THURSDAY, NOVEMBER 18, 1880

THE FUTURE OF POLAR RESEARCH

WE have had quite a flood of Arctic news during the last few weeks, and the question as to the direction to be taken by future Polar research is attracting attention in various quarters. Evidently those interested in this department of exploration are thinking that "something ought to be done"; but as to what that something should be, there is likely to be difference of opinion. It is unfortunate that the United States expedition sent out at the instigation of Capt. Howgate to found a Polar colony at Lady Franklin Sound, had to turn back through some defect in the engines of the *Gulnare*. Had this ship been successful in reaching the proposed ground of the expedition's work it would no doubt have given an impetus to the scheme of Polar research which has gained the approval of the Arctic authorities of nearly all nations except our own. On the other side of the American continent no news has been received from Mr. Gordon Bennett's expedition in the *Jeannette* of later date than August, 1879, when that vessel was off Cape Serdze Kamen, all well, and on her way to Wrangel Land. All the sea within Behring Strait, both on the American and Asiatic side, was searched this summer by the *Corwyn*, but no trace of the *Jeannette* was found. The conclusion from this that the expedition has come to grief, we have already pointed out is too hasty. Everything was in her favour when off the coasts of Kamtchatka last year, and if she had fair sea-way there can be no doubt that the expedition would take advantage of it, and push on as far northwards as was safe. We should not be surprised if a year hence the *Jeannette* might emerge by Behring Strait or by Novaya Zemlya with news of equal importance to that brought back by the *Tegetthoff* years ago.

But perhaps the most generally interesting expedition on the part of the Americans is that which returned some weeks ago from searching for further relics of the crews of the *Erebus* and *Terror*. With the details of this expedition our readers are already familiar. So far as further information concerning the fate of the Franklin expedition is concerned, the results have not been of much importance, though it would seem that the scientific results are of some value. What precisely these are remains to be seen. Had the handsome volume recently published by the U.S. Government under the able editorship of Prof. Nourse, containing the narrative of Capt. C. F. Hall's second expedition, been issued before Lieut. Schwatka set out two years ago, we doubt if he would have thought it necessary to go over the same ground again.[1] Hall's devotion to the memory of Franklin is well known, and his enthusiasm for Arctic exploration was almost a religion; his *Polaris* expedition will never be forgotten. In order to obtain certain news of the fate of Capt. Crozier and the 105 men who, in April, 1848, abandoned the *Erebus* and *Terror*, Hall lived with the Eskimo in the neighbourhood of Repulse Bay and King William Land for five years, 1864–69. He, like Barry, also had heard of records possessed by the Eskimo, and to obtain these records he submitted to become an Eskimo himself for all these years. With infinite tact and patience he carried out the object of his expedition, succeeded in visiting the scene of the memorable disaster, saw many signs of the presence of white men, obtained many relics, heard many stories from eye-witnesses of the sufferings of Crozier and his men when trying to make their way to the Fish River, but obtained not a shred of any kind of record. Among the things abandoned by the men in their last despairing efforts to reach a white settlement were certainly some books, but whether written or printed could not be ascertained. The poor Eskimo had no use for such strange things, and gave them to the children to play with, and long before Hall's visit all trace of them had vanished. Indeed the information he obtained was of pretty much the same character as that just brought back by the expedition under Lieut. Schwatka. The stories told to Hall by the Eskimo as to the wanderings and sufferings of the white men are interesting, though sad. Apart from the immediate object of his expedition, Hall's long residence with the Eskimo, with whom he lived as one of themselves, yielded results of great interest. He lived in their igloos, ate their food, wore their clothing, shared their joys and sorrows, joined in their feasts, their dances, and their hunts; in short, saw more of Eskimo life than probably any one has done before or since. The details given in his journals are a contribution of great value to a knowledge of the Eskimo, and the self-denial of the high-minded and sterlingly honest man in submitting to this kind of life for so many years, for so noble a purpose, raises him to the rank of a hero. The volume edited by Prof. Nourse, with its many illustrations and handsome get-up, might well put our own Government to shame. Prof. Nourse has done his part of editor admirably, and his volume will be of permanent value. So successful has the work been that we believe a second edition has been issued. As the work is only recently published, it may fairly be recognised as a contribution to a knowledge of the Arctic situation.

This is a good summer's work for America. On the opposite side of the Pole some good work has also been done. The Dutch in their tiny vessel the *Willem Bärents* have done some good dredging in the sea between Spitzbergen and Novaya Zemlya, while Mr. Leigh Smith has added greatly to his fame as an Arctic yachtsman by his work in Franz-Josef Land. He has as we have already told, greatly extended the known area of this archipelago, and shown fair grounds for believing that it extends polewards for a considerable distance. He has proved, as was done last year also, that this Arctic land is by no means difficult to reach in an average year, and this has an important bearing on Arctic research. Last week we gave a few details of what had been done along the Murmanian coast and the White Sea by the Russian party under Prof. Wagner and we know that Baron Nordenskjöld is spending the winter in St. Petersburg preparatory to undertaking his expedition next year to the New Siberian Islands.

All this is encouraging, though it would be still more so were these various efforts undertaken on some well-concerted plan. Already has the Geographical Society been asked to lend its influence to an expedition which we cannot but regard as an anachronism. We hear

[1] "Narrative of the Second Arctic Expedition made by Charles F. Hall." Edited under the orders of the Hon. Secretary of the Navy, by Prof. J. E. Nourse, U.S.N. (Washington: Government Printing Office.)

much talk of the traditions of the English navy and the duty of England to be the first to reach the Pole. We fear the so-called traditions of the English navy must be made to conform to the requirements of modern science if she is to do any useful work in Polar discovery, just as they have been compelled to do in order that our navy may be able to keep abreast of the fighting power of other nations. To squander 30,000*l.* in one huge attempt to reach the Pole would be as mad as for a merchant to embark all his capital in one hazardous undertaking. Polar research and Polar expeditions are not incompatible, but as Dr. Neumayer showed in an admirable address at the Danzig meeting of the German Association, the former must be subordinated to and guided by the results of the latter. Preparations are being made by nearly all the countries of Europe and by America for a regular Arctic siege, to begin in 1882; the days of Arctic campaigns are past. We have reached the precincts of the citadel itself, and now the sappers and miners must begin their slow but sure work, to be capped at the proper time by a grand assault. Germany, Austria, Norway, Sweden, Russia, Denmark, the United States, and we believe Canada are all to take part in this great work by establishing observing stations at suitable points all round the Polar area; while Italy is to send out next year a scientifically equipped expedition to the Antarctic region, our knowledge of which is meagre and uncertain. This last will really be an observing as well as an exploring expedition, preparatory to the establishment of an Antarctic station. Should our Geographical Society take any steps in the direction of Arctic work, we trust it will not be to encourage the foolish venture for which the country has been canvassed for subscriptions for years. We hope that Society will see that as a scientific body, its duty is to encourage a scientific method of work; and if it appeals to Government at all, let it be to urge it, for the honour of our country, to join in the concert of both hemispheres for the siege of the Polar citadel. We have already pointed out on several occasions the vast gains to science that might be expected from the work of a series of Polar observatories established on the plans so ably sketched by Lieut. Weyprecht. As Dr. Neumayer said in the address alluded to, men of science do not demand practical or so-called utilitarian reasons before giving their adhesion to any new work; it is enough if it can be shown that such work will conduce to the advancement of knowledge. And that Weyprecht's scheme of Polar observatories, of which so many Governments approve, will lead to vast additions being made to scientific knowledge, no man of science needs to be told. In meteorology, terrestrial magnetism, biology, geology, and glacial physics, the gains would be immense; and the history of science has taught us over and over again that the surest path to practical and beneficent results is through the gate of pure scientific research. Every day is the science of meteorology becoming more and more important; but until we are thoroughly acquainted with the meteorology of the Arctic regions, that most practical of sciences is deprived of what is perhaps its most important factor. But one element of the international scheme is that of Polar exploration, conducted, however, on scientific method, and along lines indicated by a scientific knowledge of Arctic conditions such as can only be obtained by permanent observing stations. What success is likely to result from Arctic work carried out on such a method was triumphantly shown by Baron Nordenskjöld when he sailed along the North-East Passage in the *Vega*. Why then should not England set up a station on Franz-Josef Land, and another say on some part of the American coast? Let the station be provided with the means of carrying out exploration in whatever direction and by whatever means the results of continued observation may indicate—as far as the Pole itself, if need be. Unless we are blind to the teachings of science and the lessons of our last expensive expedition, it is clear that this is the only sure method of reaching the Pole, if it be thought absolutely necessary for the credit of England that she should be the first to get at a point which it will take considerable trouble to spot. If our Government be well advised, we are sure they will never give the public funds either for any great national expedition modelled on the lines of the past, nor to any private chimera got up for the glory of one man and the gratification of balloonists. We do not see how, without national discredit, England can keep aloof from an international scheme, the scientific and practical results of which will be of world-wide importance; and it is the duty of the Geographical Society to lend all the weight of its influence to induce the English Government to take up its share in the new and only effectual method of Polar exploration.

THE SANITARY ASSURANCE ASSOCIATION

IT is admitted on all hands that a vast amount of unnecessary disease, suffering, and death is caused by defective sanitary arrangements, especially as regards drainage. A few years ago, so long as there was no foul smell, and all the pipes were "properly trapped," everybody was satisfied; but properly trapped usually meant improperly ventilated, or not ventilated at all, and we know now that foul gases will pass steadily, continuously, and certainly through water in traps.

Clinical observation having demonstrated the fact that sewer air produced diseases, the prevention of the entering of such foul air into houses became of paramount importance; and the matter being thus brought to so narrow an issue, the application of well-known physical laws was all that was required; it was necessary to study the circumstances under which foul air was produced, to prevent its production as far as possible, and to take such precautions that foul air, even if formed, could not accumulate and could not find its way into houses.

Science has done much, both directly and indirectly, towards the prolongation of life; and certainly not the least important of the results of the application of scientific methods to this end in recent years has been the discovery of the ways in which a house can be made practically sewer-air proof. The laws of health are being studied more and more every day, and will soon be taught as a matter of course in all our schools; they are already recognised as a special subject of study at the Universities. People are beginning to perceive that their health is a matter which is very largely indeed in their own hands, and are beginning to turn this knowledge to account in the matter of house sanitation. At the first meeting of the Sanitary Assurance Association, presided over by Sir Joseph Fayrer, eminent members of the two professions which must always occupy the most reponsible position in connection with household sanitary matters, the professions of medicine and architecture, bore ample evidence to this fact, and at the same time to the necessity for some organisation by which the benefit of the best advice on such matters may be brought within the reach of the many. At this meeting Mr. Mark H. Judge pointed out that the Association "was the outcome of efforts which had been going on for some months to bring together architects and medical men in connection with the important question of house sanitation," and the names already identified with the Association are a sufficient guarantee that it will be both practical and permanent in its character. Sir Joseph Fayrer rightly stated in his opening address that "there is a terrible absence of all supervision of sanitary arrangements and drainage in many of the houses of the metropolis," and that although the richer classes of the population are able to get that sanitary advice which will enable them to make their houses wholesome, "there is an enormous population left, as regards which such a thing is hardly possible." Saying that he believed the idea was beginning to grow that "sanitation generally will increase the value of life," he continued, "over and over again it has come to my knowledge, and even occurred under my own observation, that families, children and servants, have suffered by the defects of drainage or sewer air—that great enemy to public health. I would venture to offer no opinion as to the nature of the diseases that proceed from sewer air, nor even enter into any discussion on the precise character of the air—the nature of the germs and the character of the poisons that it communicates; but that it does destroy health and induce disease is beyond a doubt. That it is greatly under the control of sanitary law is equally certain, and there are men now who have so studied and comprehended the nature of those laws, that they are able, practically as well as theoretically, to give that assistance and that advice which should render those conditions almost innocuous—in fact it should prevent them altogether."

Dr. Andrew Clark, after stating that he considered the Association "one of the most pressing needs of the present time," added :—"Furthermore I am convinced that if the Association can secure and retain the services of men with the scientific and practical knowledge possessed by Prof. Corfield, and will hold itself free from undertaking the execution of the works which it may suggest, superintend, and from time to time certify as sufficient, it will do important service to the public, and confer much and just credit upon all concerned."

Mr. Edwin Chadwick, the veteran sanitarian, said that "he constantly advised people, from his knowledge, 'Do not take that house unless you have it examined first. If the drains are out of order do not take it till they are put right. That was exactly what this Association had to supply."

We are happy to state that the formation of the Association was decided upon, and the following gentlemen were appointed a committee to organise it :—George Aitchison, F.R.I.B.A.; Prof. W. H. Corfield, M.A., M.D.; Prof. F. de Chaumont, M.D., F.R.S.; Mark H. Judge, Prof. T. Hayter Lewis, F.S.A.; H. Rutherford Barrister-at-Law; with Prof. Corfield as Chief Sanitary, Officer, and Mr. Judge as Surveyor.

It is surely as necessary to be assured against preventible diseases as it is to be assured against fire, and we see from the preliminary prospectus issued that it is intended to give persons who place their houses on the Assurance Register certificates that their houses are in a satisfactory sanitary condition, and to endorse such certificates from time to time; this latter point is of great importance, as it is only by regular inspection at stated intervals that it is possible to ascertain that all continues to work satisfactorily.

A very important feature is also the proposal to examine and report on the plans of new houses, for there is at present absolutely no control exerted over the sanitary arrangements of new houses in the metropolis.

We have given such prominence to this matter because we believe that the Association will supply a widely-felt want, and will do good not only directly but indirectly too; thus wise builders will take care to have their houses supervised and certified, and will reap their reward in increased facilities for letting; architects will submit their plans for criticism and suggestion; and so the public will in many ways reap a lasting benefit. In this country few new things succeed unless public opinion is ripe for them. We are slow to adopt new ideas; but we have now learnt the importance of preventing disease, we believe that much of our health depends on the perfection of the drainage arrangements of our houses, and we are ready to place them in the hands of an association in which we can have confidence.

HINCKS'S "BRITISH MARINE POLYZOA"

A History of the British Marine Polyzoa. By Thomas Hincks, B.A., F.R.S. (London: J. Van Voorst, 1880.)

THE value to science of Mr. Van Voorst's splendid series of volumes descriptive of the Natural History of the British Islands is scarcely to be overrated. The monographs are all the work of most eminent naturalists, in whom perfect confidence may be placed, and they are sumptuously printed and illustrated with abundance of excellent plates and woodcuts. The thanks of naturalists generally are certainly due to Mr. Van Voorst. The present work is fully equal in merit to its predecessors; it consists of two volumes—one of 600 pages of text, the other containing eighty-three lithographic plates. Mr. Hincks, whose industry is indefatigable, has already contributed to Mr. Van Voorst's series the well-known excellent monograph on the Hydroid Zoophytes. The labour involved in the production of a monograph such as that now under consideration is very great. All the 235 species occurring on the British coast are figured, with one or two exceptions in cases where specimens do not exist for the purpose. All the figures have been drawn by the author himself and beautifully lithographed by Mr. Hollick. Further figures are added taken from various monographs where such are necessary for the elucidation of the subject.

The wor commences with an introduction, in which the author, after expressing his obligation to Mr. Busk, Mr. Norman, Mr. Peach, Dr. McIntosh, Prof. Ray Lankester, and others who have given him valuable aid in his work, gives an account of the structure of the Polyzoa generally, with some details concerning their development, life-history, and distribution. Several pages are devoted to the question of the name of the class concerning which it seems almost hopeless that any unanimity amongst naturalists will be attained. The author adopts J. V. Thompson's term Polyzoa on the ground of priority, and we hope it may prevail in this country, although it is scarcely probable that Continental zoologists will, as the author trusts, "reconsider the grounds on which they have hitherto given their adhesion to Ehrenberg," and give up the term Bryozoa (*Moosthierchen*).

