants, many fishes, and 500 birds. The astronomical and barometrical observations are numerous. M. Prshevalsky did not reach the sources of the Yellow River, and he supposes that they cannot be reached otherwise than along the Tibetan plateau; he doubts however that the Upper Hoang-ho makes so great a bend as it is usually shown on our maps.

The last letter from M. Prshevalsky is dated Gui-ta-din, on the Upper Hoang-ho. As is known, he returned *viâ* Alashan, and is expected at St. Petersburg by the end of January.

## *MICHEL CHASLES*

THE news of the death of Michel Chasles, perhaps the oldest and best-known mathematician in Europe, will be everywhere learned with deep regret. For the fifty-five years over which his writings extend he has devoted himself with persistent industry to the history of geometry and to the perfection of those geometrical methods with which his name will be always associated. The "Aperçu historique sur l'Origine et le Développement des Méthodes en Géométrie," which in fact forms an elaborate history of the subject from the time of Thales and Pythagoras to the beginning of the present century, is the best known of his works; it was first published in 1837, and a second edition appeared only a few years ago. His restoration of the Porisms of Euclid was published in 1860. The last great work of Chasles related to the investigation of the number of conics satisfying any five conditions: the special method which he invented for these researches, termed by him geometrical substitution, involved the consideration of the characteristics of systems of conics, *i.e.* of the numbers of conics satisfying four common conditions and (1) passing through an assumed point; (2) touching an assumed line.

In 1865 Chasles received the Copley medal of the Royal Society; this medal has, since its foundation in 1731, been given only five times for discoveries in pure mathematics, viz., in 1784 to Waring, in 1814 to Ivory, in 1841 to Sturm, in 1865 to Chasles, and in the present year to Sylvester.

In 1846 Chasles was appointed to fill the new Chair of Modern Geometry, founded by the Faculty of Sciences at Paris; and as a professor he exerted personal influence over the younger geometers of that time, which has since been apparent in their writings, although the effect of the geometrical methods to which he devoted his life is chiefly visible in the works of the Italian and German mathematicians. He was the inventor of the term "anharmonic ratio," but not of course of the ratio itself, which was known to the ancients. Chasles's memoirs on the attraction of ellipsoids are well known to English mathematicians and physicists; and a translation of his memoirs on Cones of the Second Order, and Spherical Conics, was published in Dublin in 1841 by Dr. Graves, now Bishop of Limerick.

Most of our readers will remember how in 1866 Chasles was deceived by M. Vrain Lucas by what were called the Pascal forgeries, and they will also remember how honourably he extricated himself from the matter, and did all in his power to repair the mischief done. The forger was convicted and sentenced to two years' imprisonment; and not a shadow of suspicion was ever thrown upon the honour or good faith of Chasles.

Scientific visitors to Paris will miss a well-known face at the Academy and a kind and hospitable friend. Till quite recently Chasles seemed as active as ever, both mentally and physically, and it was only last September that he issued a new edition of his "Géométrie supérieure." He was a Foreign Member of the Royal Society and of the Cambridge Philosophical Society.

## *THOMAS RYMER JONES, F.R.S.*

THE late Professor of Comparative Anatomy at King's College, London, whose death is announced, was born about the year 1820. He studied for the medical profession at Guy's Hospital, and took the diploma of the Royal College of Surgeons, London, in 1833. A chronic deafness unfitting him for the active pursuit of his profession, he devoted his attention exclusively to comparative anatomy. Some of his earliest papers were on the dissections of a tiger (*Proc.* Zool. Soc. 1834) and of an agouti (*Proc.* Zool. Soc. 1834). He was the first Professor of Comparative Anatomy at King's College, and was Fullerian Professor of Physiology to the Royal Institution in 1840. He was Assistant-Secretary to the Section of Zoology and Botany during the eighth meeting of the British Association held at Newcastle-upon-Tyne in 1838, the president of the section being Sir W. Jardine, the secretaries J. Edward Gray, Richard Owen, and John Richardson. This meeting was marked by the presence of Christian Gottfried Ehrenberg, who laid before the section a copy of his famous work, "Ueber Infusionsthierchen," making at the same time a short statement as to his views of the alimentary canal of the polygastric infusoria. These views were, in the discussion which followed, criticised by Rymer Jones, who stood almost alone among the British naturalists in opposing them. In 1838 the first part of his "General Outline of the Animal Kingdom" was published by Mr. Van Voorst, happily still among us. It was completed in ten or twelve parts, and was illustrated

by really beautiful woodcuts. This work marked an era in the study of zoology and comparative anatomy in our country. True it is that the information of the author was mostly borrowed; true that he had no great familiarity with the work of the German naturalists of the time; true that the book will not bear to be appealed to now: but forty years ago it was the best book of its sort in England, and the generation has not as yet quite passed away which learnt from its pages. We have altered since then, both in the manner and the matter of our teaching of comparative anatomy, and for the better no doubt; but after another forty years our systems may too have seen their day. It may be conjectured that this book was in advance of its day, for an eminent writer, in reviewing it in 1839, objected to Rymer Jones' facts about the Infusoria, and declared he still placed confidence in Ehrenberg's observations, while he criticised his description of *Volvox globator*, and believed this "Infusorian" had nutritive organs, mouth, eyes, &c.

Prof. R. Jones was an extensive contributor to Todd's "Cyclopædia of Anatomy and Physiology," writing no less than twelve of the articles on comparative anatomy. He was the author of at least one work on popular natural history, called the "Aquarian Naturalist." He was an excellent lecturer, and though never rising to the highest rank as a biologist, well deserves this passing notice in our columns.

## *FRANK BUCKLAND*

FRANCIS TREVELYAN BUCKLAND was born on Dec. 17, 1826. He was the eldest son of the Very Rev. Dr. Buckland, Dean of Westminster. As a boy he was a constant companion of his father in the latter's geological excursions; he was a scholar of Winchester College and a student of Christ Church, graduating M.A. of Oxford in 1848. About this date he entered St. George's Hospital as a student of medicine, taking the diploma of the Royal College of Surgeons, London, in 1851, becoming house surgeon to St. George's Hospital, and lastly receiving the appointment of assistant-surgeon to the 2nd Life Guards, a position he held until 1863. He seems to have been always well liked in his regiment, gaining the character of a pleasant, good-natured, sociable fellow. Although fond of all that pertained to natural science, he was in no sense of the word a profound naturalist; he could seize with alacrity the popular side of a scientific question, but he seldom went deeper. Perhaps the most scientific work he ever accomplished was the editing, in 1858, of his father's work on "Geology and Mineralogy," published as one of the Bridgewater treatises. He was the author of some pleasant volumes entitled "Curiosities of Natural History," was a constant writer in *Land and Water*, and an occasional contributor on subjects of economic zoology to the daily press. On the subjects of fish and fish-culture he was an authority, and it will be remembered that he had an interesting museum in connection with the subject at South Kensington. For his labours in this direction he received several honourable distinctions from France, and in 1869 he was appointed by the British Government one of the Inspectors of Salmon Fishing for England and Wales. He was also one of the Commissioners appointed to inquire into the Crab and Lobster Fisheries of this country, and the results of this Commission culminated in the useful Act regulating the oyster, crab, and lobster fisheries of the kingdom, which received the Royal assent in 1877.

One notable event of his life was the discovery he made in 1859 of John Hunter's coffin in the vaults of St. Martin's-in-the-Fields, which was re-interred at the expense of the Royal College of Surgeons in Westminster Abbey.

Familiarly known by a large circle of friends as Frank Buckland, he has left them while still in middl life, and it will be long ere they look upon the like of poor Frank again.

## *NEW GUINEA*[1]

### II.

THE various accounts of the natives given throughout these volumes leave an impression of vagueness that is very unsatisfactory. The mixture of races in various parts of New Guinea is no doubt great, but we cannot help thinking that there is a well-marked Papuan type, and that its head-quarters are in this great island. Signor D'Albertis seems to attach too much importance to minor peculiarities. He continually mentions small differences in the features, the hair, the form of the skull, or the stature, as implying a radical difference of race, forgetting that such differences are found among every people and in every country, and that on this principle we might establish a dozen different "races" in Europe. Taking the term Papuan in a broad sense as including all the dark-skinned woolly or crisp-haired tribes of the Western Pacific, it seems clear that New Guinea is very largely peopled by this race, and that its north-western peninsulas contain the most typical examples of it. In the south-east however another race is found which may be described as yellow-skinned and smooth-haired, and these are clearly Polynesians or "Mahori," that is of the same race as the natives of Samoa and New Zealand. In the Fly River and adjacent country both these occur, as well as a mixed race, which D'Albertis seems to think is destined to supplant them. He describes these races as follows:—

"The two varieties to which I allude may be defined thus: the yellow, and the black. The term yellow does not exactly express the first, nor does black the second, and those adjectives must be used comparatively only. The characteristics of the yellow variety are as follows:—hair curling or smooth—neither crisp nor woolly, black and shining, often almost of a chestnut hue; forehead large and flat; temples little, if at all depressed; eye orbits scarcely, if at all, prominent; cheek-bones rather high; round chin and round face; large brown eyes, with eyeballs of a bluish-white; the nose often aquiline, never flattened, and generally small; lips moderately full; and brachycephalous and round skull. These people are not prognathous. In colour they vary from brown to very light brownish yellow. In stature they are not generally inferior to the black race, and their forms are fuller and rounder.

"The black variety is distinguished by a narrow and retreating forehead, compressed temples, strongly-marked orbital arches, prominent cheek-bones, aquiline nose, pointed and narrow chin, long face, decidedly prognathous, an oblong skull. The eyes are small, either black or brown, the eyeball bloodshot or yellowish, and the men are tall and generally thin. The preponderating type exhibits every gradation that can result from these two varieties.

"We may therefore conclude that the present inhabitants of Hall Bay (opposite Yule Island) are a mixture of two races, one dark-skinned and crisp-haired, the other with lighter skin and smooth hair; and this is all that can be said from our present knowledge."

The light race—which we may call Papuan Mahoris—are far more civilised than the dark Papuans. D'Albertis says of them:—

"The most perfect harmony seems to reign in families, and rare indeed are cases of quarrel among members of one household. They live in communities, sometimes of more than a thousand inhabitants, in well-built villages,

[1] "New Guinea: What I Did and What I Saw." By L. M. D'Albertis, Officer of the Order of the Crown of Italy, &c., &c. In two volumes. (London: Sampson Low, Marston, Searle and Rivington, 188c.) Continued from p. 155.

worthy to be called small towns, both for their order and cleanliness. They are under the rule of the chiefs or land-owners. The chief is looked upon as father of the family. He is called Pacao, and his servant or subject is called Irine. From all I could learn, slavery does not exist, and the sale of human beings is unknown." After describing their daily avocations, amusements, dress, implements, and ornaments (a group of which are figured), he goes on: "Their natural disposition is gentle and placid. They like to spend their time in talking and games, in which men and women take an equal share. Playful and free of speech, they nevertheless do not transgress the bounds of modesty, either in word or deed. Women and children are included in every conversation, and often take part in public discussions, which are usually held in the evening. Women are always respected, and in some villages they enjoy a certain supremacy, although the government of the house belongs to the husband. Labour may be said to be fairly divided between the two sexes, and they are accustomed to work from their earliest childhood. . . . The material for civilisation is in them, but will the change make them better? Will they be the happier for

FIG. 4.—Durabi, a native of Kiwai Island, at the mouth of the Fly River.

it? This is a difficult problem, and one which cannot be solved until the experiment has been made. For my part I do not doubt that these, more readily than any other savages whom I know, would answer to the call of a civilised nation which, stretching out a paternal hand, would lead them towards our civilisation! To insure success, however, they should be treated as friends, not as slaves; they should be cherished, not destroyed."

Unfortunately our attempts at civilising savages have as yet in every case failed. Are we still, notwithstanding all our wretched failures, to go on in the old way, and allow these interesting and now happy people to be first ruined morally by the teaching of the dregs of our Australian and Pacific traders, and then physically deteriorated by the forced introduction of a form of civilisation utterly unsuited to them? Cannot either philanthropy, or religion, or Government protect these people from all such external influences as have been proved to be unsuited to their condition and stage of development, while aiding them to work out for themselves an indigenous civilisation? Here is perhaps the last chance we have to preserve one remnant of the better class of savages from being crushed under the Juggernaut car of our high-pressure civilisation and mad struggle for wealth.

The inhabitants of the lower part of the Fly River appear to be mostly dark Papuans, while further in the interior a mixed race was met with. Among the curious articles found in this part of the country were numbers of stone clubs, carved into various star-like shapes and forming terrific weapons in close combat. Stone axes are also largely used, closely resembling in form the neolithic celts of Europe.

Maino, chief of Moatta, a village at the mouth of the Fly, was a great friend of D'Albertis', and accompanied him on one of his voyages up the river. An elaborate study, both physical and mental, was made of this savage, and forms one of the best and most valuable passages in the book. A few extracts will show its character. After describing his person, our author goes on:—

"The above is a sketch of the animal Maino. I will now try to draw his portrait as a man, according to the moral sense of that definition. The opinion I have formed of him as a reasonable being is favourable. It is not however necessary to examine him very closely with European lenses, remembering that he is what we call a savage. He has sufficient intelligence for his position, and probably he is not capable of more. . . . He is friendly to the white man because he fears him, and because he knows he can gain by him. He is proud, and takes offence easily, without however showing that he is

FIG. 5.—Maino, Chief of Moatta.

irritated; only once during two months and a half did he display any anger. He is generally silent, and seems meditative. Sometimes he is lively and will laugh, but his laugh appears studied and forced, not natural or spontaneous. He is cruel rather from instinct than from education, and in a way that we Europeans can perhaps neither understand nor appreciate justly. His cruelty raises him in his own estimation and in that of his dependents—in the eyes of his friends and of his enemies. He considers men and women, if they are strangers to him, good for nothing but to have their heads cut off. Up to the present time his victims number thirty-three. A warrior who bravely attacked him, or a woman sleeping in the forest would be to him exactly the same thing. He would see in each a trophy, a victory; and what he would esteem would be their skulls. He likes to see blood, and it is with marked satisfaction he describes the *modus operandi* in cutting off a head, the instruments used in the operation, and the method of surprising an enemy by treachery, even if a woman or a child. . . . He is tender and affectionate towards his own family, and to his sons at least his temper may be said to be mild. . . . Maino is remarkably selfish. He would willingly let others die of hunger if to relieve them he would have to sacrifice some delicacy intended for himself. I experienced this during the voyage. . . . Notwithstanding certain traits which might make him appear a bad man in the eyes of Euro-

peans, I can testify that Maino is a good fellow, and was a good comrade to us all. His rank and his age prevented his being useful except as a pilot, but in that capacity he was most valuable."

Turning to the lighter race, one of the most interesting and novel facts we find recorded of them is their most ingenious mode of cultivation. Fields were observed in Yule Island so well and evenly tilled that they appeared as if they had been ploughed, but it was afterwards ascertained that all had been done by manual labour.

"The natives form gangs of eight or ten men, each man holding in either hand a very hard wooden pole, sharpened to a point, over six feet long and from an inch to an inch and a half thick. These men stand in a row, and at a given signal plant their rods in the ground, repeating the operation several times until they have penetrated to the required depth, which is generally about a foot. This done, they bear down on the other end of the poles, making them act as levers, and thus loosen a long piece of ground, ten to thirteen yards long, and from a foot to a foot and a half wide; then by alternate heaving up and bearing down, the large mass of earth is upturned, and as they take care to preserve the same measurements and distances, regularity like that of the action of a plough is produced."

On his way home, fresh from New Guinea, Signor D'Albertis suffered partial shipwreck in the Red Sea, and met a number of Somauli men and their families, and was much struck by their resemblance to Papuans. He says: "Who will believe that in these people I seemed to be renewing my acquaintance with the natives of New

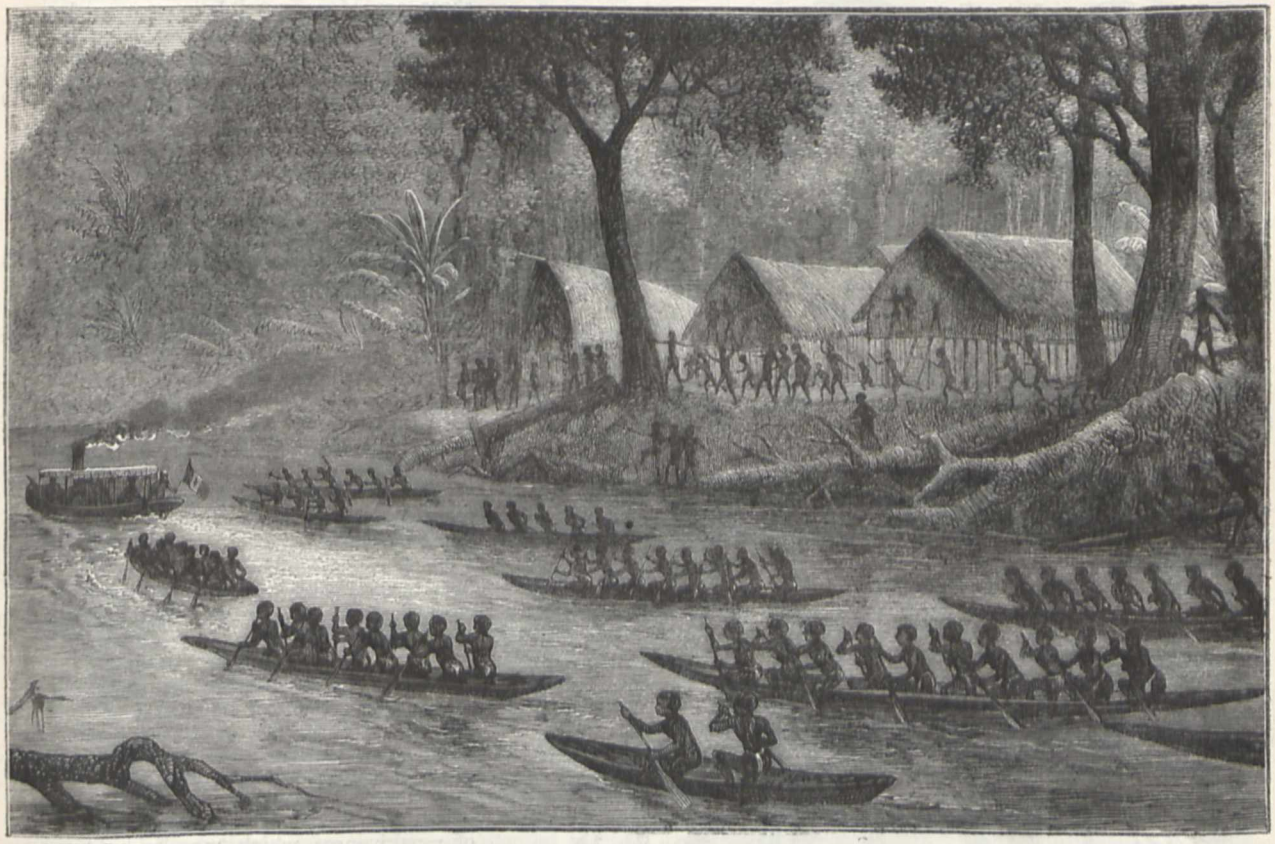

Fig. 6.—Attacked by Canoes on the Fly River.

Guinea, especially those of Torres Straits! Such is the impression they made upon me. I observed the true negro type, which differs from them in several respects; but if several of these natives were transported to New Guinea they might be mistaken for aborigines of that country; those with the receding forehead, aquiline nose, and moderately thick lips—who have curly but not woolly hair. They belong to the type I called Arab when speaking of Moatta and Tawan—the type which, although not predominating, I have often found in New Guinea, and I discover them to-day on the shores of Ras Afun." Our traveller had two true Jamaica negroes with him in New Guinea, and these also closely resembled other types of Papuans, although there were certain minute characteristics of skin and hair by which they could be distinguished. Taken as a whole, and speaking broadly, the Papuan and African races would appear to belong to the same great type of mankind.

Our readers will now perceive that, as the journal of an enterprising and observant traveller, Signor D'Albertis' work is one of considerable merit. It is written in a simple unaffected style, and bears internal evidence of accuracy and absence of exaggeration, while it no less clearly shows that in all the best qualities of a traveller its writer has rarely been surpassed.

Living among some of the wildest of savages he overcame them by kindness, courage, and by exciting in them a dread of his vast powers of destruction and command over the forces of nature; and he never took away human life except when attacked by overwhelming forces—when the vessel committed to his charge as well as the lives of its crew were in imminent danger on the Fly River, and even then he beat back his enemies while doing them the smallest possible injury.

Turning now from the general character of the book and of its author, and considering it as an expensive and

somewhat pretentious work brought out by an English publisher, we feel bound to state that it is full of grave defects. This is due probably to the incompetence of the editor, or the total absence of any such necessary functionary; for the original was written in Italian, and we cannot believe that the author himself corrected or supervised the proofs. In the first place a considerable number of the illustrations seem to be thrown in at random, and are not referred to at all in the text. Such are the portraits at pp. 59, 140, and 151 in vol. i. Ornaments and implements from the Fly River are figured in the first instead of in the second volume. A cut of thirty-four separate articles (at vol. i. p. 416), though all numbered, has no reference to the numbers; while at vol. ii. p. 136, four elaborate spears or ornamental staves are described as "Baratus," which are said in the text to be "pieces of armour for war," and to be "worked in very hard stone"!

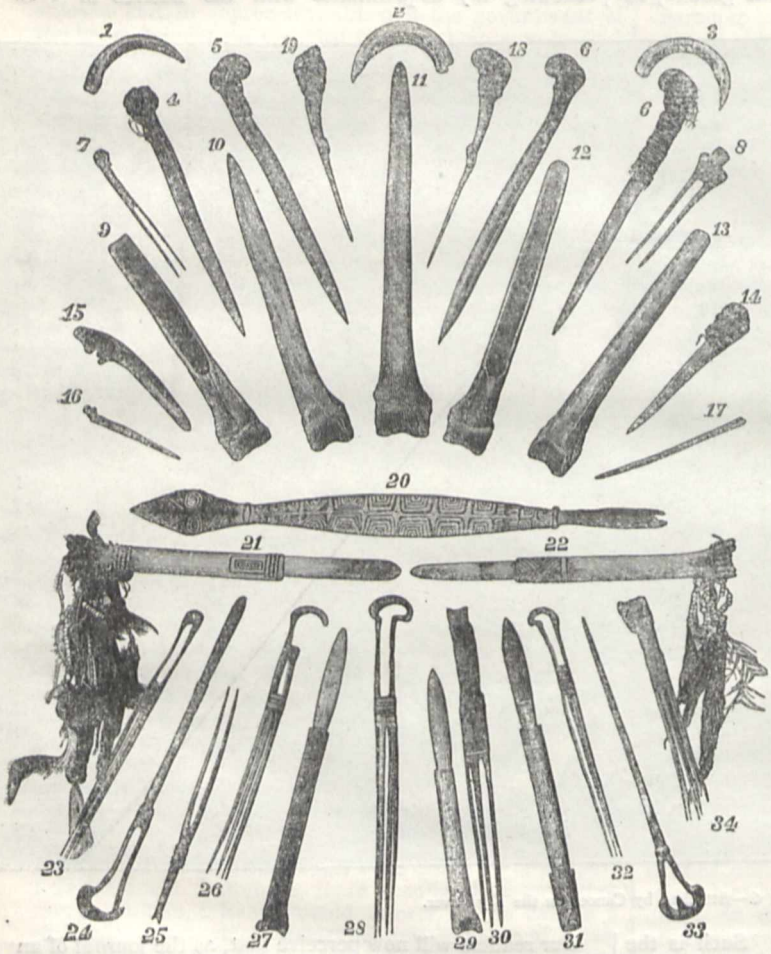

FIG. 7.—Implements and Weapons. From the Fly River (upper set) and Hull Sound (lower set).