Several pages are devoted to the question of the nature of the "brown bodies," which the author, following Prof. F. A. Smith and from his own extended observations, formerly considered to be essentially concerned in the production of new polypides by germination. He now admits that the evidence at present tallies better with the residuary theory of Nitsche and Joliet, who, as is well known, regard the bodies as merely remains of decayed polypides, but thinks that further investigation on the matter is yet required. An interesting series of woodcuts are given illustrating, as shown in a series of different species, the development of the avicularium from the first rudimentary stages, hardly distinguishable from the ordinary zoœcium, up to its most highly specialised bird's head-like form. Most readers are familiar with Mr. Darwin's account of his experiments on the avicularia of Polyozoa made during the voyage of the *Beagle* and published in his Journal. The author after citing these, and those of Mr. Busk and others, expresses himself as inclined to regard the avicularia as "charged with an offensive rather than alimentary function," believing that their vigorous movements and the snapping of their formidable jaws may drive away loafing annelids and other enemies.

Some short account of the embryonic development of the Polyozoa is given, and is illustrated by a coloured plate of larvæ taken from the splendid monograph on the subject by Dr. J. Barrois of Lille. In the matter of classification the author follows Ray Lankester as far as the main sub-classes are concerned, dividing the class according to the characters of the lophophore into the Holobranchiata, or those which have the tentacles in a continuous series, and the Pterobranchiata, in which the lophopore is broken into two distinct arms like those of Brachiopods. The Pterobranchiata include only a single genus, the remarkable Rhabdopleura of Allman. The Holobranchiata are divided, after Nitsche, into the Ectoprocta, in which the anal orifice lies without the lophophore, and the Entoprocta, in which the orifice lies within it. The latter group includes the genera Pedicellina and Loxosoma only, whilst the main mass of the existing Polyzoa come under the Ectoprocta, the marine forms of which form a single order, Gymnolæmata of Allman, which order is divided by the author according to Mr. Busk's well-known system into the sub-orders Cheilostomata, Cyclostomata, and Ctenostomata. The generic terms adopted in the work are however in many instances different from those employed by Mr. Busk and other former authors, and many familiar species have changed their names, so that the student is somewhat confused. Thus the species hitherto ranged under the genus Leptalia are separated into sections and placed under the author's three genera, Mastigophora, Schizoporella, Schizotheca, and other genera.

As before stated, the number of British species of marine Polyzoa described in the work is 235. Of these 69 have as yet not been found elsewhere, but as the author adds, no inference as to their range can be drawn from this negative fact. For 28 species Shetland is the only British locality, 8 of these not being found elsewhere, whilst the remainder are Arctic forms, with the exception of two, one of which, *Cellaria johnsoni*, ranges as far south as Madeira, and is abundant in the Mediterranean. Some of the British species have an extraordinarily wide range. Thus *Cellaria fistulosa* occurs in the Mediterranean at Madeira, in South Africa, in Scandinavia and North America, in the Indian Ocean, and in Australia and New Zealand. And there are several similar instances of almost world-wide distribution, the species not being deep-sea forms, but such as flourish between tide-marks and in shallow water, though also found at greater depths. The author suggests as a possible explanation of the wideness of range of such species, in addition to migration along coast lines and in profound depths, the agency of currents, floating timber, and ships. There is a very close resemblance between the Polyzoan fauna of the south-west coasts of France and our own, whilst a small group of Polyzoa is common to our shores and those of South Africa; but these are also Mediterranean. The author expects that a flood of light will be thrown on the subject of the distribution of the Polyzoa by the results of the *Challenger* Expedition, when published. It is obvious that in treating of any branch of the marine fauna of a restricted area, such as the British Isles, it will be necessary to make some restriction as to depth in considering questions of distribution. Once the abyssal fauna is reached by the dredge the animals obtained have no longer any special connection with the shores off which they are obtained, but belong to the ocean bottom and are mostly cosmopolitan, or rather Oceanopolitan.

The cordial thanks of zoologists are certainly due to Mr. Hincks for having produced this most useful work. It will be valuable not only to the professed naturalist, but also an entertaining addition to the sea-side libraries of those who work occasionally with the microscope for recreation.

OUR BOOK SHELF

A Popular History of Science. By Rob. Routledge, B.Sc. (London: George Routledge and Sons, 1881.)

In looking through many of the works on popular science one is inclined to exclaim, "Oh, monstrous! but one halfpennyworth of bread to this intolerable deal of sack." Mr. Routledge's recent volume is fortunately an exception to this rule, for in it we find a clear and concise statement of the development of the main branches of physical science given in a readable form with such an amount of biographical notices as to impart a human interest to the tale. Extracts, too, from the writings of the great workers in science have been judiciously interspersed throughout the text, thus bringing the student into direct communication with the master mind. Numerous illustrations accompany the description; some of these are original, and others taken from the French, and none the worse for that. Most of them are well executed, but intimate friends might possibly find some fault with the likenesses of living men of science. Of course it is an easy as it would be a thankless task to point out sins of omission, and perhaps also of commission, in a book like the one under notice. Such works must not be looked upon with the eye of microscopic criticism. If the general direction which the author takes is the right one, if he does not make his task easy by glossing over all the points of difficulty, but puts his case clearly and fairly forward, he may well be excused if he omits matters which one or other of his readers may deem necessary. These conditions Mr. Routledge, as it seems to us, has satisfactorily fulfilled. We can therefore cordially recommend this "Popular History of Science," believing that it will exert a healthy influence on all who read it, and may be a powerful means of spreading the love of science amongst the rising generation. H. E. R.

Class-Book of Elementary Mechanics, adapted to the Requirements of the New Code. Part I. *Matter.* By Wm. Hewitt, B.Sc., Science Demonstrator for the Liverpool School Board. (London: George Philip and Son, 1880.)

MR. HEWITT has probably had a better chance than any other teacher of knowing by experience the working of the meagre science-subjects of the new educational code. The defects of that code, and particularly of its directions as to the subject of mechanics, are very great; nevertheless the little book which Mr. Hewitt has produced shows how, in spite of the disadvantageous system under which he works, a really good teacher will succeed in working up the subject for his pupils. We have seldom met with a *really* elementary book which at once combined to so great a degree simplicity of language, accuracy of description, and sound science. Mr. Hewitt states as his experience that the main difficulty has hitherto been to get the children to express in anything like precise language the ideas suggested to their minds by the simple experiments shown them. He therefore intended this little work to serve as a lesson-book to be read by the pupils in the intervals between the experimental lessons. This first part covers the ground prescribed by Schedule IV. for the first stage. A second part, dealing with "Force," is in preparation, and will embrace the subjects of the second and third stages. We hope Mr. Hewitt's second part will prove as satisfactory as is his first instalment. His aims are limited, indeed, by the requirements of the Code, but within those narrow limits his success is great.

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.*]

Sir Wyville Thomson and Natural Selection

I HAVE at least great reason to be thankful that my stupidity has not prevented me from thoroughly enjoying the teachings of Mr. Darwin and Mr. Wallace, which I confess to having regarded as chiefly masterly and charming "studies in variation," for the last twenty years.

The title of the epoch-marking book which came of age last month was, however, "The Origin of Species by Means of Natural Selection." Mr. Darwin, as I am well aware, has put forward this mode of the origin of species as a part only of a hypothesis which is universally looked upon as a supreme effort of genius.

It seemed to me, rightly or wrongly, that the fauna of the enormous area forming the abyssal region existed under conditions which held out the hope that it might throw some light upon a question which appears to underlie the whole matter, and which is still unanswered. Are physiological species the result of the gradual modification of pre-existing species by natural selection, *or by any similar process*; or are they due to the action of a law as yet utterly unknown, by which the long chain of organisms rolls off in a series of definite links?

I fear I scarcely follow Mr. Darwin's illustration. If one were to pay his first visit to a breeder's, and be shown a flock of Leicesters, never having seen or heard of a sheep before, he would see nothing but a flock of sheep, and would certainly, without justly incurring the contumely of the breeder, be entitled to set them down merely as a group of animals of the same *species*, that is to say, animals fertile with one another and producing fertile progeny. He would judge so from their common resemblance, and without previous observation or information I do not see how he could know more about them. But give him an opportunity of comparing the results of breeding throughout a long period of time, or of observing the process of breeding over half the world, which comes to much the same thing; the breeder might then have cause to rail if he had not picked up the stages of the process.

The close examination of the newer tertiaries and the careful analysis of the fauna of the deep sea seem to me fairly to represent these two methods; both of these promise to yield a mass of information in regard to the course of evolution, but as to the *mode* of the origin of species both seem as yet equally silent.

I will ask you in a week or two for space for a short paper on "The Abyssal Fauna in Relation to the Origin of Species."

C. WYVILLE THOMSON

Rapidity of Growth in Corals

THROUGH the kindness of M. Parrayon, captain of the French man-of-war *Dayot*, I have received a large coral of the fungia tribe, which was yesterday found attached to the bottom of his ship as the copper was being cleaned by native divers. The following is the history of the occurrence. The *Dayot* entered the tropical waters of the South Pacific about seven months ago, coming directly from the coast of Chile. She visited some of the islands, but made no long stay in harbour until she reached Mauga Reva (Gambia Islands), where she remained for two months in the still waters of a coral basin. On entering the basin she touched the reef slightly, and without sustaining any damage. From Mauga Reva she sailed to Tahiti, where she now lies.

Several specimens of living coral were found attached to the copper sheathing, that which I have received being the largest. It is discoidal in shape, with its upper and under surfaces respectively convex and concave, and near the centre of the under surface there is a scar, where the pedicle by which it was attached to the copper sheathing was broken through. The disk measures 9 inches in diameter, and the weight of the specimen (now half dry) is 2 lb. 14 oz. On examining the under surface another disk 3¾ inches in diameter is seen partly imbedded in the more recent coral growth. Of this old disk about one-sixth part is dead and uncovered by new coral, and is stained of a deep blue colour from contact with the copper, while the outline of the rest of this old disk is plainly discernible, although partially covered in by plates of new coral.

My impression is that on touching the reef at Mauga Reva nine weeks ago a young fungia was jammed against the copper, became attached, and subsequently grew to its present dimensions.

The case affords an interesting illustration of the rapidity of the growth of coral in these waters. R. W. COPPINGER

Tahiti, August 13

Geological Climates

SINCE contributing the chapter in the history of the Coniferæ upon which Prof. Haughton remarks, I have seen *Araucaria Cunninghami* growing in gardens round Funchal, and my belief in the specific identity of the Bournemouth Eocene plant is further strengthened; yet still, as only foliage is known in the fossil, I should hardly be prepared to contest upon that alone a question of climate, however minute the resemblance. But even with the most undisputed identity there are so many possibilities of error in arguing from a single species, that little importance should be attached to conclusions drawn from it.

Assuming them however to be specifically identical, as I myself believe them to be, and to have required precisely the same temperature, I think Prof. Haughton's case is not quite so strong as he believes. The present mean winter temperature of Bournemouth in lat. 50° 43′ is 37° 4′, but the physical surroundings of Bournemouth are not now such as conduce to luxuriant forest growth, even if its temperature sufficed, and the conditions there in the Eocene time more probably assimilated to those of the south-west coasts of Ireland at the present day.

Now the mean of the coldest month at Valentia, lat. 51° 44′, is 44°, and it may be fairly assumed that if Valentia were a degree farther south, corresponding to Bournemouth, the temperature would be one degree higher; and if sheltered by mountains from all the northerly winds as Glengariff is, the mean might possibly be raised to 46°. Thus but 11° are required to reach the minimum of 57° supposed to be required by his Araucaria. Again, although the Moreton Bay Pine does not appear to support a less mean annual temperature than 67° to 70° between the Clarence and the Bellingen, which are its southern limits in Australia, it flourishes and ripens seeds in Madeira in a mean of 64° 96′, and although I have only noticed it in two gardens near the sea-level, I think it has only been excluded from others higher up the mountains in favour of the far more striking *Araucaria excelsa*. Moreover from its present restricted area it appears to be a declining type, which may, when more widely distributed, and possibly in presence of fewer competing species in remote Eocene time, have sustained greater extremes of climate.

Taking the species, however, as it exists, and apart from any such possibilities, uniformitarians have, it seems to me, but to account for an increase of 14° to 15°, that is if Bournemouth were near its northern limit, as seems probable from its having grown at or near the sea-level.

Supposing, as all evidence tends to prove, that Northern Europe and America were connected by continuous land in Eocene time, would not the mere fact of shutting off the Arctic Seas cause a general and perhaps sufficient rise of temperature? In N. lat. 70° Prince Albert Land has a mean of only 5° Fahr., and Lapland one of 32°, a difference of no less than 27°, caused solely by the presence of an Arctic ice-laden current. The general cooling effect of incessant oceanic circulation between the North Pole and the Tropics is, I think, scarcely taken into sufficient account, and although it may be contended that conversely the northerly flow of the Gulf Stream mitigates climate, I think that its action in Europe is chiefly in fending off the ice-laden currents from our coasts, the limit of trees penetrating quite as far north in Siberia away from the coast as at the North Cape, where they are under its influence. J. STARKIE GARDNER

Order Zeuglodontia, Owen

IN August 1848 H.M.S. *Dædalus* encountered off St. Helena a marine animal, of which a representation appeared in the *Illustrated News* of the latter part of that year. It is thirty-two years since I saw this figure, but I recollect that it was one of a blunt-nosed animal with a neck carried about four feet above the water, which was so long as to present the appearance of a serpent; and I remember that Prof. Owen, in combating at the time the idea that this was a sea-serpent, pointed out that the position of the gape in relation to the eye, as shown in the figure in the *Illustrated News*, was that of a mammal, and not that of a reptile; in consequence of which he argued that the animal seen was probably only a leonine seal, whose track through the water gave an illusory impression of great length. This idea, however, seemed to me untenable in the face of the representation in the *Illustrated News;* but it was obvious that to afford the buoyancy necessary for the support above the water of so long a neck (estimated on that occasion as sixty feet, though only the part near the head was actually out of the water), the submerged portion of the animal could not have had the shape of a serpent.

Two or three years after this, on reading the description of *Zeuglodon cetoides*, from the Tertiary (probably Upper Eocene) formations of Alabama, it struck me that the animal seen from the *Dædalus* may have been a descendant of the order to which *Zeuglodon* belonged; and I have ever since watched with interest for reports of the "great sea-serpent."

Three years ago the following appeared in the newspapers:—

"Borough of Liverpool, in the County Palatine of Lancaster to wit.

"We the undersigned, captain, officers, and crew of the barque *Pauline* (of London) of Liverpool, in the county of Lancaster, in the United Kingdom of Great Britain and Ireland, do solemnly and sincerely declare that on July 8, 1875, in lat. 5° 3′ S., long. 35° W., we observed three large sperm-whales, and one of them was gripped round the body with two turns of what appeared to be a huge serpent. The head and tail appeared to have a length beyond the coils of about 30 feet, and its girth 8 or 9 feet. The serpent whirled its victim round and round for about fifteen minutes, and then suddenly dragged the whale to the bottom head first.

"GEORGE DREVAR, *Master*
"HORATIO THOMPSON
"JOHN HENDERSON LANDELLS
"OWEN BAKER
"WILLIAM LEWARN

"Again, on July 13, a similar serpent was seen about 200 yards off, shooting itself along the surface, head and neck being out of the water several feet. This was seen only by the captain and one ordinary seaman, whose signatures are affixed.

"GEORGE DREVAR, *Master*."

"A few moments after it was seen elevated some sixty feet perpendicularly in the air by the chief officer and the following able seamen, whose signatures are also affixed—

"HORATIO THOMPSON
"WILLIAM LEWARN

"And we make this solemn declaration, &c.

"Severally declared and subscribed at Liverpool aforesaid, the 10th day of January, 1877, before

"T. S. RAFFLES, J.P. for Liverpool."

The locality here specified was about thirty miles off the northern coast of Brazil.