The misprints and misspellings are excessively numerous. At p. 4 we read of "temples excavated in the deserted roads" in Java. At p. 49 the traveller goes to the "source of the river" instead of to its mouth; and at p. 222 we have "stone nails" instead, probably, of stone clubs. The names of places and of plants and animals are rarely spelt correctly, and are often spelt differently in adjacent pages. The Italian mode of spelling scientific names has not been altered, and they are often almost unintelligible to an English reader, as *Oloturia* for *Holothuria*, *Stafilinus* for *Staphylinus*, and *Cicas* for *Cycas*. Orankaya (a village chief) is sometimes spelt Orankay and sometimes Oranhay. Waigiou is spelt Waigen, and immediately afterwards Waigeu. Battanta is spelt Battauta, and Daudai is spelt Dandai. At the end of the book four vocabularies of native languages are given, but as if to make these of as little use as possible, they consist of four different sets of words, all differently arranged, and none in alphabetical order; so that any comparison with each other or with vocabularies given elsewhere is practically impossible without the preliminary labour of rearranging them. Add to this that there is no index to the book and that the only map given is a poor and imperfect one, and it will be seen that the merits of Signor D'Albertis' work have not been enhanced by the manner in which it is presented to the reader.

The illustrations on the whole are good, the coloured plate of birds of paradise being excellent. But far too many skulls are figured, since these are of no possible interest to the general reader, while, as we have no guarantee for their accuracy, or that they are all figured on exactly the same scale, they will have little value for the man of science.

From the notices scattered through these volumes Signor D'Albertis appears to have made very large collections in natural history, especially of birds, reptiles, and insects. It is to be hoped that complete series of these have been kept together, and that, in conjunction with those collected by Dr. Beccari, they will be made the subject of some important works. The birds are being carefully elaborated by Prof. Salvadori; but the reptiles and the insects would probably throw even more light on the zoological relations and past history of this wonderful island.

ALFRED R. WALLACE

## *PHYSIOLOGY OF PLANTS*

THE two papers[1] which we notice together under the above heading, though relating to different questions in the physiology of plants, have nevertheless something in common. Both of them bear on the relationship between the external and internal conditions of life, between external forces, such as light and gravitation, and the constitution of the organism on which these forces act. And both tend to show the importance of recognising in plants those specific forms of sensitiveness which may be said to determine the results which will follow external changes.

I. The behaviour of leaves in relation to light may be illustrated by the cotyledons of a seedling radish; if it is illuminated from above, the cotyledons are extended horizontally, and are thus at right angles to the direction of incident light. If the seedling is then placed at a window, so that it is lighted obliquely from above, and if the stem (hypocotyl) is prevented from bending, the cotyledons will accommodate themselves to the changed conditions by movements in a vertical plane. The cotyledon which points towards the light will sink, while the other will rise, and thus both will become once more at right angles to the incident light.

Two theories have been proposed to account for this

[1] I. "The Power possessed by Leaves of placing themselves at right angles to the direction of Incident Light." II. "The Theory of the Growth of Cuttings, illustrated by Observations on the Bramble, *Rubus fruticosus*." Read by Francis Darwin before the Linnean Society, December 16, 1880.

property of leaves: the first is that of Frank ("Die natürliche wagerechte Richtung von Pflanzentheilen," 1870), who ascribes to leaves and to some other organs a specific sensitiveness to light called "transversal-heliotropismus" or diaheliotropism ("Power of Movement in Plants," p. 438). Just as an ordinary heliotropic organ has an inherent tendency to become parallel to incident light, so a diaheliotropic organ has an inherent tendency to place itself at right angles to the direction of the light. The two classes of organs differ from each other exactly as some creeping rhizomes differ from ordinary stems; the rhizome tends to extend itself horizontally under ground, while the stem above the surface grows vertically upwards (see Elfving, in Sachs' "Arbeiten," 1879).

A different theory has been proposed by de Vries (Sachs' "Arbeiten," i. 1872), whose views are supported by Sachs ("Arbeiten," ii. 1879) with additions or modifications. According to these views it is not necessary to assume the existence of any special kind of heliotropism, since the phenomena might result from the ordinary forms of heliotropism and geotropism acting in concert. Thus in the case of the seedling radish illuminated from above, if the cotyledons were apheliotropic (negatively heliotropic) and apogeotropic (negatively geotropic) it is possible that they might be kept in equilibrium by these opposing tendencies. The tendency to move away from a vertical light will make the cotyledons curving downwards towards the earth, and the apogeotropism or tendency to move away from the centre of the earth may exactly balance the downward tendency, so that the cotyledons remain horizontal.

Besides the various geotropic and heliotropic tendencies there are other modes of growth which may enter into the combination. In some cases there is a natural preponderance of longitudinal tension or growth along the upper surfaces of the petiole, so that owing to impulses arising within the plant there is a tendency for the leaf to curve downwards, or more accurately in the direction in which the morphologically lower side of the petiole is directed; this tendency is called longitudinal epinasty, or simply epinasty; the opposite tendency is called hyponasty. According to the theories of de Vries and Sachs epinasty may be opposed by heliotropism, or by apogeotropism, while hyponasty will of course be opposed by apheliotropism and geotroprism, and all these opposing forces may combine in producing an equilibrium. The object of the present paper is to test the relative values of the two above described theories: that of Frank, and that of de Vries and Sachs.

The method employed was to fix the plants under observation to a horizontal spindle, which was kept in slow rotation by clockwork. This instrument (called the klinostat) has been employed by Sachs for the study of ordinary heliotropism; light is admitted parallel to the axis of rotation, and the plants are thus subjected to a constant lateral illumination, while they are freed from the disturbing influence of gravitation, for, owing to their being kept in constant slow rotation, there is no reason why they should bend apogeotropically in one direction more than another (see Sachs in his "Arbeiten," Bd. ii. 1879). On the same principle the behaviour of leaves which place themselves at right angles to the incident light has been studied. If a plant with horizontally-extended leaves, which has been illuminated from above, is fixed on a slowly-revolving, horizontal spindle, so that the axis of the plant is parallel both to the axis of rotation and to the direction of incident light, we shall have a means of testing the opposing theories above mentioned.

The plant's leaves will still be illuminated by light striking them at right angles; therefore if Frank's theory is the right one they ought to remain in this position. But if de Vries and Sachs are correct in their views, the leaves ought *not* to be able to remain at right angles to the incident-light, since apogeotropism has disappeared, which was one of the tendencies necessary to keep the leaves in a position of equilibrium.

A considerable number of experiments were made with the celandine, *Ranunculus ficaria*, the results of which are decidedly in favour of Frank's views. The leaves of the celandine are sometimes extremely epinastic, so that they press against the ground, and when a plant is dug up it often happens that, the leaves being released from the resistance of the soil, curve nearly vertically downwards. If such a plant is fixed on the klinostat in the position above described, the leaves will be pointing away from the light, so that if the leaves were apheliotropic, as might be expected according to de Vries' theory, the leaves would remain pointing away from the window. But this is not the case, they move forwards until they are approximately at right angles to the light, and then come to rest. Again, if a celandine is placed in the dark its leaves rise up so as to be highly inclined above the horizon, if the plant is then placed on the klinostat the leaves (which now of course point towards the light) again accommodate themselves by curving backwards until they are at right angles to the light. Thus the leaves cannot be called heliotropic or apheliotropic; we are forced to believe that under the stimulus of light they are able to move in either direction, which may be necessary to bring them into the plane at right angles to the light. The other experiments with *R. ficaria*, the details of which we omit, lead to the same general result.

Besides a few observations on Vicia, Cucurbita, and Plantago, a series of experiments were made on seedling-cherries, and these lead to a somewhat different result. A cherry-plant illuminated from above has its leaves approximately horizontal, and when placed on the klinostat, as above described, the leaves are unable to remain at right angles to the light, but curve backwards so as to become parallel to the stem of the plant. This movement can be shown to be due to epinasty, not to apheliotropism, and is the result of the loss of balance which follows when apogeotropism is removed. It is clear therefore that the horizontal position of the leaves of seedling-cherries growing normally must largely depend on the balance struck between epinasty and apogeotropism, in accordance with the views of de Vries and Sachs. But since these forces obviously cannot produce the power which the cherry possesses, of altering the position of its leaves in accordance with the direction of the light, we must assume that some kind of heliotropism enters into the combination. The view to which the present research lends most probability is that dia-heliotropism (transverse-heliotropism) is the really important influence at work. In the case of the celandine we have seen that the sensitiveness to light is strong enough to determine the position of the leaves—although the natural balance is disturbed by the annihilation of apogeotropism. It seems probable that an essentially similar state of things holds good in the case of the cherry. When the plant is growing normally it trusts to epinasty and apogeotropism to produce an approximate balance, the final result being determined by the stimulus of light. But when the balance is disturbed by placing the plant on the klinostat, the light-stimulus is not strong enough to produce a condition of equilibrium.

This view is the same as that given in "The Power of Movements in Plants," and is in accordance with the principle there given: that the chief movements in plants are due to modifications of the circumnutating motion.

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II. When a cutting, for instance a piece of a willow-branch, is placed in circumstances favourable for growth, it produces roots at its lower end, while the buds at its upper end grow out into branches. The experiments of Vöchting ("Organbildung im Pflanzenreich," Bonn, 1878) on the growth of cuttings were made by suspending

pieces of stems, branches, &c., in large, darkened jars, the air in which was kept constantly moist by a lining of wet filter paper. The cuttings were suspended both in the normal position—that is with the upper end upwards—and also upside down. Vöchting found as a general result that there is a strong tendency for the roots to appear at the *basal* end,[1] and the branches to be developed at the *apical* end, whether the cutting had been hung apex upwards or downwards in the glass jar.

Vöchting believes that the growth of roots at the base and of branches at the apex of a cutting are determined chiefly by an innate, inherited, growth-tendency. When the knife divides a branch into two cuttings it separates a mass of identically-constituted cells into two sets, one which form part of the apex of the lower cutting, and another set which form part of the base of the upper cutting. And under appropriate circumstances one of these sets of cells might develop into roots, the other into adventitious buds. Vöcht holds that it is the morphological positions of these sets of cells (the fact of one being at the base and the other at the apex of a cutting) which chiefly determines the course of their subsequent development. The idea may be expressed somewhat familiarly by saying that each cutting into which a branch is divided is able to distinguish its base from its apex, and can tell where to produce roots and buds, by means of an internal impulse or morphological force which is independent[2] of the external forces, gravitation and light.

The theory which Sachs has brought forward in his paper on "Stoff und Form der Pflanzenorgane" ("Arbeiten des bot. Inst. Würzburg," 1880, p. 452) is entirely opposed to that of Vöchting. Sachs conceives that Vöchting's morphological force is not an innate hereditary impulse, but a tendency produced by the action of external forces during the growth of the formative cells. Thus Sachs believes that the force of gravity acting on the developing cells of an organ produces in it a "predisposition" or enduring impulse which manifests itself in the results which Vöchting ascribes to a hereditary force. The mode in which Sachs believes gravitation to act is interesting, not only in itself but also as a modification of a theory of Du Hamel's. It is assumed that difference of material is a necessary concomitant of difference of form, and that accordingly the materials from which roots are formed are chemically (used in a qualified sense) different from those which supply the branches. Sachs' theory supposes that the growth of roots or buds at a given place will be determined by the distribution of the root- and branch-forming materials, and that the distribution of these materials is regulated by the force of gravity. The root-material is in a certain sense geotropic and flows downwards, the branch-material having the opposite tendency. But they are not supposed to be *simply* geotropic, the tendency of the root-material to flow towards the base of a branch is continued after the branch has been made into a cutting and hung upside down, so that the root-material flows upwards towards the base of the cutting, because that end was originally downwards, and *vice versâ* with regard to the branch-forming matter.

The observations on the bramble, which form the subject of the present paper, were carried out with the object of deciding how far the natural growth of roots in the bramble agrees with Vöchting's or Sachs' theories on the growth of cuttings.

The long sterile shoots of the bramble are well known to possess the power of rooting at their ends. The terminal bud is thus protected during the winter, and the store of nutriment contained in the club-like thickened end of the branch forms a starting-point for new growth in the spring. It is commonly the long pendant branches growing vertically downwards which reach the ground and form roots. It might therefore be supposed that gravitation determines the growth of roots at the *lower* end of the branch, just as in a cutting made from an erect willow branch the roots grow at what was originally the lower end. But observations made on brambles under certain circumstances show that this is not the case. When brambles grow on a steep bank the majority of the branches grow down hill at once, or else straggle more or less horizontally along the bank and finally turn downwards. But a certain number of branches grow uphill, and some of these take root at the apex. When therefore we find on the same individual plant some branches forming roots at the physically lower, and others at the upper end, we may feel sure that the distribution of root growth in the bramble is not determined by gravitation. We mus believe that there is a morphologically directed impulse which tends to the production of roots at the apex of the branch, whether the direction of its growth has been upwards or downwards. It is true that in the observed cases the extreme end of the branches was bent so that from 1 to 9 inches was inclined at from 2° or 3° to 5° below the horizon, but it can hardly be imagined that this fact influences the growth of roots at the apex; and experiment shows that it is not necessary that even a single inch should be inclined below the horizon. A bramble branch was tied, apex upwards, to a vertical stick, and was surrounded by damp moss and covered with waterproof cloth; under these circumstances a plentiful crop of roots sprang from the terminal part of the branch. This result combined with the observations made with brambles growing on a steep bank seem to show that an internal impulse or morphological force regulates the growth of roots in the bramble.

When a cutting is made from a bramble the only development that takes place is the growth of the axillary buds at the apical end of the cutting. Under certain circumstances these side shoots take on a root-bearing function. They are stunted in growth, being, it may be, 10–12 mm. in length and 3 or 4 mm. or more in breadth; they assume a peculiar club-like form, being thicker at the apex than at the base, and are clothed with rudimentary scale-like leaves, from among which a number of relatively large roots spring forth.

In order to determine whether the production of this root-bearing type of root is determined by gravitation or by a "morphological force," cuttings were made from branches whose direction of growth was above the horizon. Such cuttings were hung apex upwards, and it was found that the most apical buds were capable of developing under these circumstances into the root-bearing type of branch. Similar rooting side-shoots are produced by cuttings made from branches which have grown beneath the horizon, it is therefore clear that gravitation is not the chief[1] determining force in this form of root production.

When the end of a branch is injured, which often occurs when a bramble grows along the ground near a pathway, the most apical bud or buds grow out into branches; these may be ordinary branches which ultimately take root. Under certain circumstances, the stunted club-shaped root-bearing side-shoots may be developed whose whole formation is devoted to the bearing of roots. It is therefore clear that the production of such rooting shoots in cuttings is the same process that occurs in branches injured in a state of nature; a process which enables the branch to perform the function, the normal performance of which had been interfered with. And this fact enables us to see in what way a

[1] The basal end is that end of a cutting nearest to the parent plant; the apical, is the opposite end.

[2] Vöchting states distinctly that gravitation and light do affect the positions in which organs are developed in cuttings, but he considers the internal impulse as the stronger determining cause.

[1] The experiments seem to show that gravitation has *some* influence on the growth of roots in the bramble.

morphological growth-impulse is better fitted for the requirements of the case than any possible dependence on gravitation as a guiding force. When the end of a branch is injured it is clear that if a side-shoot is to be developed to carry on the function of the injured apex, it will have the best chance of success if it starts from the position which the end of the original branch had already gained before it was injured. Therefore the bud which is nearest to the injured apex will be the most suitable one to be developed into a new branch. And thus it is advantageous to the plant that the place where the new development is to take place should be determined morphologically, not by gravitation.

Thus in the bramble the behaviour of cuttings is a repetition (cf. Vöchting, "Organbildung," p. 107) of the normal process of restoration of a deranged function in the plant; how far this is the case with other plants must remain at present undetermined.

## NOTES

WE are very glad to hear that Bedford College is taking a leading part in giving to women the opportunity of studying thoroughly physical science. It has this session opened a physical laboratory, under the able direction of Dr. Lodge. A chemical laboratory was added to the College some years ago, and has proved of great service to the students, several of whom have passed the science examination of the University of London.

THE death is announced of M. Lécard, a promising French botanist, as the result of excessive fatigues during his late journey in Soudan. M. Lécard was formerly director of the Public Botanical Gardens at Saïgon, in Cochin-China, and at Richard Toll in the colony of Senegal. During the past year he was intrusted by the French Minister of Public Instruction with the important mission of studying the flora of the Upper Niger, a question now of no slight interest in view of the probable construction of the Trans-Saharan Railway. Various difficulties prevented his reaching the Niger. At Kouridiam, however, the most distant point reached in his journey, where he was forced to pass the rainy season, he made the valuable discovery of five varieties of annual vines, the fruits of which so closely resemble our ordinary grapes that he regarded them as fully able to replace the grape in the production of raisins and wine. M. Lécard hoped also to find in his new discovery the means of satisfactorily combating the phylloxera, and inspired with this desire, sought to make extensive collections of the seeds of the vines to bring back to France. M. Lécard, in a letter recently read by Dumas before the French Academy of Sciences, expressed the fear of having lost his health by the privations incident to this journey—a prevision unfortunately too completely realised.

THE death is reported of Dr. Wilhelm Heintz, Professor of Chemistry at Halle University, at the age of sixty-three years.

THE death has taken place, on the 16th inst., at the age of ninety-one years, of Mdlle. de Montgolfier, daughter of Etienne de Montgolfier, the inventor of the balloon to which his name is attached.

PROF. WILLIAMSON, Graham's successor in the Chair of Chemistry at University College, London, has complied with the request of the committee of the Chemical Section of the Philosophical Society of Glasgow that he should act as adjudicator in the competition for the Graham Medal.

PROF. TYNDALL, Prof. Haeckel, and Dr. Andrew Buchanan have been elected Honorary Members of the Philosophical Society of Glasgow.

AMONG the buildings which are to be erected on the new Observatory grounds in Paris when legally handed over to Admiral Mouchez will be the great dome for the large refracting telescope which is now building. This dome will measure twenty metres in diameter, and its weight will exceed sixty tons.

THE credit of 300,000 francs asked by M. Cochéry for the forthcoming Exhibition of Electricity and Congress of Electricians at Paris has been voted by the Chamber of Deputies unanimously. The Bill has been sent to the Senate, which will probably have passed it by the time this number is published.

ON December 12 took place at the Sorbonne the celebration of the fiftieth anniversary of the foundation of the Polytechnic Association for delivering scientific lectures all over France. This Society was established a few months after the Revolution of July, 1830, by a certain number of pupils of this celebrated school. The principal address was given by M. Gambetta, who praised science in magnificent style. M. Gambetta declared his conviction that Auguste Comte was the profoundest thinker of the whole century.

FREQUENT observations on the retrograde motion of glaciers have been made of late years. One of the most assiduous of observers is Herr W. Grömer, proprietor of the Hotel on the Schafberg. He reports that during September the retrograde motion was exceptionally large, larger indeed than he had ever seen during seventeen years. The Gosau glacier (Dachstein), the Hochalmspitze, and the Uebergossene Alp showed hardly any ice at all on September 12 last, so that with the telescope only *débris* of rocks could be seen. Herr Grömer ascribes this phenomenon to the unusually high temperature which reigned upon the Alps during last winter, as well as to the constant rain during the summer.

WE are glad to receive a third edition of vol. i. of Harcourt and Madan's "Exercises in Practical Chemistry" (the Clarendon Press). Mr. Madan is the sole reviser of this edition, and we quote with approval the following passage from his preface:—"Practical chemistry seems in danger of being made far too much a study of a few reactions of salts, got up for the purpose of detecting them in the course of an analysis. This is of course due to the requirements of examiners, to satisfy which nearly all the very moderate time available for practical instruction in schools must at the present day be spent. Moreover analytical work (in the narrow, technical sense) entails, like Latin verses, less trouble to the teacher and less risk to the pupil than other kinds of practical work; while it undoubtedly affords, when intelligently used, a very excellent training in the application of logical methods. But it may well be doubted whether a more real and valuable advance in a scientific education is not made by the careful preparation and examination of the properties of such a substance as oxygen, or by an exact study of a few examples of oxidation and reduction, than by simply observing, for instance, that chlorides give a white precipitate with silver nitrate which is soluble in ammonia."

MR. C. SCHOESSTER, one of the Commissioners at the Melbourne Exhibition, we learn from the *Colonies and India*, has been visiting the Geelong vineyards, and reports that they are suffering from *Phylloxera* in the worst form, and ought to be totally destroyed.

PROF. DEWAR will give the first of his Christmas Lectures (adapted to a juvenile audience) on Atoms, at the Royal Institution on Tuesday next, December 28, at three o'clock.

A BOTANICAL society for Northern Thuringia has been founded at Sondershausen by Prof. Leimbach. The new Society takes the title of "Irmischia," in memory of the celebrated botanist Irmisch, who died at Sondershausen last year. The immediate object of the Society, which has already a good

number of members, is the minute investigation of the Thuringian flora, and the making of botanical collections.

A GENERAL meeting of the Mineralogical Society of Great Britain and Ireland will be held at the Museum of Practical Geology, Jermyn Street, to-day, at 8 p.m. The following papers will be read:—"On Tyreeite," by Prof. M. F. Heddle, F.R.S.E.; "On Minerals New to Britain," by Prof. M. F. Heddle, F.R.S.E.; "Note on Gilbertite," by J. H. Collins, F.G.S.; "On Brochantite," by Wm. Semmons; "On a Remarkably Fine Crystal of Euclase," by M. Guyot; "On the Action of Organic Acids on Minerals," by Prof. H. C. Bolton, communicated by J. H. Collins; "On Strontium from Westphalia," by Joseph J. Acworth, F.C.S., communicated by F. W. Rudler, F.G.S.

UNDER the common name of "Guaco" many plants are known belonging to different natural families, which have a reputation for curing snake-bites. In a recent number of the *Pharmaceutical Journal* particular attention is drawn to one of these guaco-yielding plants, the *Mikania guaco*, a composite plant of South America. The paper referred to is the substance of a letter received at the Royal Gardens, Kew, from a correspondent at La Salada, New Grenada, in which the writer gives his personal testimony as to the value of the remedy, and says that it forms the basis of all the preparations of the snake-bite doctors of the district. Notwithstanding that there are several species of snakes in the country whose bite is considered mortal, some killing in a very few hours, it is asserted by the writer of the letter, who has resided in snake-infested regions for many years, that properly and promptly administered the guaco is a sure cure for the bite of the most venomous. An infusion or tincture of the leaves is used internally, and hot poultices of the bruised leaves and stem are applied externally.

THE Report on the Botanic Gardens, Georgetown, Demarara, for the half-year ending June 30 last has just been received. Its matter is mostly of local interest. We note however that Mr. Jenman, the superintendent, refers in one part of the Report to the rapid growth of some introduced plants. "This," he says, "is more particularly shown by the roses obtained from England. The hybrid perpetuals from average-sized nursery plants have in the three months which have elapsed since they were put out, grown into bushes from six to seven feet high, and the other hard-wooded things have hardly done less well; while herbaceous plants such as *Coleus*, *Alternanthera*, *Iresine*, *Amaranthus*, &c., appear to rush up to maturity in two or three weeks. Much of this luxuriance is due however to the very moist season experienced, as vegetation soon suffers and becomes stagnant with even a short period of drought in the stiff, tenacious soil of the coast land of the colony."

A PLANT recently introduced to Queensland by accident is reported to be giving some trouble in the colony in consequence of its poisonous effects upon cattle. The plant is *Xanthium strumarium*, and it is said to have been introduced along with cotton seed. From experiments made with the plant by administration of the extract to some animals it seems at first that no particular symptoms were apparent, but after a period of about half an hour the animal becomes torpid and unwilling to move about. "The torpidity gradually increases, and without notable struggling or excitement the breathing ceases, after which the heart's action becomes feeble and stops. In weaker doses recovery of the functions of life takes place, and the animal appears little the worse for the experiment. The animals poisoned retained their intelligence to the last. An extract prepared from the common Bathurst Burr, *Xanthium spinosum*, gave similar results, though the stubborn character of this plant does not offer a tempting food for cattle, and they are not therefore poisoned by it." Both species are found as casual weeds in this country, though they are not considered to be indigenous.

ON the 7th inst. the distinguished Vienna anatomist, Dr. Hyrtl, reached his seventieth birthday. He received numerous addresses from medical bodies in Austria, and congratulatory telegrams from all parts of the world.

IN Banjaluka (Bosnia) a distinct shock of earthquake was felt on the 6th inst. at 9.18 p.m., direction north-east to south-west, duration four seconds. In Agram, on the 11th, a violent shock was experienced about 5 a.m., and one less violent about 7.14 a.m. Since the 12th there have been no shocks there. The entire number of shocks at Agram during the earthquake period—November 9 to December 10—is (according to official data) fifty-nine. In Gurkfeld (Styria) shocks of brief duration were felt on the 11th inst. at 5 and 7.12 a.m., direction south-east to north-west.