In this account I thought that I recognised the grip of the whale by the long neck of the attacking animal, the appearance being confounded into the double coil of a serpent by the distance and motion of the objects; but in face of the general ridicule which has been attached to this subject, and being without any assurance that the declaration so purporting to be made was genuine, I did not venture to ventilate my long-cherished idea. A relative of mine, however, just returned from India, chancing to say that two of the officers of the steamer in which she went out had on the previous voyage witnessed an immense animal rear its neck thirty feet out of the water, and that a sketch of the object had been instantly made, and on reaching port sent to the *Graphic*, I obtained the number of that paper for July 19, 1879, and I inclose a tracing of the figures in it, which are accompanied by the following statement in the *Graphic:*—

"The accompanying engraving is a *fac-simile* of a sketch sent to us by Capt. Davison, of the steamship *Kiushiu maru*, and is inserted as a specimen of the curious drawings which are frequently forwarded to us for insertion in the pages of this journal. Capt. Davison's statement, which is countersigned by his chief officer, Mr. McKechnie, is as follows:—'Saturday, April 5, at 11.15 a.m., Cape Satano distant about nine miles, the chief officer and myself observed a whale jump clear out of the sea, about a quarter of a mile away. Shortly after it leaped out again, when I saw that there was something attached to it. Got glasses, and on the next leap distinctly saw something holding on to the belly of the whale. The latter gave one more spring clear of the water, and myself and chief then observed what appeared to be a large creature of the snake species rear itself about thirty feet out of the water. It appeared to be about the thickness of a junk's mast, and after standing about ten seconds in an erect position, it descended into the water, the upper end going first. With my glasses I made out the colour of the beast to resemble that of a pilot fish.'"

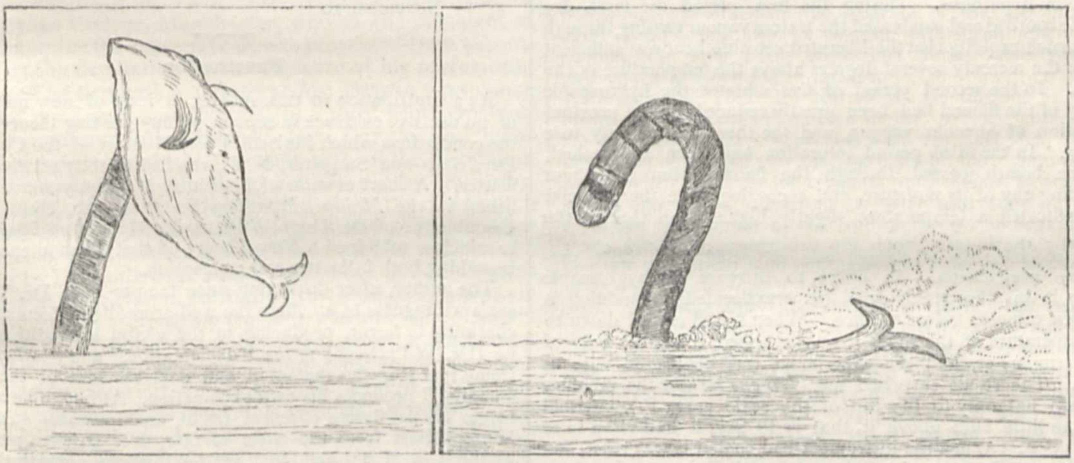
As I have not been able to find any description of the skeleton of the *Zeuglodon*, I venture to draw attention to the subject through your columns, in the hope that among your many readers in America this letter may attract the notice of some one who will tell us whether what is known of the osseous structure of *Zeuglodon cetoides* is or is not consistent with the representation in the *Graphic*. The remains of this cetacean, supposed to be extinct, indicate, according to Sir Charles Lyell, that it was at least seventy feet in length,[1] while its great double-fanged but knife-edged molars show that it was carnivorous; and as we are not so far removed from the period of the Alabama Tertiaries as to render it improbable that members of what must once have been a great order of carnivorous cetacea, totally distinct from the orders of cetacea hitherto known as living, may still survive, I have braved the ridicule attaching to this subject so far as to invite attention to it.

The second of the two figures in the *Graphic* shows the long-necked animal to possess the cetacean tail, and its head there seems to have been turned from the observer, so that the underside of it only is presented. The first figure shows that the whale had been seized on its flank by the powerful bite of its aggressor, and that to escape from this it had thrown itself out of the water. Having succeeded in this object the second figure shows the aggressor rearing its head and neck out of the water to discover the direction which its prey had taken, in order that it might follow it up; and so far from the charge of curious drawing made by the editor of the *Graphic* being justified, the representation of the whale can be at once recognised as fairly correct; while that of the tail of the unknown animal (which probably prompted this charge), so far from being curious, forms an important piece of evidence as showing the animal in question to be cetacean. SEARLES V. WOOD, Jun.

Martlesham, near Woodbridge, September 27

P.S.—Since sending to you the above I have again seen my relative, and find that the cut in the *Graphic* of July 19, 1879, is not that of the instance observed from the steamer in which she came home, which was the *City of Washington*, but of a separate instance which occurred to another ship. I have not been able yet to procure the *Graphic* containing the figure of the animal seen from the *City of Washington*, but she tells me that it was pasted up in the saloon, and represented only the head and long neck of the animal, which was raised to a great height out of the water, and near to the ship; and had been drawn for the *Graphic* by a lady passenger immediately after the occurrence. These repeated and independent notices of the same long-necked animal are, however, the more confirmatory of its existence.

I find that Prof. Owen, in his article on Palæontology in the *Encyclopædia Britannica* (vol. xvii. p. 166), in giving a description of *Zeuglodon cetoides*, says that "the skull is very long and narrow *and the nostril-single*," that Dr. Harlan obtained the teeth on which, correcting Harlan's reptilian reference of them, he founded the order *Zeuglodontia*, from the Miocene of Malta; and that the teeth discovered by Grateloup in the Miocene beds of the Gironde and Herault, and ascribed by him also to a reptile under the name of *Squalodon*, are those of a smaller species of *Zeuglodon*. The remains of *Squalodon*, along with those of the shark with huge teeth, *Carcharodon megalodon*, and of numerous cetaceans assigned to orders all still living, and of which some, such as *Delphinus*, belong to living *genera*, occur in the "Sables inférieurs" of Antwerp; which, though long called Miocene, are by M. Vandenbroeck regarded as older Pliocene, and as the base of that series of deposits of which the



middle and upper divisions are respectively represented by the Coralline and Red Crags of England; and with these "Sables inférieurs" the so-called Miocene of Malta, in which *Zeuglodon* is associated with *Carcharodon*, is probably coeval. Dr. Gibbes (*Jour. Acad. Nat. Sc.*, 2d. ser., vol. i. p. 143), figures and describes teeth of the Antwerp species of *Carcharodon* from both the Eocene of South Carolina and the Miocene of Alabama These various references bring the *Zeuglodonts*, with their *Carcharodon* associates, down to a late geological period, during which they co-existed with Delphinian prey; and of this prey the whale in the woodcut (which looks like a *Grampus*) seems an example.

It is most likely that Bishop Pontoppidan, a copy of the English (1755) edition of whose work I possess, concocted his two figures (one of which is that of a huge snake undulating on the waves, and the other that of a serpent-like animal with pectoral flappers or fins, resting almost on the surface of the sea, with head and tail erect out of the water like the letter U, and spouting water or steam from its mouth *in a single column*), from accounts given him by Norwegian seamen, some of whom had seen the animal in the position in which it was observed from the *Dædalus*, and others in that in which it is represented in the cut as seen from the *Kiushiu-maru*; for in the long narrative which he gives of the descriptions received from observers at numerous times, some of these agree with the one, and some with the other, though both of the Bishop's figures represent only preposterous conceptions of his own.

[The animal seen from the *Osborne*, and figured in the *Graphic* of June 30, 1877, as the "Sea-serpent," is quite a different thing from the one in question, and may have been a *manatee*.]

[1] He observes in the third edition of his "Manual of Elementary Geology" (1851), p. 208, that he visited the spot where a vertebral column of this length belonging to *Zeuglodon* had been dug up.

Temperature of the Breath

THE interesting observation made by Dr. Dudgeon (NATURE, vol. xxii. p. 241, and vol. xxiii. p. 10) to the effect that breathing on the bulb of a thermometer through several folds of flannel or silk raises the temperature of the instrument several degrees above that of the mouth and body, is easily verified. There is no doubt about the accuracy of the observation; but the explanation of it offered by Dr. Dudgeon is not satisfactory. He supposes that the heightened temperature is due to the expired air being hotter—not cooler, as is usually believed—than the mouth and body. A simple experiment sufficed to show that this view was untenable. A clinical thermometer was inserted in the cavity of the mouth, and the stem grasped by the teeth in such a way that the bulb lay free in the oral cavity. Inspiration was carried on by the nostrils, and expiration was effected by gently forcing the breath between the loosely-closed lips and the stem of the instrument. The bulb was thus placed in the centre of the stream of expired air and kept free from contact with the tongue and cheeks. Experimenting in this way, I found, at the end of five, and also of ten, minutes that the thermometer marked 97·2°—the temperature under the tongue at the time being 98·4°.

Had the breath been hotter than the mouth the instrument could not have failed to register a higher temperature than 98·4°, but being really cooler, the instrument, of course, recorded a lower temperature.

What is then the true explanation of the phenomenon observed by Dr. Dudgeon? I believe that it is simply an example of the conversion of latent into sensible heat by the rapid condensation of aqueous vapour. The organic fabrics which compose our clothing are all more or less hygroscopic—that is to say, they have the capacity of imbibing aqueous vapour and condensing it into the solid and liquid forms. The expired breath is heavily charged with aqueous vapour; and aqueous vapour, at the moment of condensation, liberates an enormous amount of latent heat, which thus becomes sensible to the thermometer. In this particular watery vapour exceeds far away all other gases.

The following experiments were made with a view of testing the correctness of this view. Two strips of flannel were prepared, each six inches long and an inch and a quarter wide. The first strip was rolled, without any preliminary preparation, round the bulb of a clinical thermometer. The bulb, thus enveloped, was inserted between the closed lips, and the expired air was forced through the porous material for a period of five minutes. The thermometer rose to 104°. The instrument was then allowed to cool, and, after having been re-set, was again inserted between the lips, and breathed through for a second period of five minutes. This time the temperature only rose to 101°. The experiment was repeated a third time for a similar period, but this time the thermometer did not rise above 98·6.

These results tallied exactly with the requirements of the condensation hypothesis. During the first period the fresh dry flannel absorbed and condensed the watery vapour passing through it with such rapidity that the liberated sensible heat was sufficient to raise the mercury several degrees above the temperature of the mouth. In the second period of five minutes the hygroscopic activity of the flannel had been greatly reduced by the previous absorption of aqueous vapour, and the thermometer only rose slightly. In the third period saturation had been approached, and the breath passed through the flannel almost without depositing any of its moisture, and accordingly the thermometer only indicated a temperature slightly higher than that of the mouth.

The second strip of flannel was subjected to a little preliminary preparation. In order to increase its hygroscopic activity it was thoroughly dried (superexsiccated) by holding it for a few minutes before the fire. When it had cooled down to the temperature of the room it was wrapped round the bulb of the thermometer, and the experiment was proceeded with as before. The result surprised me. *In one minute* the mercury had risen not only to the top of the scale (112° F.), but had filled the little bulb above it, that is to say, it had risen to at least 115° F. When the instrument had cooled it was reset, and inserted again between the lips and breathed through for three minutes. At the end of this time the scale marked 106° F. After the instrument had been cooled and reset the experiment was repeated a third time, and the temperature only reached 102° after breathing through the envelope for four minutes. A fourth trial of four minutes only produced a record of 98·4°. Here again the development of heat steadily declined as the flannel became less hygroscopic.

It is probable that, with the superexsiccated flannel the first portions of aqueous vapour condensed at the beginning of the experiment pass at once from the gaseous into the solid form, and constitute that portion of water which is incorporated in intimate union with all organic tissues. This accounts for the extreme rapidity of the development of heat at the commencement of the experiment. I found that even a single long expiration through the freshly-warmed flannel raised the mercury to 110° F.

Dr. Dudgeon's observation will not necessitate a revision of our conclusions respecting the temperature of the breath, but he has supplied us with an exceedingly elegant and easy way of demonstrating the liberation of sensible heat which takes place during the passage of water from the gaseous into the solid and liquid state. WM. ROBERTS

Manchester, November 10

Height of the Aurora

IN NATURE, vol. xxii. p. 291, is inserted a letter of Mr. T. Rand Capron, on the determination of the height of auroræ, wherein I read: "It is unfortunate that simultaneous observations of the auroral corona are almost entirely wanting. I . . . would be glad if any particulars could now be furnished me."

Having treated the subject of the auroræ and their properties in an ample manner in my "Théorie cosmique de l'Aurore polaire" (*Memorie della Società degli Spettroscopisti Italiani*, 1878, vol. vii.), wherein I have adduced proofs of the thesis that *The corona is an optical illusion, due to the laws of celestial perspective*, I was astonished to find the alleged words used by so great an authority. That "simultaneous observations" of the auroral corona will be ever without any result, as far as its height above the earth is concerned, follows already from the known property, that the corona always shows itself in the direction of the *local* magnetic total force (given by the inclination needle).

Regretting that such a well-established fact seems not generally known, I take the liberty to refer Mr. Rand Capron to the chapter of my treatise, "Dans quelle Région de l'Atmosphère terrestre se trouvent les Rayons de l'Aurore polaire, et est-ce que la Couronne est une Chose réelle?" and will repeat here that very beautiful determinations of the height of streamers and beams were obtained by Prof. Heis and Dr. Flögel, and by Prof. Galle in Germany, showing a height of the phenomenon from 20 to 100 miles (of 15 in 1 degree). These results are published in the *Zeitschrift der oesterr. Gesellsch. f. Meteor.* vii. p. 73.

I regret to have found no earlier opportunity of answering the request of Mr. Rand Capron, but think that this letter may still have some interest, notwithstanding the valuable article by Mr. Plummer in NATURE, vol. xxii. p. 362.

Groningen (Netherlands), H. T. H. GRONEMAN
November 10

Fascination

As a contribution to this subject, at least of new material if of no decisive evidence in support of any existing theory, I offer the conclusions which Malachi Foot, Member of the College of Physicians and Surgeons, N.Y., reached in 1807 relative to this matter. A short memoir of his which I recently met was published in the *Medical Repository* for that year, entitled "An Examination of Dr. Hugh Williamson's Memoir on Fascination, to which is subjoined a New Theory of that Phenomenon," and is striking both in matter and conception.

The author, after displaying some temper over Dr. Williamson's willingness to attribute the well-accredited effects of snake-charming to terror, producing in the victim a condition which he (Dr. Williamson) terms "dementation," and "wherein extreme fear stupefies the mind and deprives him of the understanding," produces his own explanation. Although he acknowledges the paralysing effects of fright, and instances quadrupeds falling lifeless from the effect of fear, deer stricken motionless by the light of a torch, &c., yet he inveighs against the false reasoning which discovers in these cases of arrested volition any analogy to the phenomena of so-called fascination. Our author, evidently of no superstitious habit, distinctly admits the fact that the snake repeatedly captures prey by a method seemingly so occult as to merit the characterisation of fascination, and develops his theory in the light of that very thought.

He ascribes to the primary sensations of animals, in them unmodified by reflection as to their source or character, complete efficacy to awaken emotions of pleasure of an intensity to us quite incommensurate with the apparent causes which evoked them—emotions so powerful as to absorb all other secondary feeling, enfolding the animal in a delightful but numbing trance, whose stages advance from attention through ecstasy to anæsthesia. And he finds in the eye a sensory centre which most expansively responds to all outward stimuli. This much premised, he applies it to the case in hand. The snake, fixing its glittering eyes with hungry expectancy upon its victim, at the same time throws its body into graceful curves and raises its tail, undulating with a soft and inviting motion. (Foot insists upon the almost invariable accompaniment of motion as auxiliary in attracting and pleasing the prey.) The bird's eye, once caught, becomes ensnared in the endless succession of contortions, and it draws near, dominated by simple delight.

As Foot expresses it, "the pleasurable movements of the organs of vision stimulate to approach and excite an eager desire to embrace." *Reverie oculorum* ensues, and the bird flutters helpless to the ground. Foot speaks of having seen a cat succeed in similarly charming birds by wreathing the body and waving the tail. He might have confounded this with the ordinary nervous concentration of attention common to the Felidæ before "pouncing." He speaks of larks being attracted in the South of France by means of an octagonal box holding a mirror mounted on a pivot which is turned by the wind. The reflected rays of sunlight dazzle and delight the birds, and they approach near enough to be caught by a spring net. The preliminary phase, that of attention, wherein curiosity perhaps predominates, is illustrated in the known trick of a fox amusing ducks by rolling itself down a bank, as also in the perilous interest excited in a loon by a handkerchief waved by an unseen hand. Many must have experienced, on looking over very high galleries upon floors beneath, or over sheer precipices, an almost uncontrollable impulse to throw themselves headlong down. Can this feeling be described as akin to "fascination"?

L. P. GRATACAP

Amer. Mus. Nat. Hist., N. Y., October 28

A. PERCY SMITH.—The little centipede is *Geophilus electricus*, well known to be occasionally luminous.

HOMAGE TO MR. DARWIN

ON Wednesday, November 3, a deputation from the Yorkshire Naturalists' Union waited upon Mr. Darwin at his residence, Down, Beckenham, Kent, for the purpose of presenting him with an address expressive of admiration for his long devotion to scientific research, and appreciation of the great and important results to which his investigations have led. Prof. Williamson, F.R.S., of the Owens College, Manchester, who is the president of the Union for the current year, was prevented from accompanying the deputation by the pressure of his professorial duties. The deputation arrived at Mr. Darwin's residence about 1 p.m., and was received in a most hearty manner by the great naturalist himself, Mrs. Darwin, and other members of the family. The members of the deputation were introduced individually to Mr. Darwin by Dr. Sorby, vice-president of the Union, and then the interesting ceremony of the presentation of the address was at once proceeded with. After a few words on the work of the Union by Dr. Sorby, the address was read by Mr. Thomas Hick, B.A., B.Sc., and formally presented to Mr. Darwin by Dr. Sorby. Replying to the address, Mr. Darwin assured the deputation of his deep sense of the honour the Yorkshire Naturalists' Union had conferred upon him on that occasion, and only regretted that he had not done something more deserving of such an honour. He had no idea previously that there was so strong a body of working naturalists in Yorkshire, but was pleased to learn that such was the fact, and to find from the *Transactions* that had been forwarded to him that they were doing useful work. Coming from such a body, the address was all the more gratifying to him, though he still feared he hardly merited the good things that had been said of him. The address which had been presented to him he and his family would for ever treasure and preserve, and he desired to express his warmest thanks, both to the deputation and those whom they represented, for it, and for the kind and considerate manner in which everything connected with it had been arranged. Subsequently the deputation were entertained at luncheon, and having spent a short time in familiar conversation with their hospitable host and his family, took their departure amid mutual expressions of kindness and regard.

The following is the text of the Address, which is dated August last:—

To Charles Darwin, LL.D., M.A., F.R.S. &c., &c.

SIR,—The Council and Members of the Yorkshire Naturalists' Union, all of whom, with scarcely an exception, are working students of one or more of the various branches of natural history, desire to express to you in a most respectful manner, and yet with the greatest cordiality, their admiration of your life-long devotion to original scientific research and their high appreciation of the almost unparalleled success of the investigations by which you have contributed so largely to the modern development and progress of biological science.

More especially do they desire to congratulate you on the fact that your great work on the Origin of Species will come of age at an early date, and that your life has been spared long enough to enable you to see the leading principles therein enunciated accepted by most of the eminent naturalists of the day. On the conspicuous merits of that and of your other published works they need not dwell, as those merits have been recognised and admitted even by those who have dissented most strongly from the conclusions at which you have arrived. They may nevertheless be permitted to remind you that your writings have been instrumental in giving an impetus to biological and palæontological inquiries which has no precedent in the history of science, except perhaps in that which followed the promulgation of the gravitation theory of Newton, and that which was due to the discovery of the circulation of the blood by Harvey.

One of the most important results of your long-continued labours, and one for which you will be remembered with honour and reverence as long as the human intellect exerts itself in the pursuit of natural knowledge, is the scientific basis you have given to the grand Doctrine of Evolution. Other naturalists, as you yourself have shown, had endeavoured to unravel the questions that had arisen respecting the origin, classification, and distribution of organic beings, and had even obtained faint glimpses of the transformation of specific forms. But it was left to you to show, almost to demonstration, that the variations which species of plants and animals exhibit, and in natural selection through the struggle for existence, we have causes at once natural, universal, and effective which of themselves are competent not only to explain the existence of the present races of living beings, but also to connect with them, and with one another, the long array of extinct forms with which the palæontologist has made us familiar.

Farther, the Yorkshire Naturalists are anxious to place on record their firm conviction that in the care, the patience, and the scrupulous conscientiousness with which all your researches have been conducted; in the ingenuity of the experiments you have devised; and in the repeated verifications to which your results have been submitted by your own hands, you have furnished an example of the true method of biological inquiry that succeeding generations will deem it an honour to follow, and that cannot but lead to still further conquests in the domain of organic nature.

In presenting this small tribute of their high regard and esteem, the members of the Yorkshire Naturalists' Union cannot but hope and pray that many years of happiness and usefulness may yet remain to you, and that our Science and Literature may be still further enriched with the results of your researches.

(Signed) WILLIAM C. WILLIAMSON, F.R.S., President,
H. C. SORBY, LL.D., F.R.S., Vice-President,
GEORGE BROOK, ter. F.L.S., Secretary,
WM. DENISON ROEBUCK, Secretary,

and Eleven other representative Officials.

THE ATOMIC WEIGHT OF BERYLLIUM

FOR some time chemists have been doubtful what value to assign to the atomic weight of beryllium. Some years ago Prof. Emmerson Reynolds determined the specific heat of this metal to be 0·642; this number multiplied into 9·1 gave 5·8 as the atomic heat of beryllium; in other words it confirmed the generally accepted atomic weight. In 1878 Nilson and Pettersson re-determined the specific heat of beryllium, and found the number 0·408 for the temperature interval 0°–100°; hence these chemists concluded that the atomic weight of the metal must be increased by one-half ($13·6 \times 0·408 = 5·6$). If Be = 9·1 the oxide of beryllium is BeO, and the metal is placed in the magnesium group; but if Be = 13·6 the oxide is Be_2O_3, and the metal is placed in the aluminium group. But there is no place in Mendelejeff's classification of the elements according to the magnitude of their atomic weights for a metal with the atomic weight 13·6, forming an oxide M_2O_3, and exhibiting the properties of beryllium. The value of Mendelejeff's classification is however so great that chemists were not inclined to alter the atomic weight of beryllium except upon most cogent evidence.

Nilson and Pettersson have recently repeated their determination of the specific heat of beryllium, and find these numbers:—

$0°-50°$ spec. heat = 0·3973 : $0°-100°$ spec. heat = 0·4246,
$0°-200°$,, = 0·475 : $0°-300°$,, = 0·5055.

If the atomic weight is taken as 13·6 then the atomic heat for the interval—

$0°-50° = 5·46 : 0°-100° = 5·79 : 0°-200° = 6·48 : 0°-300° = 6·9$, hence the Swedish chemists conclude that the atomic weight of beryllium is 13·6.

But in the last number of the *Berichte* of the German Chemical Society, Lothar Meyer has calculated, from Nilson and Pettersson's numbers, the true specific heat (*i.e.* the ratio between the quantity of heat required to raise unit weight of the given substance through 1°, starting from the given temperature, and the quantity of heat required to raise unit weight of standard substance through 1°, also starting from the given temperature) of beryllium for various temperatures: his results are as follows:—

(γ = true specific heat at temperature t : $\Delta\gamma$ = value of increase of specific heat for 1°).

t.		t.		t.	
+ 23°	γ = 0·3973 ...	73·2	γ = 0·4481 ...	157°	γ = 0·5193
	$\Delta\gamma$ = 0·00101 ...		$\Delta\gamma$ = 0·00085 ...		$\Delta\gamma$ = 0·00063

t.
256°·8 γ = 0·5819.

Hence the atomic heats of beryllium are:—

t.	Be = 9·1.	Be = 13·65.
23°	3·62	5·43
73°	4·08	6·12
157°	4·73	7·10
257°	5·29	8·94

The value of $\Delta\gamma$ decreases as the temperature rises; in this respect beryllium resembles boron, carbon, and silicon. For other elements whose specific heats increase with increase of temperature the value of $\Delta\gamma$ also increases. Lothar Meyer therefore concludes that beryllium is analogous to boron, carbon, and silicon, in that its specific heat increases as temperature increases, and in that the value of this increase is less for 1° at high than at low temperatures. Hence the atomic weight of beryllium is almost certainly 9·1, the oxide is BeO, and the metal finds its place in Mendelejeff's system of classification of the elements according to their atomic weights.

THE PHOTOPHONE

MANY readers of NATURE will doubtless be glad to know that Mr. Graham Bell's extraordinary experiments may be repeated on a small scale with very simple apparatus, no special appliances being required beyond the mirror transmitter and the selenium receiver, both of which may be easily constructed. I propose to give a short description of an arrangement which has in my hands been very successful.

The mirror is made of the thin mica which is sold by opticians for covering *carte de visite* photographs. It is cut by scissors into a circle 2¼ inches in diameter, and silvered by the process for silvering glass specula. The box in which it is mounted is an ordinary wood turned box 2½ inches in diameter. A circular hole of about 2 inches diameter is cut in the lid, behind which the mirror is laid with the reflecting side outwards, a flat ring of vulcanised india-rubber of suitable size and thickness being placed behind the mirror; when the box is closed the ring should hold the mirror firmly in position. If the lid screws on, so much the better. At the bottom of the box is cut a hole, into which is glued one end of a flexible speaking-tube 18 inches long, having at its other end a wooden mouthpiece. It will be found convenient to attach a short wooden arm to the box in a direction perpendicular to its axis. By means of this arm the transmitter may be held in a clamp in any desired position. This completes the transmitter as described by Mr. Bell. I have made a small addition which, though not essential, is a decided improvement. At the back of the mirror I cemented a disk of calico 1 inch in diameter, in the centre of which had been previously inserted a loop of silk half an inch long. A hole ⅛ inch diameter is bored perpendicularly in the side of the box at a point about ½ inch from the mirror end of it, and in this hole is inserted a piece of watch-spring 1⅜ inch long, with its flat sides parallel to the top and bottom of the box. The spring is fixed into the hole with wooden plugs so that one end is flush with the outer surface of the box; the other end where it intersects the axis is bent into a shallow hook. Into this hook is slipped the silken loop, and the tension of the spring draws the mirror into a slightly concave form, and seems to make it respond more perfectly to sound vibrations.

By far the most important part of the whole apparatus is the selenium "cell." After making some dozens of different forms, most of which were more or less sensitive, but none satisfactory, I tried the one now to be described, which turned out very successful. Take a slip of mica 2¼ inches long and ¾ inch broad, and beginning at ¼ inch from one end, wind round it in the form of a flat screw some No. 40 copper wire. The pitch of the screw is $\frac{1}{16}$ inch, that is, each wire on the two faces of the mica is $\frac{1}{16}$ inch from its neighbours. Continue winding up to ¼ inch from the other extremity; then fix the two ends of the wire by passing them through holes drilled in the mica. Now take a second wire and carefully wind this on beside the other, thus forming a second screw, the threads of which are midway between those of the original one. Fix this as before. Great care must be taken that the two wires do not touch each other at any point: it will be well to make sure of this by testing with a galvanometer before proceeding further. If a lathe is at hand, the tedious operation of winding may be very greatly facilitated. Turn a cylinder of hard wood 4½ inches long and 1 inch in diameter: cut this cylinder longitudinally into two equal parts, and between the two semi-cylinders thus formed place, sandwich-like, a slip of mica of equal breadth. Secure the ends with screws. Smooth down the whole in the lathe, and when the edges of the mica are quite flush with the surface of the wood, cut upon the cylinder a screw of thirty-two threads to the inch. On removing the mica from the cylinder its two edges will be found to be beautifully and regularly notched. Wind the first wire into alternate notches, and the second into the others. The wire should be annealed to take away its springiness and make it lie flat, and the mica should be stout enough to bear tight winding without buckling.

For the succeeding operation a retort-stand at least 15 inches high is convenient. Fix one ring 15 inches above the foot; on a lower ring stand a medium-sized Bunsen burner. On the top ring lay a flat sheet of brass $\frac{1}{16}$ inch thick, and on the brass a piece of mica (to save waste selenium). Place the embryo cell on the mica, laying small weights on its two ends to keep it steady and bring it into closer contact. Having brought the Bunsen burner close under the brass, melt a few grains of vitreous selenium in a small spoon and let four or five drops fall upon different parts of the cell. Spread the melted selenium evenly over the surface with a slip of mica, pressing it well between the wires. During this process the temperature must be carefully regulated by raising or depressing the burner. If it is not high enough, the selenium will begin to crystallise; if too high, the selenium will gather up into drops, being apparently repelled from the surface of the cell. The temperature should in fact be just above the fusing point of crystalline selenium. When a smooth surface is obtained, quickly remove the cell with microscope forceps and let it cool. Its surface will now be smooth and lustrous.

The cell must next be annealed. And here my experience differs in a remarkable manner from that of Mr. Bell, as stated in his celebrated lecture. It is true that selenium may be rendered crystalline in "a few minutes," but in this condition I find it far less sensitive to light than after it has undergone a process of long heating and slow cooling. My method is as follows:—The brass plate being cool, lay the cell upon it again, and place the burner at its lowest possible point. The selenium will soon begin to crystallise, as evidenced by its surface assuming a dull leaden appearance. (If the crystallisation has not begun in five minutes, raise the burner an inch or two.) In from five to ten minutes the whole of the selenium should be crystallised. Then very gradually raise the burner until signs of fusion just begin to appear. This will probably take place when the flame is within 3 inches of the brass. Instantly remove the burner, and in about ten seconds re-crystallisation will occur. Now fix the burner $\frac{1}{2}$ inch below the point at which it was when fusion commenced, and let it remain for four hours, merely looking at it from time to time to ascertain that, owing to increase of gas pressure or other causes, the heat has not become too great. After four hours begin the cooling by lowering the burner an inch or two, and repeat this operation every ten or fifteen minutes, until the burner is at its lowest point. Then slightly lower the gas-flame at short intervals, until it is finally extinguished. When the brass plate is quite cool the cell may be removed.

I may mention that I first made a cell of this form, which I believe to be original, on October 28.[1] If the two wires were wound on a cylinder made of some suitable non-conductor (*e.g.* slate) with a double screw cut upon its surface, a cell might be formed which, it appears to me, would unite all the advantages of Mr. Bell's with far greater simplicity.

My experiments were made with the transmitter and selenium cell above described, a magic-lantern with a 4-inch condenser, the focussing lenses being removed, two plano-convex lenses obtained by separating a $3\frac{1}{2}$-inch condenser, a "blow-through" lime-light, a battery of eleven cells (small Leclanché's answer well), and a pair of Bell telephones. It is essential that the bobbins of the latter be wound with finer wire than that generally used. Mine contain No. 40 (instead of 35 or 36), and I intend to try 42. Their diameter is also larger than usual—$1\frac{3}{8}$ inch.

The transmitter is clamped so that its axis is inclined at an angle of about 30° to that of the lantern condenser, the centre of the mirror being 7 or 8 inches from the centre of the condenser; and the position of the lime-light is so adjusted that the condensed rays may just cover the whole surface of the mirror.

The reflected beam is rendered as nearly parallel as possible by one of the plano-convex lenses (this can only be done approximately), while the other, placed a foot or two away, concentrates the light upon the selenium cell, forming an elliptical image of the mirror. The major axis of the ellipse should be parallel to the length of the cell, and the minor axis slightly longer than its width. A great deal depends upon the focussing, and the best results have been obtained when the image of the mirror was not quite sharp. The selenium cell is joined in circuit with the battery and the pair of telephones, the latter being for obvious reasons placed in a distant room. The arrangements are now complete, and a person listening with a telephone applied to each ear will, if everything is right, plainly hear words which are spoken into the transmitter. When I first made the experiment I was so much astonished at the distinctness of the reproduction that I believed that one of the battery connections must be defective, thus acting like a microphone. This was disproved by screening the mirror, when all sound instantly ceased.