A SLIGHT shock of earthquake was felt at Charleville, Ireland, on Saturday morning. It passed from the north-west to the south-east, and lasted for five seconds.

THE new "Year-book of Photography" contains a nice portrait of Daguerre, the father of photography, from a daguerrotype taken in 1846 by Mr. J. E. Mayall.

IN a moor of the Canton of Vaud (Switzerland) a well-preserved boat, dating from the age of pile-dwellings, has been found. It measures eleven metres in length and one metre in breadth, and has been conveyed to Lausanne.

THE ruins of a once magnificent bathing establishment have been recently discovered by Prof. Giuseppe Novi not far from Herculaneum. They are covered with a layer of ashes and lava of ten metres thickness. What has been brought to light up to the present is said to eclipse all previous discoveries of a similar nature both in Herculaneum and Pompeii. The fountains and tanks of these "Terme" are made of oriental granite and adorned with sculptures. The floors are of coloured glass mosaic; unfortunately it is but badly preserved. The walls of the various buildings are elegantly ornamented with paintings and stucco-work. The excavations are to be continued.

## OUR ASTRONOMICAL COLUMN

SWIFT'S COMET.—The evidence in favour of a period of about 5½ years instead of about 11 years for this comet is apparently strengthened by an able note from Mr. S. C. Chandler, jun., which we find in an advance number of the Boston *Science Observer*. He brings the two periods to bear upon the representation of the observations of 1869. Starting with Prof. Bruhns' parabolic elements in *Ast. Nach.* No. 1788, he computed an ephemeris and compared therewith all the published observations, thirty-five in number, after taking into account parallax and aberration. The residuals were found to be considerable and systematic, and with the view to obtaining a nearer approximation to the orbit before proceeding with the determination of final elements, he formed three normals, using for the first all the observed places, six in number, from November 29 to December 1 inclusive; for the second all the places from December 8 to 10 inclusive, eleven in number; and for the third six observations between December 26 and 31: these observations were made at Hamburg, Königsberg, Kremsmunster, Leipsic, Manheim, and Vienna; he thus gets for the foundation of his subsequent work the following normal positions:—

| Washington M.T. | | App. R.A. | | | App. Decl. | | |
|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | ″ |
| 1869, November | 29·82475 ... | 23 | 1 | 5·20 ... | + 15 | 51 | 57·7 |
| December | 8·81453 ... | 0 | 3 | 37·28 ... | 20 | 55 | 2·1 |
| December | 29·43628 ... | 2 | 39 | 22·08 ... | + 26 | 30 | 56·8 |

From these data Mr. Chandler calculates elements upon three different hypotheses: (1) that the orbit is a parabola; (2) that it is an ellipse with a period of 4006 days, or about 11 years (3) that it is an ellipse with a period of 2003 days, or about 5½

years, and he finds from these three orbits the following residual errors for the second normal place :—

| | Longitude. | Latitude. |
|---|---|---|
| | ″ | ″ |
| Parabola ... ... ... | − 3·1 | + 25·7 |
| 11-year ellipse ... ... | − 0·6 | + 12·9 |
| 5½-year ellipse ... ... | − 0·3 | + 4·1 |

Mr. Chandler finds that an attempt to reduce these errors in latitude on the assumption of a parabolic orbit or an elliptic orbit of 11 years' period, will only lead to intolerable discordances in the longitudes, and he considers that for both these hypotheses the residuals are far in excess of the probable error of the normal position. For the shorter period, on the contrary, the residuals seem well within reasonable limits of error, and his conclusion therefore is that the comet will be found to revolve in about 5½ years. His ellipse with this assumed period is as follows, and will be found in close agreement with that obtained on a similar hypothesis from the observations of the present year, by MM. Schulhof and Bossert, which we gave last week :—

Perihelion passage, 1869, November 18·59702 Washington M.T.

| | | |
|---|---|---|
| Longitude of perihelion ... ... ... | ° ′ ″ 42 58 53 | M. Eq. 1869·0 |
| ,, ascending node ... ... | 296 46 2 | |
| Inclination ... ... ... ... ... ... | 5 23 44 | |
| Excentricity ... ... ... ... ... ... | 0·6581359 | |
| Semi-axis major ... ... ... ... ... | 3·10971 | |
| Log. perihelion distance ... ... ... | 0·0265728 | |

It appears that the comet was observed at Harvard College until January 3, 1870, or three days later than at any other observatory, and Prof. Pickering has had these late observations very carefully reduced.

At the actual appearance a communication from Mr. Lewis Boss, Director of the Dudley Observatory at Albany, N.Y., shows that the comet was micrometrically referred to a star, with the 13-inch refractor of that establishment, on the evening of October 11, but the declination of the comparison-star (B.D. + 17°·4611) needs further examination; it might be referred to Bessel's star 38s. following and about 6½′ north. If good observations can be obtained towards the end of the present month the elliptic orbit may admit of pretty close determination from the observations of 1880 alone. The following ephemeris is calculated from MM. Schulhof and Bossert's ellipse of 5½ years :—

*At Greenwich midnight*

| | R.A. | Decl. N. | Log. Δ. |
|---|---|---|---|
| | h. m. s. | ° ′ | |
| Dec. 23 ... | 5 28 18 ... | 35 3·4 ... | 9·3514 |
| 24 ... | 5 30 38 ... | 34 28·9 | |
| 25 ... | 5 32 51 ... | 33 55·6 ... | 9·3736 |
| 26 ... | 5 34 58 ... | 33 23·4 | |
| 27 ... | 5 36 59 ... | 32 52·5 ... | 9·3957 |
| 28 ... | 5 38 55 ... | 32 22·6 | |
| 29 ... | 5 40 47 ... | 31 53·7 ... | 9·4177 |
| 30 ... | 5 42 35 ... | 31 25·8 | |
| 31 ... | 5 44 19 ... | 30 58·9 ... | 9·4828 |
| Jan. 1 ... | 5 45 59 ... | 30 33·0 | |
| 2 ... | 5 47 35 ... | 30 8·0 ... | 9·5041 |
| 3 ... | 5 49 7 ... | 29 44·1 | |
| 4 ... | 5 50 34 ... | 29 21·2 ... | 9·5252 |
| 5 ... | 5 51 56 ... | 28 59·2 | |

A New Comet.—A small, pretty bright comet was discovered by Dr. Pechüle at Copenhagen on the evening of December 16, in R.A. 18h. 49m., Decl. + 10° 30′. Daily motion, + 5m. and + 40′.

Occultation (?) of 73 Piscium by Jupiter.—On February 3, 1881, according to Leverrier's Tables of the planet Jupiter and the position of the star 73 Piscium (rated 6·0m. in the *Durchmusterung*) brought up from the Greenwich Catalogue of 1872, the star should be occulted by the planet about 2h. 8m. G.M.T. Very small change however in the place or semi-diameter of the planet, might suffice to bring about merely an appulse. The facts of the case may be well ascertained in easterly longitudes, as at Madras, where the conjunction in Right Ascension appears to occur when the planet is 3h. 26m. past the meridian, about 7h. 29m. mean time. The apparent place of the star on February 3 is in R.A. 0h. 58m. 43·53s., Decl. + 5° 1′ 10″·2. The polar semi-diameter of the planet, according to the value of mean semi-diameter now adopted in the *Nautical Almanac*, will be 17″·2, and allowing for parallax, this seems to place the star a little over 2″ within the planet's northern limb.

## METEOROLOGICAL NOTES

From an able and temperately-worded article in the New York *Nation* on the Signal-Service Succession, it is plain that meteorology is in a critical position in the United States at the present moment. The whole question of the future of meteorology in that country practically turns on the sort of man who is to be appointed to succeed the late lamented Gen. Myer. As regards the bearing of the question on the promotion of the great financial, commercial, and educational concerns of the country, the writer of the article well puts it when he states that "it depends altogether on the future management of the office whether its activity shall be confined to a lifeless routine without any attempt to make new discoveries or introduce improved methods, or whether it shall be animated by that progressive spirit which will not be satisfied until every man within reach can be informed of coming meteorological changes as long in advance as it is possible for them to be foreseen." To accomplish this end much more is needed than a most diligent discharge of the daily duties of the office, such as will put the public in possession of forecasts drawn up on the lines that have hitherto been followed in forecasting the weather. It was an essential feature of General Myer's procedure that in framing the forecasts in the office he confined himself simply to making the best use of what was already known of meteorology. But whilst this continued the practice of his office, he had the genius to see that if the system of forecasting weather is to make way it is absolutely indispensable to strike out entirely new lines of observation with the view of arriving at some positive knowledge of the great movements of the atmosphere and their determining causes. Hence his great scheme of International Meteorology, by which was secured one daily observation at the same physical instant, where possible, over the globe, and the regular publication of the monthly results in the U.S. Weather Maps, with which our readers are familiar. These admirable maps, together with the Weather Maps of the States themselves, published at intervals of eight hours through a period of ten years, now furnish a mass of material the value of which it is not possible to overestimate; and the adequate discussion of which, it may be very safely said, is the next great step to be taken by meteorology. This step it is in the power of the United States to take, and whether it be taken or not depends almost wholly on the character of the man who may be called to fill the place so suddenly left vacant by General Myer's premature decease. What, above all, is imperatively required, is a sympathy with science and workers in science, so strong and so decided that he will, without fail, enlist in the service of his country some of the best intellects who will give their time and their energies to work out the great problem of weather prognosis.

The American mails inform us that a frost of unusual severity for the season set in over Canada and the middle States on November 19. It came so suddenly and with such intensity that vessels of every description were frozen up and fixed, in many cases in mid-stream. The cold was greatest all along the St. Lawrence, where the thermometer ranged from zero to − 10°·0. Several ocean steamers, even, were placed in a very precarious position, and altogether it is estimated that 800 vessels laden with grain, potatoes, fruit, and other produce were frozen up; and many deaths have occurred in consequence of the frost. So early and intense a frost has not been experienced in Canada since 1873. Closely following it occurred a remarkable depression of temperature in the British Islands, which as regards certain districts in North Britain was unprecedented at so early a period in the winter months. It was an accompaniment of a wide-spread area of high pressure which appeared off the north-west of Scotland on the 20th as shown by the English and German daily weather maps. On this day temperatures fell low for the season, particularly along the west from Cornwall to Shetland. On the 21st the high-pressure area had advanced a considerable way towards the south-east, and under the clear skies and light winds which characterised it, the temperature fell in many places in Scotland to a degree which would have been noteworthy in the depth of winter. The protected thermometer fell at Aboyne Castle on Deeside to zero, and to 1°·0 at several places, viz., at Lanark in Clydesdale, at Stobo Castle near the head of the Tweed, and at Thirlestane Castle on the Leader. These low temperatures were approximated to at a considerable number of the other stations of the Scottish Meteorological Society situated in the larger valleys in in-

land situations. As on similar occasions, the influence of the sea in arresting the fall of temperature was strikingly seen. Thus the minimum temperatures on the 21st were 31°·7 at Portpatrick, 8°·3 at Drumlanrig Castle on the Nith, 1°·0 at Stobo Castle and Thirlestane Castle, 11°·7 at Milne Graden near Coldstream, and 17°·7 at Eyemouth on the East Coast. At Douglas Castle and Thirlestane Castle the unprotected thermometer fell to −6°·0.

MR. H. S. EATON has rendered a great service to meteorology by a paper on the average height of the barometer in London, which has just appeared in the *Journal* of the Meteorological Society for October. The great value of the paper consists not so much in the long period of 100 years for which the monthly averages of each year are given, as in this, combined with a careful and laborious elimination of instrumental errors and errors arising from breaks of one or more days in the observations of the months. The series is sufficiently extended as to entitle it to be considered one of the most valuable we possess in dealing with questions of secular meteorological variations. The mean atmospheric pressure at 32° and sea-level for London is 29·952 inches, the mean monthly maximum 29·996 inches occurring in June, and the minimum 29·900 inches in November, the mean for October being nearly as low, viz., 29·909 inches. In a discussion which followed the reading of the paper Mr. Strachan remarked that even another 100 years' observations would not alter the positions of these points of the London curve—a remark no doubt quite true for London. On advancing however to the south-west the means for June and July approach towards equality, and ultimately the July mean becomes the larger as we advance into the region of high pressure which occupies the Atlantic to the south-west during this month. On the other hand, as we proceed northward, the means for May and June approach towards equality till about the south of Scotland the mean for May becomes the maximum for the year, and the further north the more decidedly is May the maximum, till in Iceland it exceeds the mean of any other month by the tenth of an inch. Attention was drawn to the dips in the curve of pressure for April and July. These in all probability are permanent features in the London curve of pressure for March-April and July when drawn from a long average, since the former is connected with the east winds of spring and the latter with the great summer barometric depression which falls to the lowest point in July in the interior of the Europeo-Asiatic continent.