Though the articulation is not perfect, it is far better than I had expected, judging from the accounts of the performances of the photophone in Paris. A leading article might not be altogether intelligible, but ordinary colloquial phrases are readily understood. The loudness of the reproduced speech varies in an unaccountable manner. Sometimes the voice is rendered almost as loudly as in an ordinary telephone; at other times, under apparently the same conditions, it is scarcely audible. Alternations from loudness to faintness, and *vice versâ*, frequently occur in a single sentence.

The distances across which the beam is carried have varied in my experiments from 1 foot (when the two plano-convex lenses were in actual contact) to rather more than 4 feet.[1] With a larger receiving lens this distance could be greatly extended, especially if the electric light were used.

For the "musical" effects produced by an interrupted beam I use a disk of zinc 1 foot in diameter, having eight radial slits cut in it, and mounted upon a vacuum tube rotator. The cell is placed 6 inches from the lantern condenser, and the disk made to rotate close before it. The sound produced is very loud, and can be heard when the telephones are at a distance of a foot or more from the ears.

It is very singular, that whereas I have been so successful in repeating Mr. Bell's more complex experiments, I have utterly failed in all attempts to produce sound by the simple incidence of an interrupted beam upon a thin diaphragm. I have experimented with disks of ebonite varying from $\frac{1}{64}$ to $\frac{1}{4}$ inch in thickness, and with several metals, and can only suppose that my source of light is not sufficiently powerful. SHELFORD BIDWELL

[1] If a larger surface is desired, two or more of these cells may be placed together side by side, the ends of the wires being properly connected. The width of $\frac{3}{4}$ inch for a single cell cannot be much exceeded, because the expansion produced by the heat necessary for melting the selenium would make the wires on a wider surface so loose as to touch each other.

[1] With a $5\frac{1}{2}$-inch receiving lens the distance has been increased to upwards of 10 feet.

THE CHRONOGRAPH

MESSRS. E. DENT AND CO., of the Strand and Royal Exchange, London, have been for some time past at work upon three galvanic chronographs of unusual accuracy and power. They surpass in both respects, so far as we know, any similar instruments yet constructed; and we believe, therefore, some account of them will be interesting to our readers. They are destined respectively for the Royal Observatory of Brussels, for the Japanese Government, and for the Egyptian Government.

The advantages of the "chronographic" registration of the times of observations in observatories are not to be gainsaid. In the absence of any such arrangement an astronomer, whilst watching through his telescope, has to compute the time by counting up the clock-beats. More often than not he will find that no clock-beat exactly coincides with the instant of his observation. He must then reckon the difference—the fraction of the second elapsed—by judgment as best he is able. Skilled observers can reckon to tenths of seconds, but these are large and coarse amounts compared with what may be noted upon such chronographs as those we are referring to. In any case the astronomer must make a hurried memorandum of his results; otherwise he is liable to forget them.

The Astronomer-Royal was, we believe, the first to introduce a system of astronomical chronographic measurement into England; and he designed and had constructed at the Royal Observatory a large apparatus for the purpose. The reader must bear in mind that though differing in some respects both in their mechanism and the means employed, the chronographs we are going to describe are fundamentally the same as the Astronomer-Royal's.

C C (see Fig. 1) is a cylinder around which one thickness of paper is wrapped, and underneath it is a long screw W W. A wheel on the axis of C C gears into one mounted on W W; thus when the cylinder turns, the screw turns. W W is tapped through the lower portion of a carriage K (compare Fig. 2), and K rests on rails parallel with W W. When the screw W W turns, K cannot turn too, and is therefore propelled by the screw up or down the rails underneath the cylinder.

L is clockwork which drives the screw, and consequently the cylinder and carriage. The rapidity with which L moves is regulated by the pendulum P P. P P is a conical pendulum; that is, instead of oscillating, it swings round in the surface of a cone. P P is suspended by two pairs of springs S S, S S at right angles to each other.

Let us consider the actions of C C and K (see Fig. 2). K carries two prickers, one of which is placed in electrical communication with the Observatory standard clock. It

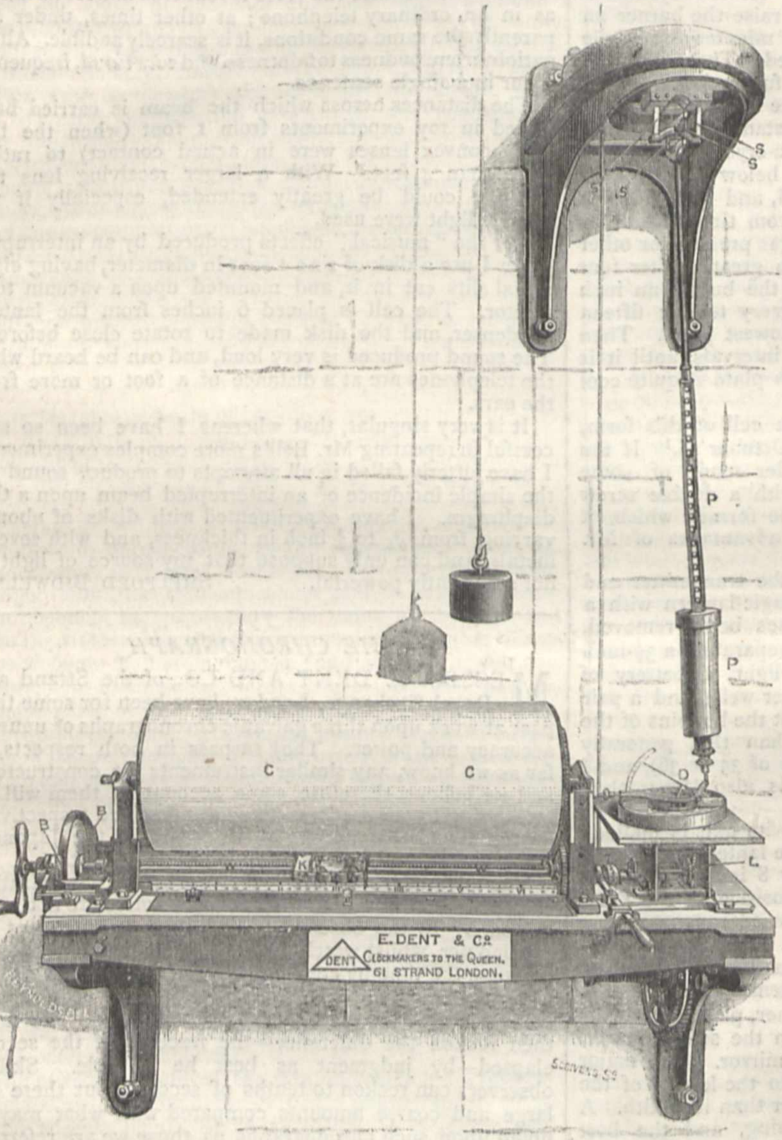


Fig. 1.

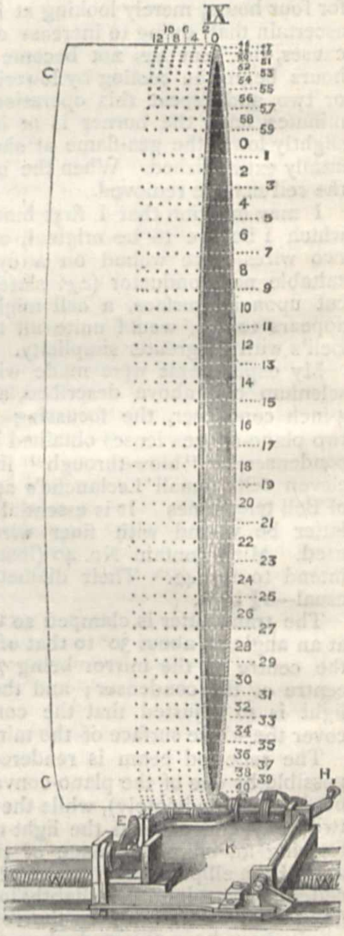


Fig. 2.

is so arranged that at every beat of the standard clock (except the 60th second of each minute) the pricker shall rise and puncture the paper wrapped round the cylinder. Now suppose that whilst the clock keeps pricking, the cylinder is turning, and the carriage K moving to the left. Then we shall get a succession of pricks marked off upon the cylinder in the form of a slightly inclined spiral, and the distance between each prick will represent one second. Every 60th prick (or second) being omitted, the occurrence of each minute is easily distinguished.

The carriage K carries another pricker alongside the clock-pricker—this is the observation-pricker. The observation-pricker is placed in electrical communication with any instrument in the observatory the astronomer may be going to use, and it is so arranged that the astronomer by merely pressing down a stud can cause the observation-pricker to rise and puncture the paper on the cylinder. This it will do somewhere alongside the spiral of clock-pricks. By reference to the latter the time of the observation can then be determined to the $\frac{1}{10}$th of a second.

Let us examine the pricks on the cylinder (Fig. 2). The spiral of the clock-pricks winds around the cylinder from left to right. As the cylinder turns once in two minutes, there is between each prick and its fellow similarly positioned on the next spiral a difference in time of two minutes. As stated above, we note by the absence of the pricks the occurrence of the minutes. By reference to the figures placed (for explanation) along the top and side of the section of the cylinder, we see that the time of the highest prick on the left-hand spiral was 9h. 12m. 46s. Following the course of the spiral down towards the

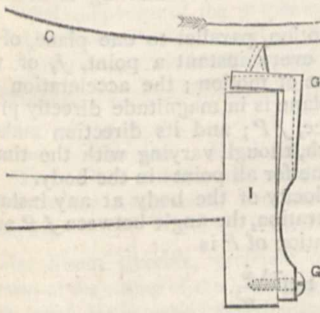


FIG. 3.

pricker which is tracing it, we first pass the blank line indicating the occurrence of the next minute, and then come to three observation-pricks at about the 8th and 9th seconds beyond it. These in practice would be measured off and their values determined to the $\frac{1}{50}$th or $\frac{1}{100}$th of a second. There are other observation-pricks at the 22nd second, the 24th, and 25th, and there is a group of others at about the 40th.

When all the observations have been reckoned up the paper is put away, and it is not the least advantage of

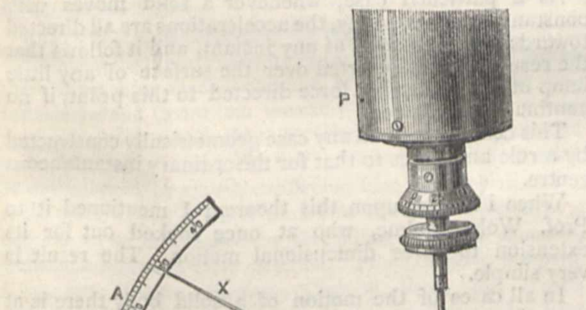


FIG. 4.

the "chronographic" method that in any case of doubt the original observation can be itself referred to years afterwards.

As the paper is moving whilst being punctured, the prickers have to be mounted on springs to enable them to yield a little. In Fig. 3 is a side view of the pricker, G G being the spring, and C C a portion of the cylinder.

There is no difficulty in reading off the observations after a little practice: but in order to facilitate the eye in following the sequence of the punctures—before the paper is used a continuous spiral line is ruled upon it which shall exactly correspond with their course. This is done in the following way (see Fig. 1):—At T are two clutch-wheels, which connect the screw and cylinder with the clock-work L. By moving a lever near them the clock-work is thrown out of gear, and simultaneously the winch on the left is thrown into gear with the screw. On the carriage K (see Fig. 2) is a little roller E, and by moving a handle this is sprung up against the paper on the cylinder. The winch before referred to is now turned, the cylinder rapidly revolves, and the carriage quickly traverses the screw, the spiral line meanwhile being traced by the pressure of E upon the paper of the cylinder. To prevent damage to the prickers during the operation, the act of disengaging the clock-work breaks their electrical communication, and they can neither of them be raised until the clutch-work is restored. The cylinder moves very swiftly whilst the line is being traced, and were it brought to a standstill suddenly great damage would be done. To prevent this it is arranged that when the carriage K is approaching either extremity of the screw it shall work a brake arrangement B B, which brings the machinery quietly to repose. The act of putting the clutch-wheels T into position again also releases the brake. The clutch-wheels T are mounted on a spring, so that should their teeth not correspond when they are put into gear, one will give and wait for the other to overtake it.

It is desirable that the clock L should drive C C with great uniformity; and as the time of a conical pendulum is affected in a very great degree by any variation in the force of the clock-train, a special governing arrangement, the invention of the Astronomer-Royal, is employed. U (see Fig. 4) is a trough filled with glycerine and water. Power reaches the pendulum by means of its connection with the vertical spindle seen at the centre of the trough, which rises from the clock-work. In this connection there is a joint, and a dipper D forms part of it. Too much power drives out the pendulum, and it would then go faster, were it not that the dipper, entering the glycerine and water more deeply, checks its motion. On the other hand, whenever the power falls off the pendulum performs a smaller circle, thereby lifting the dipper a little more away from the liquid, and diminishing the resistance in exactly the same proportion as the force. The pointer X is a very delicate index of the angle the pendulum is swinging. The compensatory action of this governor is very considerable; doubling the power produces no perceptible difference in the time. The quickness with which it works is surprising; an infinitesimal change in the power is immediately indicated on the scale A, showing how well the apparatus is doing its work.

To prevent damage to the governor and the more delicate clock-wheels by any sudden check to the cylinder, a ratch-wheel arrangement has been introduced, which, when the cylinder is suddenly stopped, enables the pendulum to run on until it comes to rest gradually, by want of power.

Fig. 1 gives a very faint idea of the dimensions of the apparatus. The cylinder C C is 12 inches in diameter, and 30 inches long. Its weight is about 70 lb. The space between each seconds prick is $\frac{3}{10}$ inch, and the distance between the successive turns of the spiral of pricks $\frac{3}{20}$ inch. There is room on the paper for 200 spirals, and as each is more than one yard long, we can get more than 200 yards ($6\frac{2}{3}$ hours) of continuous observation without disturbing the instrument. There is always a spare cylinder covered with paper kept ready to replace the first.

The iron base-plate on which the instrument is mounted weighs over 3 cwt., the rails on which the carriage K runs are cast in one piece with it, and, along with all other bearing surfaces are planed. The pendulum, which weighs some 18 lb., and is compensated, goes round once in two seconds. Its suspension-piece weighs 2 cwt. As regards the accuracy of the construction of these chronographs, the best criterion is to be found in the force that is required to work them. We find that 7 foot-pounds per hour drives the clock-work and pendulum; 7 foot-pounds more drives the carriage as well; and only 3 foot-pounds more is wanted for the cylinder—17 foot-pounds per hour for the whole instrument. Considering the resistance of the carriage, the resistance of the glycerine, and the weight of the cylinder, we think the result as surprising as it is satisfactory.

THE BELGIAN ENTOMOLOGICAL SOCIETY

IN April, 1855, a circular with ten signatures was addressed to entomologists residing in Belgium, proposing the formation of a National Entomological Society, the students of Insecta and allies having at that time no organisation, no central meeting-place for interchange of ideas, no special medium in which to publish the results of their researches. The proposal was met by cordial approval, and the first volume of the *Annales* of the newly-formed Society, published in 1857, indicated a strength of forty-seven effective and four honorary members, with Baron de Selys-Longchamps as president. At first its publications were occupied almost entirely by subjects concerning the Belgian fauna, the volumes were thin, and each represented the work of more than one year. The Society was however well grounded, and notwithstanding occasional short periods of depression, it gradually increased in the number of its members, in the wideness of the scope of the papers read at its meetings, and in reputation as one of the leading entomological societies. Naturally the size of the volumes of the *Annales*, and the frequency of their appearance, also increased, and now the Society produces a volume each year that no similar society need be ashamed of. The twenty-second volume appeared in 1879, showing that the weakness inherent on infancy was soon overcome. The list in this volume shows a total of 171 effective Members (including many foreigners, of whom, however, only six are our own countrymen), twelve Honorary Members (including Messrs. Stainton and Westwood), with the addition of Corresponding and Associate Members. It had also at that time acquired the distinction of being recognised by the State and of receiving a certain amount of State aid.

On October 18, 1880, the Society celebrated its twenty-fifth anniversary, rejoicing in the attainment of more than its majority, on which occasion the present President (M. Weinmann) read a short congratulatory address, and the indefatigable secretary (M. Preudhomme de Borre, to whom the Society owes much of its recent success) gave an instructive sketch of the history and progress of the Society. On that occasion an especial honour was bestowed upon its first president, Baron de Selys-Longchamps (recently elected President of the Belgian Senate), by conferring upon him (in spite of his protestations) the title of Honorary President, a graceful tribute to one who for so long had continually used his energies, his social and scientific position, and his purse in furthering its interests.

Even apart from purely scientific considerations, the history of Belgium is so indissolubly mixed up with our own, and the feeling of fraternity so close, that all students of entomology in this country cannot but reciprocate the mutual congratulations that passed on this occasion between the native members; and the hearty and unaffected demonstrations of friendship accorded to our own entomologists who have attended the meetings of the Society show how warmly they welcome those of the foreign members who occasionally visit Brussels. The meetings are held in a room in the Royal Natural History Museum, in which is the library, and in connection with the entomological collection of the Museum. The annual subscription is small, and entitles the members to receive all the publications, including elaborate separate reports of the proceedings at the monthly meetings. We hope soon to see Englishmen figuring far more numerously in the lists of members. R. McL.

A GENERAL THEOREM IN KINEMATICS

THE following theorem with regard to the motion of a rigid body will doubtless be interesting to mathematical physicists :—

In all cases of the motion, parallel to one plane, of a rigid body there is at every instant a point, J, of no acceleration, in the plane of motion; the acceleration of every point, P, in the plane is in magnitude directly proportional to the distance, JP; and its direction makes with JP an angle which, though varying with the time, is at any instant the same for all points in the body.

If ω is the angular velocity of the body at any instant and $\dot{\omega}$ the angular acceleration, the angle between JP and the direction of acceleration of P is

$$\tan^{-1}\frac{\dot{\omega}}{\omega^2}.$$

We have therefore in all cases of uniplanar motion of a solid body an *instantaneous acceleration centre*, which is analogous to the ordinary instantaneous [velocity] centre.

Of course the ordinary equation

$$I\dot{\omega} = L,$$

which holds for motion round an axis fixed in space and in the body, and which expresses that the moment of the external forces about the axis is equal to the moment of the forces of inertia, holds also for the instantaneous acceleration centre.

As a particular case, whenever a solid moves with constant angular velocity, the accelerations are all directed towards the same point at any instant, and it follows that the resultant stress exerted over the surface of any little lump of the matter is a force directed to this point, if no continuous forces act.

This centre can be in any case geometrically constructed by a rule analogous to that for the ordinary instantaneous centre.

When I had hit upon this theorem I mentioned it to Prof. Wolstenholme, who at once looked out for its extension to three dimensional motion. The result is very simple.

In all cases of the motion of a solid body there is at every instant a point, J, of no acceleration; and if at J there be drawn two axes, JA and JB, which are those respectively round which the resultant angular velocity, ω, and the resultant angular acceleration, $\dot{\omega}$, take place, the acceleration of any point, P, is compounded of two—one along the perpendicular, p, from P on JA, and the other perpendicular to JB and to the perpendicular, q, from P on JB, these two components being, respectively,

$$\omega^2 p \text{ and } \dot{\omega} q.$$

It seems surprising that such a simple and general property of the motion of a rigid body should not have been well known long ago. GEORGE M. MINCHIN

Royal Indian Engineering College,
Cooper's Hill, November 6

NOTES

THE awards of medals for the present year made by the President and Council of the Royal Society are as follows :—The Copl y Medal to Prof. James Joseph Sylvester, F.R.S., for his long-continued investigations and discoveries in mathematics; a Royal Medal to Prof. Joseph Lister, F.R.S., for his contributions on various physiological and biological subjects published in the Philosophical *Transactions* and *Proceedings* of the Royal

Society and elsewhere, and for his labours, practical and theoretical, on questions relating to the antiseptic system of treatment in surgery; a Royal Medal to Capt. Andrew Noble, F.R.S., for his researches (jointly with Mr. Abel) into the action of explosives, his invention of the chronoscope, and other mathematical and physical inquiries; the Rumford Medal to Dr. William Huggins, F.R.S., for his important researches in astronomical spectroscopy, and especially for his determination of the radial component of the proper motions of stars; the Davy medal to Prof. Charles Friedel of Paris for his researches on the organic compounds of silicon, and other investigations.

WE regret to have to record the death of M. d'Almeïda, secretary of the French Société de Physique, and editor of the *Journal de Physique.* M. d'Almeïda published a "Traité de Physique" in collaboration with M. Boutin. The *Comptes rendus* of the Academy of Sciences contain a number of his memoirs.

MR. SPOTTISWOODE, president of the Royal Society, was present at the sitting of the French Academy of Sciences on the 15th inst. He witnessed experiments made at Meritens' workshop on the magneto-electric engines which have been ordered by the Trinity House. The trials were successful.

SIR EDWARD REED writes from Corunna to the *Times* of yesterday, pointing out, as we were able to do last week, that the reports as to the injury sustained by the *Livadia* have been greatly exaggerated, and were not more than a few Clyde shipwrights could have repaired in a couple of days. There was no difficulty in getting the two injured compartments put to rights, barring the laziness of the French shipwrights. The *Livadia* returns to Ferrol for the winter, as her services are not required by her Imperial owner.

FURTHER details concerning the earthquake in Austria on the 9th confirm the reports as to its extent and severity. At Agram there were three shocks—the first, at 7.24 a.m., was the most formidable and lasted ten seconds; the second, also severe, occurred at 7.30; while the third, which was much the weakest, took place at 8.28 a.m. The first shock is described as circular. It was followed by violent oscillations from north-north-east to south-south-west. After it the whole town was covered by a dense cloud of dust caused by the falling down of chimneys, walls, and houses in every direction. From Laibach, Marburg, Klagenfurt, Kanizsa, Serajevo, Derwent, Brod, Pola, Trieste, Cilli, and the region of the river Drave, intelligence has been received of more or less severe shocks about the time of the first great shock in Agram. The earthquake was also felt in both Vienna and Pesth, but so slightly that it attracted the notice of only a few persons. The direction of the motion was everywhere the same, from north-east to south-south-west. As far as can be judged from the information hitherto received, the movement extended from the 44th to the 48th degree north latitude, and from the 32d to the 37th degree of east longitude (Ferro). From almost every district on the right bank of the Danube there is news of a greater or less disturbance with more or less damage done, while from the other side there is no such intelligence from even a single place. It was also felt at Szegedin and on the Theiss. Slight shocks were also felt on the night of the 9th and morning of the 10th, at Agram, and at noon on the 11th, a shock caused a number of houses to fall; the last was preceded by slighter shocks at 5.30 and 11 a.m. The disturbance was continued on the evening of the 11th, and on the morning, afternoon, and evening of the 12th. In the neighbourhood of Agram two mud volcanoes are said to be formed and in full eruption, and several hot springs have risen. The earth has also been rent in many places in the open country, and considerable quantities of mud with hot water and sulphur have been thrown out. The Vienna correspondent of the *Times* writes under the date of November 14: "The earth has been rent in many places in the open country, and considerable quantities of mud and hot water with sulphur have been thrown out. One of the largest of these rents is near the village of Resnik. Agram has often been visited by these earthquakes, especially within the last few years. Indeed scarcely a year has passed without more or less violent shocks." On the night of the 15th–16th there were at least five shocks at intervals between midnight and 4 a.m. Geologists have gone from Vienna and Berlin to Agram to study the phenomena more closely.

MR. J. MUNRO has drawn our attention to the fact that in NATURE, vol. xviii. p. 169, there appeared a short letter signed "J. F. W." and dated from Kew, June 3, 1878, suggesting the principle of Prof. Bell's photophone. The letter is as follows:—"Till now I have looked in vain for any account in NATURE of experiments with the telephone or phonoscope, inserted in the circuit of a selenium (galvanic) element (see NATURE, vol. xvii. p. 312). One is inclined to think that by exposing the selenium to light, the intensity of which is subject to rapid changes, sound may be produced in the phonoscope. Probably by making use of selenium, instead of the tube-transmitter with charcoal, &c., of Prof. Hughes, and by exposing it to light as above, the same result may be obtained. I should be glad to know whether experiments have been made in this direction; for if the above should prove true, there is no doubt that many applications would be the result."

OUR entomological readers will be glad to know that Mr. McLachlan will still continue his valuable services to the *Zoological Record*, reporting as usual on the groups of the Neuroptera and Orthoptera. Mr. Rye will henceforth confine himself to editorial work, while the groups hitherto recorded by him will be undertaken by Mr. Kirby, who will also do the Coleoptera.

LARGE additions are now being made to the Muséum d'Histoire Naturelle in the Jardin des Plantes at Paris. A new front is being erected and two new sides, which, combined with the former "Galerie," will form a hollow square. This square will be covered with glass and used for the exhibition of skeletons of whales and other specimens of inordinate dimensions. The total cost of these buildings is estimated at five million francs (160,000*l.*).

UNDER the auspices of the Russian Geographical Society M. Merejkovsky has been investigating the prehistoric anthropology of the Crimea. He has explored numerous caverns and made large collections of skulls, and the conclusion he comes to is that the age of stone in the Crimea may be divided into three periods: 1. Diluvian period, with mammoth fauna and arms of large dimensions, rudely worked. 2. Alluvial period, with contemporaneous fauna and the use of the arrow. 3. A later period, remarkable for the use of stone arrows, with scarcely any arms of large dimensions. In the Ural M. Malakhof has obtained important results, both geodetical and anthropological. He believes he has discovered on the Neïva, 75 versts from Ekaterineborg, traces of a prehistoric city.

A REGULAR analysis of the air is carried on by M. Davy at Moutsouris. It has been found that the number of bacteria was twice greater than usual during the last period of high mortality.

THE President of the French Republic has established telephonic communication between the Elysée and the Chamber of Deputies, as well as the Senate. The first message of this instrument was the intelligence that the Cabinet had been placed in a minority.

AN interesting exhibition took place on Sunday, the 14th, at the Paris Conservatoire des Arts et Métiers, Rue St. Martin. The *portefeuille* of Vaucauson was opened for the first time to public inspection. On this occasion the most important documents of this collection were affixed to the walls, with a number of other articles belonging to the archives. The most interesting is certainly the original letter written by Fulton to Mollard explaining to him the principles of steamboat construction. The letter is very long and exhaustive, and is accompanied by a drawing. M. Mollard returned a very cold answer after having meditated for a full month, and he says that "Mr. Fulton's communication will be lodged in the archives of the Conservatoire." The date of Fulton's communication is the beginning of Pluviose, An. 11; Mollard's answer is not exhibited, but has been seen by our correspondent.

THE Jablochkoff light has been introduced by M. Hervé-Mangon into the Conservatoire. It will be fed by a Gramme machine, which the establishment has purchased for its constant use. The light will be placed in the amphitheatre, where M. Hervé-Mangon delivers, twice a week, his own lectures.

THE lighting of the Victoria Station of the District Railway by means of the Jablochkoff electric light has been so successful that it has been also applied to the Charing Cross Station, and will shortly be introduced at Earl's Court.

M. MARTIN is engaged in polishing the object-glass of the large refracting telescope now building at the Paris Observatory. The diameter of this exceptional lens is 73 centimetres, and its weight 200 kilograms. The quality of the glass having proved defective it has already broken twice, and the operation is now being made on the third casting.

ON the occasion of the opening of the Ronalds Library at the Society of Telegraph Engineers, a considerable number of rare and curious books relating to electricity, magnetism, navigation, &c., was exhibited. A list of these has been printed and would be valuable to any one interested in the history of the departments of science concerned.

A GOOD example of the thoroughness of German education is given in the publication by Brockhaus of Leipzig of an "English Scientific Reader," edited by Dr. F. J. Wershoven, its purpose being to familiarise students with the style and terms used by the best English scientific writers. The first part relates to physics, chemistry, and chemical technology, and the extracts are made with great judgment. Among the authors from whom selections are made are Clerk-Maxwell, Fleeming Jenkin, Crookes, Roscoe, Lockyer, Rankine, Bloxam, George Wilson.

WE have received the first two volumes of a new "Bibliothèque Belge," for the popularisation of the sciences and arts, published at Mons by Manceaux. The two volumes received are "Traité élémentaire de Météorologie," by MM. J. C. Houzeau and A. Lancaster, two names well known in connection with this subject; and "Zoologie élémentaire," by Prof. Felix Plateau, whose name must also be familiar to our readers in connection with original research in a special department of the subject. Both volumes are well printed and illustrated. Among the volumes to follow are "Palæontology and Conchology," by A. Briart; "Geology," by F. Cornet; "Botany," by F. Crépin; "Mineralogy," and "Mineral Physiology," by L. L. de Koninck; "Mechanics," by H. Hubert; "Astronomy," by M. Niesten; "The Beginnings of Animal Life," by E. van Beneden; and "Physics," by vand der Mensbrugghen.

PROF. CORNELIUS DOELTER of Gratz was to proceed on the 15th inst. to Paris, thence to set out on a mission of scientific investigation to West Africa.

ACCORDING to official reports of the statistics of Bosnia and Herzegovina, these contain 1272 parishes, 43 towns, 31 markets, 5042 villages, 189,662 houses, 200,747 dwellings. Of the 1,158,440 inhabitants 607,789 are male, 550,681 female, 448,613 Mahommetan confession, 496,761 Greek-Oriental, 209,391 Roman Catholic, 3426 Jewish, 249 other confessions.

THE Procureur-General of Paris having complained, in his official address on the occasion of the opening of the courts, that the legal experiments in cases of poison were executed without sufficient precautions being taken against the professional prejudices of the operator, all the medical advisers of the criminal courts in Paris sent in their resignation, after having taken the advice of the Dean of the School of Medicine and other scientific authorities. Their number is nineteen.

A FAIRLY satisfactory Report is given by Surgeon-Major Bidie on the Government Central Museum at Madras. The number of visitors, especially female, continues to increase, and the special arrangements for native ladies attracted an average of 116 on the afternoon of the first Saturday of each month.

THE *Garden* has increased its size and reduced its price, introducing several improvements.

LORD GIFFORD, one of the Scotch judges, in opening the session at the Edinburgh School of Art the other day, summed up very neatly the advantages which a full and accurate scientific knowledge would bestow on those who were engaged in any practical work whatever—(1) That scientific knowledge of their subject would make work, whatever it was, intelligent, not mechanical; (2) it would make their work skilful and easy; (3) it would enable them to produce more exact and perfect work; (4) it would make their work advancing and progressive; and (5) it would make their lifework in itself delightful, and a source of pure and profound joy.

A VERY favourable Twelfth Report of the Working Men's College is issued. This institution completed its twenty-fifth year last year, and during its existence has doubtless done much good. The science classes have attracted an increasing number of students in recent years.

UNDER the title of "The Free Libraries of Scotland" some useful information is brought together in a pamphlet by "An Assistant Librarian." The towns in Scotland in which there are free libraries are Airdrie, Dundee, Forfar, Galashiels, Glasgow (Mitchell Library), Hawick, Paisley, Thurso. The University towns of Edinburgh, Aberdeen, and St. Andrews are still without such useful institutions; the Act has been adopted in Inverness and Dunfermline; Arbroath has twice rejected the proposal to adopt the Free Libraries Act.

WE are glad to notice that the Highbury Microscopical and Scientific Society is increasing in numbers and has some good papers promised for the new year. It gave its fourth annual *soirée* at Harecourt Hall on October 14, and the president, Mr. Frederick Fitch, F.R.M.S., gave his address on the "History of the Microscope and Microscopic Research" on October 28. On Saturday, the 13th inst., a visit will be paid to the Museum of Practical Geology under the guidance of Prof. Rudler, F.G.S.

IN the *Transactions* of the Royal Society of Victoria, April 1880, recently received, the Rev. R. H. Codrington contributes some valuable "Notes on the Customs of Mota, Banks Islands." Since Mr. Tylor in his "Early History of Mankind" so graphically sketched the remarkable custom of the "*couvade*" all information as to its further geographical distribution is ethnologically valuable, and Mr. Codrington here adds the Banks Islands to the area in which it is practised. There is also a tradition that among the inland mountains there is or used to be a race of wild men, which agrees with the stories that are current in most of the Asiatic Islands. The *Mota* practices here described are not to be confounded with those of the *Motu* of New Guinea.