IN the same number Mr. Marriott gives a brief *résumé* of three years' observations made by Mr. F. E. Cobb at Stanley, in the Falkland Islands, which, from the geographical position of the place, possess some interest. The results show a mean annual pressure of 29·604 inches, the maximum occurring in winter, and the minimum in summer. A singular feature of the monthly means is their comparative steadiness from year to year, the highest being 29·819 inches for August 1876, and the lowest 29·342 inches for February of the same year. The difference of these two extremes is only 0·477 inch. It would be difficult to select from Mr. Eaton's 100 years mean pressures for London any consecutive three years which would show so small a variation between their two extreme monthly means as do these Falkland Islands' observations. The prominent features of pressure in those islands would appear to be its variability, the constant recurrence of rapid changes, and the comparative absence of protracted periods of very low, but especially very high pressures—occasioned in all likelihood by there being no great mass of land in that quarter of the globe. A like equableness from year to year characterises the temperature and rainfall of the climate. The rainfall is surprisingly small, amounting only to twenty inches in the year; but the falls, though not heavy, are frequent, there being 236 rainy days in the year. The lowest mean temperature of any of the thirty-six months was 35°·4, and the highest 52°·6. The climate is eminently a dripping one, and when the range of its temperature is taken into consideration, and its high winds, it is one of the most disagreeable climates of the globe.

## GEOLOGICAL NOTES

NAINI TAL LANDSLIP.—In NATURE, vol. xxii. p. 505, attention was directed to landslips in connection with the catastrophe at Naini Tal on September 18. We have just received part 4 of vol. xiii. of the *Records* of the Geological Survey of India, containing a paper by Mr. R. D. Oldham, of the staff of that Survey, who was deputed to examine and report on the landslip to the Director. From this paper and a note appended to it by Mr. Medlicott, it appears that we were in error in supposing Naini Tal to stand upon Tertiary rocks. It lies just to the north of the younger formations, and is situated upon "more or less imperfectly-cleaved clay slates." These rocks are subject to a decomposition which penetrates deep into their mass, and it would seem to have been the cover of loose, decomposed detritus which, thoroughly saturated with water from the heavy rains, slid down the hill, and gave rise to the catastrophe.

THE "CHALLENGER" WORK.—Steady progress is being made in the investigation of the deep-sea deposits dredged up by the *Challenger* Expedition. M. Renard has established himself at Edinburgh, where, in concert with Mr. J. Murray, he is busily engaged in subjecting the various dredgings to chemical and microscopic analysis. In the first volume, devoted to an account of the bottom of the ocean, will be gathered together the facts amassed during this laborious study. It will avoid all speculation, but will contain such a body of data for the explication of the sedimentation and chemistry of the ocean abysses as has never before been available. In a subsequent volume the authors will develop the views to which their prolonged and minute investigations have led them. No part of the work of the *Challenger* promises to possess a profounder interest in geology.

GEOLOGICAL SURVEY OF BELGIUM.—The dual organisation for the Geological Map of Belgium is likely to lead to some curious reduplications and complications. Besides the staff under the direction of M. Dupont, there are other geologists independently at work under the Ministry of the Interior who are determined to lose no time in bringing out sheet after sheet of the geological map as surveyed by them. In particular the Baron O. Van Ertborn and M. Paul Cogels have been eminently energetic. The Baron made a convention with the Ministry towards the end of last year to complete six sheets with their explanatory texts before June 1 of the present year. He has been able to keep his engagement except as regards the Lubbeek sheet, for which he obtained a delay until the close of this year. We have just received the Boisschot and d'Aerschot sheets. Meanwhile M. Dupont makes no sign. Specimens of his map were seen at the Paris Exhibition in 1878, and also at the Dublin meeting of the British Association last year. But so far as we are aware, nothing has yet been issued. The Director is understood to be resolved to make his map the most perfect geological map that has ever been published. It is being chromolithographed at Leipzig. Considerable interest is naturally felt among geologists to see the first completed specimens of this long-expected work. We are curious also to know what will happen when the Official Survey and the free-lances meet on the same ground. Will the Government publish two different geological maps? The position reminds us of that which roused the activity of the Congress of the United States a few years ago, when it was discovered that the same Territory in the far West was sometimes independently surveyed by two or three different organisations, all paid out of the public purse. Only in Belgium things are worse, for the country is small, and the certainty of reduplication must have been foreseen from the beginning.

## GEOGRAPHICAL NOTES

AT the meeting of the French Geographical Society on November 19, M. Henri Duveyrier read an important memorandum which he had drawn up on the subject of the sources of the Niger. After going carefully into the question of Major Laing's prior discovery and various matters relating to the hydrographic system of the Niger basin, he thinks it very doubtful if any other stream will ever be discovered having a right to be deemed the chief source of the river, than the Tembi-Kundu visited by MM. Zweifel and Moustier. M. Duveyrier's remarks will no doubt be published in an early number of the French Geographical Society's *Bulletin*, and it may be hoped that it will be illustrated by a large scale map. At the annual meeting of the Society last Friday, M. Maunoir read his usual report on the work of the Society and the progress of geographical knowledge. It was announced that the Society had now about 2100 members, being an increase of about 100 in the year.

HEFT 3 of vol. ii. of the *Mittheilungen* of the German African Society contains a brief report of the work of the year. The

most striking feature of the work is the successful journey of Dr. Lenz from Morocco to Timbuctoo and thence to St. Louis in Senegal. In the region to the south of the Congo some good work has been done. Dr. Buchner has probably got beyond the district known as the kingdom of Muata Yanvo, while Major von Mechow has reached the Coango from Malange by following down the valley of the Cambo, a tributary of that river. The navigation above the junction is obstructed by cataracts, but Major von Mechow did not expect to meet with any difficulty in sailing down the Coango to its mouth in the Congo. Dr. Pogge is on his way out to Portuguese West Africa to proceed to the interior to found a station at Mussumba, the chief town in Muata Yanvo's kingdom. Herr Flegel has been exploring the Niger in the *Henry Venn*, and expects shortly to reach Sokoto. Dr. J. Hann has a paper in this number on the meteorological and hypsometrical results of Rholfs' expedition to the Kufra Oasis. The Society have received instructions from the Imperial Government regarding the manner in which the 3750*l.* granted by the Reichstag is to be divided. Dr. Gerhard Rohlfs' expedition to Abyssinia will receive 1600*l.*, and 150*l.* is to form a reserve fund for this same undertaking. The expedition now being organised at Zanzibar under the leadership of Herr von Schöler will receive 800*l.*, and the remaining 1200*l.* are for Dr. Pogge, who is attempting to reach the capital of Muata Yanoo, in Central Africa, in order to found a station there. The Society has also granted 250*l.* to Herr R. E. Flegel, who ascended the Binuë River this year.

THE new number (No. 9 of vol. vii.) of the *Verhandlungen* of the Berlin Geographical Society contains papers by Herr Gustav Niederlein on some of the scientific results of an Argentine expedition to the Rio Negro in Patagonia, and by Dr. Nachtigal on the ethnological place of the Tubu and Kanuri.

THE December number of *Petermann's Mittheilungen* contains an interesting paper by Dr. Rholfs on the Libyan Desert, in which he shows that it is the eastern part of the Sahara, and not the western, that is the real desert, broken only here and there by oases. Indeed the extreme west of the Sahara, for a distance of from 400 to 500 kilometres from the coast, does not strictly belong to the desert at all; and even the eastern half, the more we know of it, the more numerous are its oases found to be. There is an eclectic article on the Liu-Kiu Islands, by Dr. v. Klöden; a paper on the New Volcano on Lake Ilopango; and a map of the South Coast of Franz Josef Land, based on Mr. Leigh Smith's recent discoveries. In the *Monatsbericht* some interesting details are given of Dr. Junker's journey to and his sojourn in the Niam-Niam country. A letter from Dr. Emin Bey, the Governor of the Egyptian Equatorial Province, informs us that Mtesa, King of Uganda, whom Mr. Stanley so whitewashed, is as tyrannical and bloodthirsty as ever, and does not intend to be either Christianised or Mohammedanised, but to adhere to the ways of his forefathers. Dr. Emin is anxious that explorers should turn their attention to the Equatorial Province, which forms a splendid field for botanists, zoologists, and other specialists.

NOTWITHSTANDING the belief in some quarters that the American Arctic steamer *Jeannette* has been lost with all hands, it is thought in San Francisco that Capt. De Long and his staff and crew may have only abandoned her, and be waiting succour at some point. An attempt is therefore being made to get a small schooner sent out next spring to search Wrangell Land.

EARLY in the present year Mr. W. H. Cornish, of the Surveyor-General's Department at Adelaide, was engaged for some two months in examining the country in the far interior for the extension of the trigonometrical survey and traverse of the Herbert River. In about lat. 30° 59′ near that river he crossed a piece of country which by his account almost baffles description; it was flood country of the Herbert, and was completely rotten. "Cracked ground," he reports, as a term is scarcely applicable, for there were yawning chasms from four to five feet deep, and even deeper, and eight to twelve inches wide at every few feet. The country indeed was so bad that it took the camels six hours to travel seven miles, and Mr. Cornish's difficulties were increased by the unusually intense heat of the weather. Mr. Cornish believes that before long the cattle-trade from the part of Queensland which he visited will go southwards to Australia as soon as the settlers who are beginning to open up the country on the Herbert, Diamantina, and Mulligan become sufficiently acquainted with the means of communication. During his journey Mr. Cornish did not see more than 300 natives, who were all friendly, but he believes there are large numbers in the region he travelled through, and that it would not be prudent to trust them.

DR. LAWS, the head of the Livingstonia station on Lake Nyassa, is actively engaged on linguistic work. He has translated various portions of the New Testament into Chinyanja, and the Laing trustees have agreed to publish his translation of St. Mark's Gospel. Dr. Laws has also begun the Yahitonga language spoken at Bandawi, and he has collected a short vocabulary of the Chungu dialect at the north end of the lake. The Livingstonia and Foreign Missions Committee of the Free Church of Scotland have recently agreed that, on the assurance that there will be no difficulty there as to civil government, owing to the presence of powerful chiefs, Bandawi shall be made the principal port of the mission on Lake Nyassa, while sanitary out-stations are to be sought on the neighbouring hills among the Angoni. As soon as possible however the east side of the lake is to be explored, in the hope of finding a better sanitarium on the so-called Livingstone Mountains.

MESSRS. GRIFFITH AND HUTLEY, who lately established the first mission station on the west side of Lake Tanganyika at Mtowa, near the mouth of the Lukuga Creek, have sent home to the London Missionary Society some information respecting the religious notions of the Waguha. There appears to be a marked difference on this point between the tribes on the opposite shores of the lake. Those on the east side have no images or idols, but on the west shore they have them in great numbers, and have certain beliefs connected with them. Mr. Griffith observes that the first thing which strikes the African traveller on entering the western half of the continent is an image at the entrance of every village, besides many others inside it. The image is in imitation of the human figure, and is called *Mkissi*, which is the same as the Mzimu of the Swahili, and means spirit.

THE new *Bulletin* of the Belgian Geographical Society contains reports relating to the International African Association's expeditions in East Africa, including tables of meteorological observations taken by M. Popelin. There is also a report on the "Conférence Géodésique Internationale de Munich," and an essay by Col. Verstraete on biological geography.

THE *Bulletin* of the Norman Geographical Society contains a paper by M. G. Gravier on M. Paul Soleillet's journey to Adrar between December, 1879, and May, 1880, as well as the continuation of M. Ch. Benner's journey from M'ruli to the capital of Unyoro.

THE Italian Expedition to the Antarctic Regions will not set out till 1882, but Lieut. Bove will shortly set out on board a whaling vessel to make a voyage of reconnaissance.