A NEW destructive insect is recorded from America; *Cetonia inda*, a beetle which, according to the *American Naturalist*, was harmless, feeding on the sap of freshly cut maple-trees, has within two or three years become very abundant and destructive in different parts of New England. During the past summer it collected in great numbers on green corn, "eating the kernels and partly destroying a field in Middleboro, Mass."

FAVOURABLE reports reach us as to the thriving condition of the Botanical Gardens, Peradeniya, Ceylon, under the direction of Dr. Trimen, who recently succeeded Dr. Thwaites. In the experimental nurseries, our contemporary the *Colonies* says, good work was being done. Every effort was being made to extend the cultivation of *Cinchona*, the export of which for the season, up to the date of latest advices, had been 1,135,236 lb. In the district of Kotmale report represented the india-rubber tree as flourishing, and the export of its valuable juice from the colony may, it is hoped, be eventually looked upon for supplementing the falling off in export of this valuable article from the forests where it is indigenous.

THE *Colonies and India* draws attention to the riches of the New Zealand forests in their indigenous timbers. Though the woods of New Zealand, like those of Australia, are by no means unknown in this country, owing to the assistance afforded for making their acquaintance through the various International Exhibitions, they are nevertheless almost unknown in commerce in consequence of their extreme hardness and the cost of freight in bringing such heavy material so long a distance. Our contemporary thinks that the timbers "will become of much greater value when it is more generally known when to cut and how to season them." We are told that experiments in this direction are being made in order to test their value for various purposes. Several of the best woods are enumerated, and it is said of the "Matai" (*Podocarpus spicata*) that Mr. Buchanan "reports having found a tree of this species prostrate on a piece of land near Dunedin, which from various circumstances was estimated to have been exposed for at least three hundred years in a dense damp bush under conditions most favourable to decay. It was still however sound and fresh."

MAMMEE APPLES (*Mammea americana*) are, we understand, being exported in quantities from the West Indies to New York. The result of the experiment is being watched with some interest.

IN the last number of the *Revue d'Anthropologie* has appeared not only an excellent photograph of the late Dr. Paul Broca, but also a biographical sketch and a complete list of his various contributions to science. His contributions to medical science commence in 1847, and his first anthropological memoir bears date 1850; from these dates to the time of his death this "Bibliographie" is a record of both untiring industry and scientific production, which will be remembered as long as anthropology remains a science.

OUR ASTRONOMICAL COLUMN

THE SOLAR ECLIPSE OF DECEMBER 31.—Although the eclipse of the sun on the last day of the present year will not in any part of these islands amount to six-tenths of the sun's diameter, it is nevertheless as large a one as will be visible until May 28, 1900, and only that on the morning of June 17, 1890, will compare with it in magnitude in the interval. The *Nautical Almanac* furnishes the results of direct calculations for Greenwich, Edinburgh, Dublin, Cambridge, Oxford, and Liverpool. If to the results for the former three observatories we apply the very convenient Littröw-Woolhouse method of distributing the predictions, we shall have the following formulæ for finding Greenwich mean times of first contact, greatest phase and last contact, and the magnitude of the eclipse at any place within or near to the area comprised:—

		h. m.	
First contact	=	1 41.14	− [9·9891] L + [9·6113] M
Greatest phase	=	2 36.32	− [9·7942] L + [9·3838] M
Last contact	=	3 28.63	− [9·4618] L + [8·7599] M

Where the latitude of the place is put = 50° + L, and M is the longitude from Greenwich in minutes of time reckoned positive to the east, and negative to the west. Quantities in square brackets are logarithms.

Or the following may be substituted with sufficient accuracy, the factors of L and M being now numbers:—

		h. m.	
First contact	=	1 41.14	− 0·98 L + 0·41 M
Greatest phase ...	=	2 36.32	− 0·62 L + 0·24 M
Last contact	=	3 28.63	− 0·29 L + 0·06 M

and the magnitude will be = 0·368 + 0·013 L − 0·002 M. If we test these formulæ upon Oxford, the latitude of which is 51° 45′ 36″, longitude 5m. 2·6s. W., we have then L = + 1·76°, and M = − 5·04m; then for first contact the expression becomes 1h. 41·14m. + 1·76 × − 0·98 − 5·04m. × 0·41 = 1h. 41·14m. − 1·72m. − 2·07m. = 1h. 37·35m. Greenwich mean time, or applying the longitude − 5·04m. = 1h. 32·3m. agreeing with the *Nautical Almanac*, and similarly for the other phases. The differences from direct calculations will be within 0·2m., if the place is not too distant.

THE DUNECHT COMET.—There appears to be no doubt now that the comet discovered by Mr. Lohse at Lord Lindsay's Observatory on November 7 is the same as that detected by Mr. Lewis Swift at Rochester, N.Y., on October 11, which had not been previously observed in Europe. The elements, according to the calculations of Mr. S. C. Chandler, jun., of Boston, U.S., and those of Dr. Copeland and Mr. Lohse at Dunecht, have great resemblance to the elements of the third comet of 1869, discovered by M. Tempel, and there seems a probability that he may thus be found to have detected no fewer than four comets of comparatively short period. If the revolution of this comet should prove to be performed in a little less than eleven years it will be found that it must approach very near to the orbit of Mars shortly before the descending node, and, which is of more importance, within 0·4 of the earth's mean distance, from the orbit of Jupiter in about heliocentric longitude 257°. Mr. Chandler sends us elements calculated from approximate positions on October 21, 25, 28, and in his letter dated November 2 points out their great similarity to those of the Comet 1869 III., and in a circular received from Lord Lindsay we find an orbit computed from Dunecht observations on November 7, 9, and 10; we have thus for comparison:

	Comet of 1880. Chandler.	Comet of 1880. Copeland and Lohse.	Comet of 1869. Bruhns.
T ...	Nov. 7·714	... Nov. 6·6127	Nov. 20·7168
	° ′	° ′ ″	° ′ ″
π ...	41 41·0	... 40 24 10	41 17 13
Node ...	295 25·4	... 300 49 41	292 40 29
i ...	7 21·7	... 7 22 13	6 55 0
Log. *q* ...	0·04262	... 0·043314	0·042416
Motion.	Direct.	Direct.	Direct.

Mr. Chandler's T is for meridian of Washington, the other two for that of Greenwich. An ephemeris which he adds proves the identity of Swift's comet with that found by Mr. Lohse.

It may be remarked that, taken as a whole, there is a distant resemblance to the elements of the comet of Biela.

INTRODUCTORY LECTURE TO THE COURSE OF METALLURGY AT THE ROYAL SCHOOL OF MINES[1]

THE distinguished metallurgist who has held this lecturership since the foundation of the Royal School of Mines, concluded the introductory lecture he delivered more than a quarter of a century ago[2] by pointing out to the students who were then beginning their course that "in proportion to the success with which the metallurgic art is practised in this country will the interests of the whole population, directly or indirectly, in no inconsiderable degree be promoted." This is a fact that none of his students are likely to forget.

Looking back on the actual advance of this country during the

[1] By Prof. W. Chandler Roberts, F.R.S., Chemist of the Mint. Condensed by the Author.

[2] *Records* of the School of Mines, vol. i. pt. 1 (1852) p. 127.

past thirty years, and remembering that the success with which any manufacturing art is practised must bear a direct relation to the way in which it is taught, we cannot but feel how greatly this development of metallurgical knowledge must have been influenced by Dr. Percy's labours. During this period the conditions under which metallurgy is practised have changed considerably; for the field of knowledge has so widely extended, the scale on which operations are conducted is now so great, and the mechanical appliances they involve are so varied and complicated, that while the interest of our subject is deepened its difficulty is gravely increased.

In turning to the history of metallurgy, more especially in its relation to chemical science, it is easy to be led away by the charm of the antiquarian riches of our subject into devoting too much time to this kind of literary research; I may remind you however that much of what is both interesting and full of suggestion, even at the present day, is to be found buried in the treatises by the old writers whose work we inherit and continue.

Primitive metallurgical processes are referred to in some of the oldest known historical records; naturally therefore the development of metallurgy as a science must have been long preceded by its practice as an art, an art for which a place has even been claimed among the religious systems of antiquity.[1] The earlier literature of the subject consists mainly of descriptions of processes; but it is well known that chemistry was to a great extent built up on a metallurgic basis, and Black's singularly advanced definition of chemistry as the "effects produced by heat and mixture" [2] might well be applied to metallurgy. But of all the phenomena of our subject, probably none have more contributed to advance the science of chemistry than those bearing upon the relations between oxygen and lead; indeed the interest attaching to the mutual behaviour of these two elements is so great that I propose devoting a few minutes to i s consideration, more especially as I am anxious to indicate the influence of an ancient process on the scientific views of the present day.

When lead is melted with free access of air, a readily fusible substance forms on its surface. This substance may be allowed to flow away, or if the metal is contained in a suitable porous receptacle, the fusible oxide sinks into this containing vessel; in either case the oxidation of the lead affords a means of separating it from precious or inoxidisable metals if any were originally present in the lead. The above fact has been known from remote antiquity, and the early Jewish writers allude to it as old and well known. They clearly show, for instance, that lead can be removed from silver by being "consumed of the fire," while the silver is not affected. That the Greeks knew and practised the method is abundantly proved, if only by certain specimens of gold and silver now in the adjoining museum, which were recently discovered by Dr. Schliemann. The Arabians investigated the subject; for passing to Geber,[3] the greatest of the early chemists (he died in 777), we find a remarkable account of cupellation; he also describes the conversion of lead into a fine powder by calcination with much clearness, and he noticed the fact that after calcination the mass has "acquired a new weight in the operation." I think his subsequent observations on the reduction of altered metals from their "calxes" show that he knew the weight to be increased; in any case it is interesting to remember that his work was in a sense quantitative. He moreover was cognisant of the fact that two different substances may be produced by heating lead in air, and he assumed that "in the fire of calcination a fugitive and inflammable substance is abolished." The alchemists refer continually to the subject, and "deliver themselves," as Roger Bacon said, in his "Speculum Alchimæ," "in the enigmas and riddles with which they clouded and left shadowed to us the most noble science." In the middle of the sixteenth century the truly accomplished metallurgist Biringuccio,[4] contemporary of Paracelsus and Agricola, seems to have been specially attracted by the phenomenon in question, and he remarks: "If we had not lead we should work in vain for the precious metals, for without its aid we could not extract gold or silver from the stones containing them. . . . The alchemists also," he said, "make use of it in their operations, calcining it by itself or with other substances; but," he goes on to observe, "the calcination, conducted in a reverberatory furnace, is accompanied by a marvellous effect, the result of which should not be passed by in silence; for lead thus treated increases 10 per cent. in weight, and, considering that most things are consumed in the fire, it is remarkable that the weight of lead is increased, and not diminished." Although he subsequently gives evidence of much accurate knowledge of practical metallurgy, his views as to this particular phenomenon were hardly in advance of Geber's; but we may claim Biringuccio as an early metallurgist, who knew the facts, and recognised that they were theoretically important. It was not until nearly a century later (1630) that a French chemist, Jean Rey,[1] stated that the increase in weight came from the air. The problem attracted much attention in England, and it is not a little interesting that among the very first experiments recorded by our own Royal Society is a metallurgical series relating to the weight of lead increased in the fire on the "copels" at the assay office in the Tower, the account being brought in by Lord Brouncker in February, 1661.[2] [Subsequently, in 1669, John Mayo showed that the increase in weight of calcined metals was due to a "spiritus" from the air.[3] Boyle heated lead in a small retort,[4] and attributed the increase in weight, as Lemery also did,[5] to his having "arrested and weighed igneous corpuscles."[6]

I need hardly point out how important this calcination of lead was considered by those who defended the Phlogistic theory in regard to chemical change, a theory which, for more than a century, exerted so profound an influence on scientific thought. [As this theory originated with a metallurgist, Becker, it was considered at some length, and it was made evident that the main aim of chemical investigation down to the end of last century was the explanation of calcination, combustion, or oxidation, and that lead was especially useful in solving the problem.]

I might perhaps add that the *absorption* of oxygen by molten litharge has furnished M. Ste. Claire-Deville,[7] a physicist and metallurgist, with an important step in the argument as to dissociation, and thus connects the history of the metal with the great advance on the borderland of chemistry and physics in modern times, to which I shall constantly refer.

The above remarks will, I trust, be sufficient to show that conclusions of the utmost importance in the history of chemical theory were based on a very ancient metallurgical process; but I have also selected lead as an illustration, because, in the gradual development of the knowledge derived in the first instance from its metallurgy, there is much that is typical of the mutual relation of theory and practice that still prevails.

When Dr. Percy began his teaching, he considered at some length the kind of assistance that other sciences might be expected to render our subject, considered as a manufacturing art; and this at the time was necessary for two reasons: [8] first, because he was "able to adduce from his own observation several striking cases in illustration of the advantage of the application of science to practical metallurgy; and, second, because the practice of metallurgy, so far as relates to magnitude of operation, having been developed to an unparalleled extent in this country in the absence of specific public instruction on the subject, it was necessary to justify the providing of such instruction."

The absence of accurate knowledge on the part of those engaged in metallurgy was lamented as long ago as 1700, in an "Inaugural Dissertation of Pyrotechnical Metallurgy," delivered, on March 25 of that year, in the University of Magdeburg; no less a person than the great supporter of the theory of Phlogiston, George Ernest Stahl, presided, and the lecturer was

[1] Rossignol, "Les Métaux dans l'Antiquité" (1863).
[2] "Lectures by Joseph Black, M.D.," vol. i. p. 8 (Edin., 1803).
[3] "The Works of Geber," translated by R. Russell (1686), pp. 74, 78, 220, 234.
[4] "Pirotechnia" (Vinegia, 1540), translated into French by T. Vincent Rouen, 1627), p. 41.

[1] "Essays de Jean Rey" (reprinted in Paris, 1777), p. 64.
[2] MS. Register Book of the Royal Society.
[3] "Tractatus quinque Medico-Physici," p. 25 *et seq.* (Oxonii, 1674).
[4] Collected works, vol. iii. (1744), p. 347.
[5] "Cours de Chymie" (1675), 2nd English edition (1686), p. 107.
[6] I am indebted to my friend Prof. Ferguson, M.A., of the University of Glasgow, whose eminence as a historian of chemistry is well known, for several interesting additional facts in connection with the calcination of metals. After referring to Eck (1489), Glauber (1651), and others, he writes: "One of the most curious passages I know is in the 'Hippocrates Chemicus' of Otto Tachen, or Tachenius, a German who lived at Venice and published his book there in 1666. He describes how lead, when burnt to minium, increases in weight. This increase he ascribes to a substance of acid character in the wood used for burning, and then, by a very curious course of argument, based on the saponifying powers of litharge, makes out that lead is of the nature of or contains an alkali, which combines with the 'occult acid of the fat.' This is a curious anticipation of a very modern classification which brings lead into relationship with the alkalies and alkaline earths, as well as of Chevreul's investigations."
[7] "Leçons sur la Dissociation," 1864.
[8] *Records* of the School of Mines, vol. i. pt. 1 (1852), p. 128.

Fritschius, who said:[1]—"If in any part of the working of metals there is commonly more owing to experience than reason, truly it is in fusion or melting . . . nevertheless if the reason be asked why the business succeedeth well in this way but in another doth not succeed at all, you have no solid answer, but only that most general one, which is most commonly false, viz. that one fire is stronger and another weaker, and so insufficient." It is just a century since Bishop Watson, Professor of Chemistry and Regius Professor of Divinity in the University of Cambridge, pointed out[2] that "the improvement of metallurgy and other mechanic arts dependent on chemistry might best be made by public establishment of an Academy, the labours of which should be destined to that particular purpose;" and the School of Mines, thus foreshadowed, was established in 1851, its principal object being to "discipline the students thoroughly in the principles of those sciences upon which the operations of the miner and metallurgist depend."