TWO Englishmen, with sixteen men belonging to an Indian convoy, are reported to have arrived at Yarkand from the direction of Tibet, whither they returned after visiting Kashgar.

M. RABOURDIN, who accompanied Col. Flatters on his survey for the proposed Trans-Saharan Railway, reports that he discovered numerous remains of cut flints, not less than eighteen manufactories being found in a length of 800 kilometres from Wargla. He also found remains of the great horned oxen which, according to Herodotus, were found in the country of the Garamantes.

DR. NACHTIGAL has furnished the *Tour du Monde* with a *résumé* of the concluding portion of the forthcoming volume of his "Reise in Afrika" in advance of publication, and it now appears in that periodical under the title of "Voyage du Bornou au Baguirmi," accompanied by a sketch-map and some very interesting illustrations.

WE hear that the Geographical Society of Marseilles have awarded their gold medal to Major Serpa Pinto for his journey across Africa.

ACCORDING to the *Echo du Japon* the King of Corea has been induced to make an offer of entering into treaties with foreign powers, through his fear of his kingdom being annexed by Russia, and he has despatched two envoys to open negotiations. Though the opening of Corea will hardly be of any great commercial importance, it will pave the way for interesting geographical researches in a country which is almost unknown, except from the imperfect accounts of Roman Catholic missionaries.

THE first volume of Löwenberg's "Geschichte der geographischen Entdeckungs- und Forschungsreisen," which treats

of voyages of discovery made during antiquity and the middle ages, as far as Magellan's first voyage round the globe, will be shortly published by Herr Spamer of Leipzig. It will contain some 100 illustrations, besides maps, charts, &c.

## CRITICAL TEMPERATURE OF ETHYLENE

M. AMAGAT (*Compt. rend.*[1] [1879], lxxxix. p. 437, corrected *Beiblätter* [1880], iv. p. 19) has submitted hydrogen, oxygen, nitrogen, air, carbon monoxide, methane, and ethylene at temperatures from 18° to 22° to pressures ranging between 28 and 431 atmospheres, and finds that, except for hydrogen, the product $pv$ first diminishes and then increases as $p$ increases, the most marked case being that of ethylene, for which the values of $pv$ at 31·58, 84·16, 398·71 atmospheres are proportional to 2·29, 1, 3·13 respectively. Dr. van der Waals deduced this general peculiarity theoretically in 1873, and showed that its markedness is the greater, the less the temperature of compression exceeds the critical temperature: concluding, therefore, that for ethylene the critical temperature is not far below 18°, as M. Amagat has also surmised, he has recently (*Meded. der k. Akad. van Wetenschappen in Amsterdam*, Mei 1880)[2] determined it directly by a Cailletet compression-apparatus, finding it to be 9°·2, and the critical pressure 58 atmospheres.

On p. 55 of his dissertation "Over de Continuiteit van den Gas- en Vloeistoftoestand" (Leiden, 1873), van der Waals finds the characteristic equation of a gas in the form—

$$\left(p + \frac{a}{v^2}\right)(v - b) = R(1 + \alpha t),$$

where $a$, $b$, $R$ are constants and $\alpha$ the coefficient of expansion, and on p. 79 *et seq.* it is shown that at the critical temperature all three values of $v$ given by this equation, which may be written

$$v^3 - \left\{ b + \frac{R(1 + \alpha t)}{p} \right\} v^2 + \frac{a}{p} v - \frac{ab}{p} = 0,$$

are equal: hence, if $V$ is put for this common value of $v$, and $T$, $P$ for the corresponding values of $t$, $p$, *i.e.* for the critical temperature and pressure, the theory of equations gives

$$3V = b + \frac{R(1 + \alpha T)}{P}, \quad 3V^2 = \frac{a}{P}, \quad V^3 = \frac{ab}{P},$$

whence

$$P = \frac{a}{27b^2}, \quad V = 3b, \quad PV = \frac{a}{9b}, \quad 1 + \alpha T = \frac{8a}{27bR},$$

and also

$$a = 3PV^2, \quad b = \tfrac{1}{3}V, \quad R = \tfrac{8}{3}\frac{PV}{1 + \alpha T}.$$

The minimum value of $pv$ at any temperature $t$ may be determined in the usual way by $\frac{d.pv}{dv}$ being equated to zero, and, if $p'$, $v'$ are written for the corresponding values of $p$, $v$, there result

$$v' = \frac{V}{3(1 - \tau)}, \quad p' = 27(1 - \tau)(2\tau - 1)P, \quad p'v' = 2(2\tau - 1)PV,$$

where

$$\tau^2 = \frac{bR(1 + \alpha t)}{a} = \tfrac{8}{27}\frac{1 + \alpha t}{1 + \alpha T}.$$

Thus a minimum value of $pv$ exists only when

$$1 > \tau > \tfrac{1}{2},$$

*i.e.* only at temperatures that lie between

$$\frac{a}{bR\alpha} - \frac{1}{\alpha} \text{ and } \frac{a}{4bR\alpha} - \frac{1}{\alpha}.$$

If $p_1$ represents the pressure of the gas when occupying unit volume at $t$, then

$$(p_1 + a)(1 - b) = R(1 + \alpha t),$$

and, $p_1$ being the value of $pv$ in this initial state, the markedness of the minimum value of $pv$ is greater the less

$$\frac{p'v'}{p_1} \text{ or its equivalent } \frac{(1 - b)(2\tau - 1)}{\tau^2 - b(1 - b)},$$

that is, since the sign of the $t$-differential coefficient of this expression is the same as that of $(\tau - b)(1 - b - \tau)$, the less $t$, provided that

$$1 - b > \tau > b,$$

or that the temperatures lie between

$$\frac{\alpha(1 - b)^2}{bR\alpha} - \frac{1}{\alpha} \text{ and } \frac{ab}{R\alpha} - \frac{1}{\alpha}.$$

If $v$ represents the volume of the mass of gas which occupies unit volume at 0° under unit pressure, then

$$R = (1 + a)(1 - b),$$

as is taken in the following calculations.

In the case of ethylene van der Waals' experiments give $T = 9°2$ and $P = 58$: hence, by the above relations with $\alpha = 0·00367$,

$$\frac{a}{b(1 + a)(1 - b)} = 3·489, \quad \frac{a}{b^2} = 1566,$$

which lead to a cubic equation that gives

$$a = 0·00786, \quad b = 0·00224, \quad R = 1·0056,$$

so that the characteristic equation is

$$p = \frac{0·0037(272·5 + t)}{v - 0·00224} - \frac{0·00786}{v^2},$$

the pressure being reckoned in atmospheres; hence too $V = 0·0067$ and $PV = 0·39$. Further, when $t = 20$, the mean temperature in Amagat's experiments, $\tau = 0·5547$, and thus by calculation $p' = 76·25$, while Amagat's direct observations give $p' = 84$ approximately, so far justifying the the theory. The temperatures for which $pv$ has a minimum value range from 678° to −35°.

The intimate agreement between Amagat's experiments and van der Waals' formula (which is entirely independent of them) is shown by the following table, wherein the first column contains the pressures (expressed in atmospheres) employed by Amagat, the second his experimental values of $pv$ divided by 23500, and the third the values of $pv$ calculated for $t = 20$ from the formula :—

| $p$ | $pv$ observed. | $pv$ calculated. |
|---|---|---|
| 31·58 | 0·914 | 0·895 |
| 45·80 | 0·781 | 0·782 |
| 59·38 | 0·522* | 0·624 |
| 72·86 | 0·416 | 0·387 |
| 84·16 | 0·399 | 0·392 |
| 94·53 | 0·413 | 0·414 |
| 110·47 | 0·454 | 0·456 |
| 133·26 | 0·520 | 0·520 |
| 176·01 | 0·643 | 0·642 |
| 233·58 | 0·807 | 0·805 |
| 282·21 | 0·941 | 0·940 |
| 329·14 | 1·067 | 1·067 |
| 398·71 | 1·248 | 1·254 |

The only serious discrepancy occurs for $p = 59·38$, and van der Waals accounts for this by supposing that in Amagat's table 12263 is misprinted for 15263, so that the asterisked number should be 0·650; for by experiment he finds that the ratio of the values of $pv$ for $p = 45·80$ and $p = 59·38$ is 1·26 (the calculated ratio being 1·25), while Amagat's actual numbers give 1·50, but, when corrected, 1·20.

For methane the equation of van der Waals' form that best satisfies Amagat's experimental values has for constants $a = 10^6 \times 2·9$, $b = 53$, $R = 25525$, if $t = 20$, $\alpha = 0·00367$, pressures being measured in metres of mercury, and this gives $-99\frac{1}{2}°$ for the critical temperature and $50\frac{1}{3}$ atmospheres for the critical pressure. The constants have large values here, for, as calculation shows, the mass of the gas considered is about $24\frac{1}{2}$ grams, which would occupy, at 0° under one atmosphere, about 33518 c.c.

This discussion—with the numbers recalculated—by Dr. van der Waals of M. Amagat's experiments in connection with the critical temperature is here reproduced, together with the brief *résumé* of his theory (which has not hitherto appeared in an English dress), for ready application in other cases.

September 17 ROBERT E. BAYNES

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Natural Science Tripos Class List has just been issued. There are eight names in the first class, eight in the second, and fifteen in the third. Of those in the first class three attain their first class for Physics and Chemistry, viz.: Fleming, St. John's (distinguished in Physics); S. L. Hart, St. John's, and Heycock, King's. Two attain their first class for

[1] Since the following was written, M. Amagat has published further results, which do not however affect its main point.

[2] Mr. Dickson seems to have independently discovered (*Phil. Mag.* for July, 1880) the principles laid down by Dr. van der Waals in his above mentioned dissertation, pp. 79-93, which is not sufficiently known in England.

Botany: Hillhouse, Trinity, and Hoffmeister, Caius (distinguished); and three for Zoology, Anatomy, and Physiology: Caldwell, Caius; Pigeon, Christ's; and Shaw, Sidney.

Mr. J. A. Fleming, B.A., of St. John's, has been appointed to the new post of Demonstrator of Mechanism and Applied Mechanics; Mr. Fleming is a distinguished graduate of London University, as well as having attained distinction in Physics, with first class honours in the Natural Science Tripos of this year.

Mr. J. J. Lister, B.A., of St. John's College, has been appointed Demonstrator of Comparative Anatomy, in place of Mr. A. C. Haddon, who has been appointed to the Professorship of Zoology and Comparative Anatomy in the Royal College of Science, Dublin, vacated by Prof. Bridge.

Mr. A. H. Cooke, B.A., Fellow of King's College, has been appointed Curator of the Zoological Museum.

## SCIENTIFIC SERIALS

*Annalen der Physik und Chemie*, No. 11.—Magnetic researches, by F. Auerbach.—New researches on magnetism, by C. Baur.—On so-called polar induction, by E. Riecke.—Determination of the absolute velocity of current electricity from Hall's phenomenon, by A. v. Ettingshausen.—Method of calibration of a wire for galvanic measurements, by W. Giese.—Action of gases and vapours on the optical properties of reflecting surfaces, by P. Glan.—On a new interference-photometer, by Fr. Fuchs.—Influence of the density of gases on their conduction of heat, by A. Winkelmann.—Currents of liquids resulting from unequal temperature within them, by A. Oberbeck.—Theory of the interference-phenomenon presented by dichroïtic crystal-plates cut at right angles to the axis, by E. Ketteler.—On the polarisation of diffracted light, by M. Rethy.—On changes produced in the spark and brush phenomena by coverings of the electrodes, by W. Holtz.—On atmospheric refraction of sound rays, by A. Kneser.—Double-acting mercury-pump without cock, by F. Neesen.—Alteration of Rüdorff's absorption-hydrometer, by the same.—Reply to a note by O. E. Meyer, by L. Boltzmann.—Remarks on U. Dühring's paper on the law of corresponding boiling temperatures, by A. Winkelmann.

## SOCIETIES AND ACADEMIES

### LONDON

**Zoological Society**, December 14.—Prof. W. H. Fowler, LL.D., F.R.S., president, in the chair.—Mr. Sclater exhibited and made remarks on a skin of a brown female of *Pauxis galeata*, formerly living in the aviary of the late Mr. G. Dawson Rowley, F.Z.S.—Dr. A. Günther, F.R.S., exhibited and made remarks on a skin of a new species of *Rhynchocyon* from Eastern Africa, discovered by Dr. Kirk.—Prof. T. H. Huxley, F.R.S., read a paper on the application of the laws of evolution to the arrangement of the Vertebrata, and more particularly of the Mammalia.—Lieut.-Col. H. H. Godwin-Austen, F.R.S., read a paper on the anatomy of *Ferussacia gronoviana*, Risso, from Mentone, pointing out its general relationship with *Lovea tornatellina*, Lowe, of Madeira, and with *Ferussacia follicula*, Gronov., from Algiers.—Mr. Arthur G. Butler read a paper on a second collection of Lepidoptera made in Formosa by Mr. H. E. Hobson. Thirty-three new species were found in this collection.—Mr. Oldfield Thomas, F.Z.S., read a paper containing the description of a new species of *Reithrodon*, obtained in Venezuela by the late Mr. D. Dyson, which was described as *Reithrodon alstoni*.—Dr. A. Günther read a paper containing notes on some rare reptiles and batrachians now or lately living in the Society's Gardens.

**Physical Society**, December 11.—Prof. W. G. Adams in the chair.—New Members: Mr. W. R. Brown, Mr. T. Mightson, C.E.—Lieut. L. Darwin read a paper on the rate of loss of light from phosphorescent substances. His experiments were made at Chatham on Balmain's luminous paint, by comparing the intensity of the phosphorescent light with the light of a sun-burner; the luminous surface being kept cool by placing ice and water near, as a slight increase of temperature in the surface considerably increases the quantity of light given off in a certain space of time. The supply of light was communicated to the paint from a mirror reflecting sunlight. A table and a curve exhibited to the meeting showed the rate of loss found by Lieut. Darwin. It is independent of the original intensity of the illumination. According to the curve the light diminishes very nearly in proportion to the square of the intensity of the light. In a report on the use of Balmain's paint in mines, it had been stated that the phosphorescence became brighter a few minutes after exposure in the dark; but the curve showed this to be an error, due probably to the fact that the eye becomes more sensitive to light after being a few minutes in the dark. Mr. Pearsall emphasised the advantages of such a light in fiery mines. Prof. Guthrie inquired if the phosphorescent power grew weaker by time, and Lieut. Darwin instanced a specimen eighty years old to the contrary; but Dr. W. Crookes stated that these luminous substances give off sulphuretted hydrogen in damp air and deteriorate. If sealed in a vacuum they would not. Dr. Crookes remarked that in Balmain's patent it was stated that the phosphorescence died out sooner when exposed to a strong light for a short time than to a weak light for a longer time; but Lieut. Darwin thought this was explained by the slow decrease in the lower part of the curve when the phosphorescence became faint. Mr. R. J. Lecky mentioned that Evelyn in his Diary (1650) describes a phosphorescent powder as "bottling up" sunlight. Dr. Coffin inquired if short exposure to strong light was equivalent to long exposure to feeble light. Lieut. Darwin thought not.—Dr. C. R. Alder Wright read a full paper on the determination of chemical affinity in terms of electromotive force. He considered first the value of the B.A. unit of resistance, which from different experimenters might be taken as really 1·005 earth quadrants per second, or not more than half per cent. out. Clark's element when carefully prepared was practically correct at 1·457 volts, and it kept constant for three or four months after being made, but deteriorated thenceforth some 3 per cent. in about two years. The deterioration was assisted by air, which could not be well excluded by the paraffin cork, as it cracked. If sealed in a Sprengel vacuum the element lasted better. Joule's mechanical equivalent of heat ($J$) he estimated at $42 \times 10^6$, or not over 1 per cent. greater than Joule's water value. The chief result of Dr. Wright's researches was the conclusion that the action of a current in electrolysis is to decompose the electrolyte into "nascent" products which evolve heat in changing into ordinary products of electrolysis. These nascent products may be the ultimate atoms composing the molecules of the ordinary products, and the heat is given out in these atoms coming together to produce molecules, say of oxygen and hydrogen in the case of water. A number of deductions from this theorem are verified by experiment. One of these is that no gas battery can give a higher E.M.F. than 1·5 volts. A result, not before published, is that the E.M.F. of a Daniell cell is a function of the current and is a maximum when the current is indefinitely small. The variation may amount to 10 degrees. Therefore all methods of determining resistance by means of two currents of different strength are inaccurate. Dr. Wright's experiments also verified Faraday's law that conduction in an electrolyte is always accompanied by electrolysis. Prof. Adams inquired if Dr. Wright had seen the letter of Prof. Rowland's assistant to the effect that Dr. Wright's former estimate of the ohm was on the wrong side of unity. He had been too busy to see it. Prof. Foster thought that the variation of E.M.F. in a cell with the current was to be expected, and was probably due to the slowness of diffusion. Dr. Wright thought diffusion would account for it. Dr. Lodge said that there was no way of measuring the resistance of a cell except by employing two currents of different strength, and therefore it was necessary to know the law of variation of E.M.F. with current strength. Dr. Wright stated that he had found two methods of proceeding with currents of the same strength. With regard to the deduction of Dr. Wright that no current passes without producing electrolysis, Mr. Walenn inquired if the ordinary law of solution held when there was no evolution of hydrogen, and was answered in the affirmative.—Prof. Guthrie cited the experiments of Mr. C. V. Boys and himself on the conductivity of liquids as an instance of a current passing without electrolysis, or if there was decomposition it was followed by instant recomposition. Dr. Wright thought there must be electrolysis in Dr. Guthrie's experiments (which were conducted by rotating a glass vessel filled with the liquid between the poles of a magnet, after Arago's experiment), because some two parts of the rotating vessel would be at different potentials, and a current would be set up in the liquid.—The Society then adjourned till after Christmas.

### PARIS

**Academy of Sciences**, December 13.—M. Edm. Becquerel in the chair.—The following papers were read:—Solid and

liquid products which continued issuing in April, 1880, from a crater of Dominica (English Antilles), by M. Daubrée. The lake of boiling water which filled the crater in January had shrunk to a boiling spring, the dark liquid from which joined a river. The weight of solid matter is nearly half the liquid, and mainly consists of silica and alumina; there is also iron oxide, with carbonate of lime, &c. Chloride of potassium abounds in the water.—Order of appearance of the spikelets in the ear of Lolium, by M. Trécul.—On the orbit described by a material point which is attracted by a spheroid, by M. Gyldén. —M. Abria was elected Correspondent in Physics in place of M. Lisssajous.—Application of the theory of germs to parasitic champignons on plants, and especially to diseases of the vine, by M. Cornu. In some cases the diseased leaves may be variously utilised, after such treatment as will prevent the spores being disseminated when their time of vegetation comes. Other kinds of parasites do not allow of the leaves being used as food for cattle, compost, or litter. Their dormant spores are not killed by digestion or putrefaction of tissues; after prolonged burial they may produce new germs. The *débris* in that case should be burnt. Oïdium and anthracnose exemplify the former; *peronospora* the latter.—On the discovery of the winter egg in the Eastern Pyrenees, by M. Campana. He found three in the end of September.—On a process of preparation of sulphide of carbon in the solid state for treatment of phylloxerised vines, by M. Lafaurie. He solidifies the sulphide by making an emulsion of it with a solution of algæ (Japanese moss does very well). The proportion of sulphide may be varied up to 80 per cent. It evaporates very slowly, so that vapours can be thus maintained a long time about the roots.—Swift's comet (*e* 1880), by MM. Schulhof and Bossert.—Influence of the slope of refringence on astronomical refraction, by M. Glasenapp. By this term he denotes the effect of atmospheric layers of equal density not being generally distributed in concentric surfaces on the earth's surface (as they are supposed to be in all theories of astronomical refraction). He proposes to investigate the influence of this phenomenon and its law of variation; to find whether it have an annual period, and if so, of what nature; to study the influence of this on the annual parallax of fixed stars and their aberration; also to study lateral refraction.—On the contact of conics and surfaces, by M. Darboux.—On a class of linear differential equations, by M. Appell.—On the integration of equations with partial derivatives of the first order, by M. Collet.—On linear differential equations of the second order, by M. Mittag-Leffler. —Reclamation of priority on the subject of the law of corresponding boiling temperatures, by M. Dühring.—On radiophony (second note), by M. Mercadier. The sounds may be got from oxyhydrogen lamps and gas lamps without concentrating lenses, if the lamps be brought very near the (glass) interrupting wheel, and the rays limited by a diaphragm with aperture. A copper disc (0·002 m. thick) was placed near the wheel, and heated on the side opposite to that of the wheel with an oxyhydrogen blowpipe. Sounds were heard when the disk still remained invisible in the dark (though louder when the disk was raised to a dark or bright red).—On new and economic methods of producing intermittent luminous signals, by M. Mercadier. Instead of using a diaphragm with a constant source of light, he varies the source; *e.g.* by introducing oxygen suddenly into a low flame. This is done by pressing a key, and so releasing from pressure a tube conveying the oxygen.—On the absorption-spectrum of ozone, by M. Chappuis. Eleven dark bands are observed in the visible spectrum, and several correspond with telluric bands of the solar spectrum.—Action of hydrochloric acid on metallic chlorides, by M. Ditte.—Action of hydrofluoric acid on bichromate of ammonia, by M. Varenne.—On chlorised derivatives of strychnine, by MM. Richet and Bouchardat. They have isolated three such compounds, retaining in different degrees the chemical properties of strychnine.—On the cause of spontaneous alteration of the raw sugar of cane, by M. Gayon. He gives reasons for thinking this process a true fermentation.—On the variations of luminous sensibility according to the extent of the retinal parts excited, by M. Charpentier. One region, seventeen to eighteen hundredths of a millimetre in diameter, and corresponding to the *fovea centralis*, requires a determinate quantity of light, independent of the extent of surface, to excite it. In other parts the minimum illumination is proportional to the surface.—Anatomic researches on *Onchidium*, Cuv. (*Oncidiella celtica*, Gray), by M. Joyeux Laffine. —Serpentines of Corsica; their age and origin, by M. Dieulafait. M. Hebert dissented from some of the results in this paper.

VIENNA

**Imperial Academy of Sciences**, December 16.—Herr v. Burg in the chair.—Table of the most important relations of astronomy and geography, by Herr Letoschek.—Further researches on identity of the comets 1869 III. and 1880 *e*, by Herr Zelbr and Dr. Hepperger.—On leucæmia, by Herr Ludwig.—Fourth report of the Prehistoric Commission, containing (1) Szombathy on this year's prehistoric investigations and excavations at Kiritein and Mokrau in Moravia; (2) Luschau on several old burial-places in Bosnia and Dalmatia; (3) Heger on skeleton graves of Tlonic, grave-mounds at Tschemin (Bohemia) and at Wässering in Lower Austria, and tumuli at Mars in Hungary.—Theoretical researches on the displacements of the radiation-points of dissolved meteor-streams, by Herr v. Riessl.—Application of hyposulphate of soda to separation of copper from cadmium, by Herr Vortmann.—Some experiments on an earth-magnetic inductor, by Herr Stefan.

BERLIN

**Geographical Society**, December 4.—Dr. Nachtigal in the chair.—It was stated *inter alia* that Herr Flegel, who is busy in the Niger region, had gone from Lukodja to the King of Nupe or Nife, seeking letters of introduction to the rulers of the Haussa States, so as to make a safe journey up the Niger, especially on the stretch between Tawa and Sai. He had a friendly reception, and wrote in good hopes (October 10). From Sai he means to go to Sokoto, the chief town of the Haussa States, and there to get letters for the ruler of Adamaua. A large collection of ethnological objects of the Niger region is looked for in Berlin.—Rumours of the death of Herr Hildebrandt in Madagascar prove false. A letter from him dated Krabé in Bessileo (Central Madagascar), September 2, 1880, states that he had made a journey, rich in results, from the West Coast to the Central Plateau; but his health broke down, when he was two hours' journey from the capital, to which however he was shortly brought by Herr Cousins and tended for a time in the Norwegian mission-house till able in July to visit the hot springs of Siralé (for health). He discovered in the moor at Siralé the skeleton of an extinct species of hippopotamus.—Dr. Kiepert gave details of Mr. Doughty's expeditions in Central Arabia, which have cleared up much of the physical geography of that region. —Dr. Holub spoke on the Maruthameich in southern interior Africa, north of the lower, and about the middle course of the Zambesi.

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