Our honoured founder, Sir Henry de la Beche, in his Address at the opening of the School of Mines,[3] said:—"We still too frequently hear of practical knowledge, as if in a certain sense opposed to a scientific method of accounting for it, and as if experience, without that advantage, was more trustworthy than the like experience with it." Such remarks might, with truth, be made at the present day; but it should nevertheless be remembered that many metallurgical works are successfully conducted in this country by so-called practical men. I do not mean the kind of man so forcibly described by Mr. Bramwell[4] as one "whose wisdom consists in standing by, seeing, but not investigating the new discoveries which are taking place around him . . . the aim and object of such a man being to ensure that he should never make a mistake by embarking his capital or his time in that which has not been proved by men of large hearts and large intelligence;" nor do I mean the man who accepts no rule but the "rule of thumb"; but I do mean practical men possessing technical knowledge of a high order, whose careful observation enables them to use the results of past experience in dealing with circumstances and conditions analogous to those they have met with before, and with which long practice has made them familiar. It would be difficult to overrate the value and importance of such knowledge as theirs, and, when we remember the scale on which smelting and other operations are carried on, it will be obvious that this kind of knowledge can only be gained in the works, and not in the laboratory or lecture-room; for, however careful the metallurgical teaching here may be, it can only be practical in a limited sense. At the same time it must be borne in mind that a man trained to scientific methods starts with the enormous advantage of being able to deal with circumstances and conditions that are new to him, and with which therefore he cannot be said to be "familiar." The technical skill that time and opportunity can alone give him will then rest on a solid basis. I repeat, however, that I am anxious at the outset to guard against undervaluing the teaching of experience unaided by reasoning that we should recognise as scientific; for it is only necessary to witness such operations as the roasting of a large mass of ore on the bed of a furnace, or the forging of many tons of iron under a steam hammer, to appreciate the value of the subtle skill of sight and touch on which success depends.

I have thus ventured to trace the relation between scientific and technical men, as hitherto there have been misunderstandings on both sides, or, as Dr. Williamson so well observes:[5]—"Men of detail do not sufficiently appreciate the value and usefulness of ideas, or of general principles: and men of science, who learn to understand and control things more and more by the aid of the laws of nature, are apt to expect that all improvements will result from the development and extension of their scientific methods of research, and not to do justice to the empirical considerations of practical expediency, which are so essential to the realisation of industrial success in the imperfect state of our scientific knowledge."

While it is no longer necessary to justify the scientific teaching of metallurgy, as Dr. Percy did, it is as important as ever that the true relation of Theory and Practice should be clearly understood. It rarely happens that a process can be transferred from the laboratory to the works without important modifications;

[1] "Pyrotechnical Metallurgy," by J. C. Fritschius of Schwartzburg (translated in 1704), p. 203.
[2] "Chemical Essays," 2nd edition (1782), vol. i. p. 47.
[3] *Records* of the School of Mines, vol. i. pt. 1 (1852), p. 20.
[4] British Association Report, Brighton (1872), p. 238.
[5] "A Plea for Pure Science" (Inaugural Lecture, University College, London, 1870).

and we must remember that metallurgy is a manufacturing art, and that, when the truth of a theory has been demonstrated, a dividend has to be earned; this would indeed often be difficult without the aid of the technical man. Practical men have, however, ceased to undervalue science; and the most practical body of men in the world, in the best sense of the term, the ironmasters of this country, on whom its prosperity so largely depends, formed themselves ten years ago into an Iron and Steel Institute, many of the members of which possess high scientific attainments and are distinguished for scientific research.

Let us turn, then, to the advice given us by those who are accustomed to deal with metals on a large scale. Mr. I. Lowthian Bell stated in his address as president of the Institute in 1873[1]:—"If we would avoid the failure of what may be designated unscientific practice, or the failure of impracticable science, we must seek to combine commercial intelligence with a knowledge of those natural laws which form the only trustworthy groundwork of the complicated processes in which we are engaged."

Dr. Siemens[2] said in 1877:—"It is not many years since *practical* knowledge was regarded as the one thing requisite in an iron-smelter, whilst *theoretical* knowledge of the chemical and mechanical principles involved in the operations was viewed with considerable suspicion;" and he adds, with reference to the teaching of the School of Mines and of a general Technical University:—"But it must not be supposed that I would advocate any attempt at comprising in its curriculum a practical working of the processes which the student would have to direct in after-life. . . . Let technical schools confine themselves to teaching those natural sciences which bear upon practice, but let practice itself be taught in the workshop and in the metallurgical establishment."

The president for 1879, Mr. E. Williams, a most eminently practical man, and one of the founders of the prosperity of the great Cleveland iron district, urged[3] "educated intellectual young men, who now hang listlessly about the professions . . . to break through the absurd old prejudice against seemingly rough work," in order that they may act as scientifically trained managers.

I have thus appealed to authorities, because my own practical work has been mainly confined to a limited branch of metallurgy. I say limited, for although, on looking into the matter, I find, to my surprise, that I have during the last ten years been responsible for the fineness of 330 tons of gold and 740 tons of silver, this, though of a total value of forty-seven millions sterling, is a comparatively small bulk of metal, and the operations through which it passes are seldom complicated; but I am none the less convinced that in metallurgical works generally, as in a mint, the work can only be efficiently conducted by taking advantage to the utmost extent of the aid that science has to offer, a mint only differing from other works by the extraordinary care and vigilance which must be exercised to insure accuracy and avoid loss in dealing with the precious metals. Even this difference is less marked than formerly, and as attention to minute details is becoming more and more essential to the profitable conduct of works, my experience in this respect will be useful to you.

As regards the actual training in the school, I believe that our utmost efforts should be devoted to giving the students a thorough acquaintance with scientific methods and metallurgical principles, furnishing them at the same time with as many well-ascertained *facts* as possible. Here I may perhaps be permitted to quote a few words from Prof. Huxley's[4] recent address at Birmingham, as they bear so directly on our subject; he said, "What people call applied science is nothing but the application of pure science to particular classes of problems. It consists of deductions from those general principles, established by reasoning and observation, which constitute pure science. No one can safely make these deductions until he has a firm grasp of the principles; and he can obtain that grasp only by personal experience of the processes of observation and of reasoning on which they are founded."

In one important branch of metallurgy—assaying—the teaching in the School is thoroughly practical, and the operations you may in future be called upon to conduct will not differ from those taught in this laboratory. The teaching will, I am glad to say, be now specially entrusted to my friend Mr. Smith, the value of whose instruction in my own case I gratefully acknowledge.

[1] *Journal* of the Iron and Steel Institute (1873), No. 1, p. 12.
[2] *Ibid.* (1877), No. 1, p. 7.
[3] *Ibid.* (1879), No. 1, p. 24.
[4] NATURE, vol. xxii. p. 548.

It can hardly be questioned that until the School of Mines was established the metallurgical success and reputation of this country rested to a remarkable extent on the exceptional skill of its technical men. I think therefore we may fairly be asked to consider whether the metallurgical teaching of the School has been justified, and how far advance has been due to trained scientific thought.

Of all the metallurgical operations conducted in this country, those connected with iron are, of course, the most important. The production of pig-iron alone in the United Kingdom has increased from two million seven hundred thousand tons in 1852 to six million two hundred thousand tons last year, a maximum slightly in excess of this figure having been reached in the year 1872. Now the Bessemer process, the first patent in connection with which was taken out in 1855, has reduced the cost of steel from 50*l*. to 6*l*. per ton, and has changed the whole aspect of the iron and steel manufacture; indeed, the success with which this process alone is conducted may almost be regarded as an index of our national prosperity. Notwithstanding the almost universal depression of trade during the last few years, the outturn of steel has been steadily increasing; and it is estimated that in 1879 this country produced nearly a million tons in the Bessemer converter, double the entire produce of the remainder of the world in the year 1870 by the same process.[1] The outturn of Bessemer steel in America has, however, advanced with still more rapid strides; for last year she actually produced, with far fewer converters, ninety-four thousand tons more than this country. It will be evident, therefore, that every improvement effected in this process is of truly national importance, and I would briefly refer to the greatest that has been introduced in recent years.

In 1855 the fact was established that pig-iron from the blast-furnace contains the greater part of the phosphorus originally present in the ore. Dr. Percy pointed out that phosphorus is not eliminated in a sensible degree in the Bessemer process, as it is in the old process of puddling; and he stated that if the Bessemer process is to be "generally applicable in this country, it must be supplemented by the discovery of a process of producing pig-iron sensibly free from sulphur and phosphorus, with the fuel and ores which are now so extensively employed in our blast-furnaces."[2] The problem, so far as it relates to the elimination of phosphorus, has received the attention of many of the first metallurgists in this and other countries;[3] but the practical application of basic linings in the Bessemer converter is the outcome of Dr. Percy's teaching; for Mr. S. G. Thomas was a student of the School of Mines, and his partner, Mr. Gilchrist, is an Associate. Mr. Snelus is also an Associate, and Mr. Riley long worked in the metallurgical laboratory. The process not only gives hope that it will be possible to utilise the large quantities of ore in the well-known Cleveland district, but is also widely practised with success on the Continent.[4] It is probable therefore that the large deposits of ore in the basin of the Saar, and those of Lorraine and Luxembourg, which in extent are equal to the Cleveland district, while containing a much greater amount of phosphorus, will now be available. During a recent visit to the Hoerde Works in Westphalia, where I witnessed the operation, Herr Massenez, the director, told me that 10,000 tons of "Thomas-Gilchrist" metal have already been produced there since the adoption of the process a few months ago. . . .

I had intended to indicate the metallurgical work done by the more prominent men who have been associated with the school, but I found that it would not be possible, in the brief time at my disposal, to do justice to such as Bauerman, Dick, Gibb, Hackney, Matthey, Pearce, Riley, Willis, and others, whose labours have placed them so high in the ranks of English metallurgists. You will, however, as the course proceeds, have opportunity of becoming familiar with their names.

In referring to the past teaching of the school I must remind you of the importance of rigorous and minute inorganic analysis; and it is the more necessary that I should do so from the fact that the peculiar charm of organic research appears, as has been pointed out by Prof. Abel,[5] to lead the younger chemists to "under-estimate the value and importance, in reference to the advancement of science, of the labours of the plodding investigator of analysis." I am satisfied, however, that, if we bear the traditions of the chemical and metallurgical laboratories of the School of Mines in view, we are not likely to under-rate the importance of analytical work; and much conclusive evidence as to the value of the teaching of the past thirty years is afforded by the labours of the accomplished analysts who have from time to time worked under Dr. Percy's direction.

[1] *Times*, December 31, 1879.
[2] "Metallurgy—Iron and Steel" (1864), p. 819.
[3] M. Gruner, *Annales des Mines* (1869), t. xvi. p. 199.
[4] M. Gruner, *Annales des Mines*, part 1 (1879), p. 146; H. von Tunner, *Zeitschrift der berg- und hüttenmännischen Vereins für Steyermark u. Kärnten*, xii. Jahrg., Mai-Juni 1880; Herr J. Massenez, *Engineering*, vol. xxx. (1880), p. 198.
[5] British Association Report, Plymouth (1877), p. 44.

The direct influence of the School on the success with which metallurgy has been practised in this country has been most marked, and would alone afford an answer to the question whether the possession of high scientific attainments is generally advantageous to the successful conduct of metallurgical works. It must not be forgotten that our subject is constantly receiving valuable aid from branches of science other than chemistry; and this can hardly be better shown than by the growing importance of physical research in connection with metallurgical problems. I would incidentally remind you that it is the more important for us to consider this, because special attention was directed to the question in the evidence given before the Royal Commission on Scientific Instruction,[1] whose recommendations will, it is to be hoped, extend the influence of the School of Mines.

In connection with this branch of our subject a most prominent position must be given to the production of high temperatures, as it will be obvious that we have principally to consider the reactions of the elements when under the influence of heat. In the first half of the present century temperatures higher than the melting point of zinc were not known with any degree of certainty; but in 1856[2] M. Henri Ste. Claire-Deville pointed out that chemistry at high temperatures, that is to say, up to the blue-white heat at which platinum volatilises and silica fuses, remained to be studied. Since then, in conjunction with M. Troost, he has given us certain fixed points, such for instance as the boiling points of cadmium and zinc; and Deville's researches on dissociation have entirely modified the views generally entertained in regard to the theory of combustion. Indeed we owe so much to this illustrious teacher, that the best homage we can offer him will be to work in the directions he has indicated. M Stas has proved that it is perfectly easy to distil even large quantities of silver from one lime crucible to another,[3] a fact which has been taken advantage of by Mr. Lockyer and myself in some experiments on the absorption-spectra of the vapours of certain metals at high temperatures.[4]

As regards scientific advance of a more essentially practical character, the gradual discovery of the fact that in certain cases fuel can be best employed if it be previously converted into gas, and the recognition of the advantages to be derived from a preliminary heating of the gases and the air, has led to the wide adoption of the regenerative system, by which the waste heat of the furnace is utilised for heating the incoming air or combustible mixture of air and gas necessary to effect the required operation. Dr. Siemens has thus shown us how to economise fuel to a vast extent, it being now possible to produce a ton of steel by the use of 12 cwt. of small coal instead of three tons of coke required to melt it in the old form of furnace. By the command of high temperatures, moreover, he has developed new processes in the metallurgy of iron, which are resulting in the replacement of the old "cinder-mixed" wrought iron by "cinder-free" ingot iron and steel.[5] The degree of heat attainable by the regenerative furnace is, however, limited to the temperature of dissociation of carbonic acid and aqueous vapour, so that the temperature never can exceed about 2600° C.; but during the present year[6] Dr. Siemens has employed the far greater heat of the electric arc for the fusion of steel and platinum.[7] Bearing in mind the interest excited by recent experiments on the effect of intense heat on bodies now considered to be elementary, we may expect physicists to look to us for aid in developing the methods of employing high temperatures.

The essential difference in the properties of certain alloys produced by a small difference of composition brings me to one very distinctive feature of metallurgy, the enormous influence

[1] Report, vol. ii. Minutes of Evidence, p. 86 (1874).
[2] *Ann. Chim. et Phys.* [3], t. xlvi. p. 182; *Comptes rendus*, t. xc. (1880), p. 773.
[3] "Sur les Lois des Proportions chimiques" (1865), p. 37.
[4] *Proc.* Roy. Soc. vol. xxiii. (1875), p. 344.
[5] Akerman, *Journal* of the Iron and Steel Institute, No. 2 (1878), p. 360.
[6] *Engineering*, vol. xxix. (1880), p. 478.
[7] Figures convey but little impression as to such high temperatures; but it may be mentioned that Dewar has given 7000° C. as approximately the temperature of the electric arc (Brit. Assoc. Rep. 1873, p. 466), and, according to Rossetti, the true temperature of the sun can hardly be less than 10,000° C. or more than 20,000° C.—*Phil. Mag.* [5], vol. viii. p. 550 (1879).

exerted on a large mass of metal by a trace of another metal or metalloid—that is, by a quantity so small that it appears to be out of all proportion to the mass in which it is distributed.

I think it may safely be asserted that in no other branch of applied science has the operator to deal with quantities that are at once so vast and so minute; and the course will not have proceeded far before you will recognise this fact.

It may be that the trace to be extracted is alone of value—as, for instance, the few grains of gold that can be profitably extracted from each ton of a material, which, though containing only one part of gold in five millions by volume, is thereby entitled to be regarded as an auriferous deposit that can be profit ably worked; or it may be the minute percentage of a metalloid which must be extracted in order that the physical properties of a large mass of metal may not be entirely altered.

[Numerous instances of the influence of small traces of metals and metalloids, including the following, were then given:—]

In 1866 Graham showed,[1] by experiments with which I had the privilege of being connected, that the presence of occluded gases in metals often exerts a marked influence on their molecular structure. In the case of iron he urged that metallurgists should study the effects of occluded gases, more especially carbonic oxide, the weight of which, according to his experiments, could not exceed the $\frac{1}{15}$ per cent. of the weight of iron in which it was present. The significance of such facts is now under consideration by a Committee of the Institution of Mechanical Engineers,[2] and the question of the presence of gas in steel, either occluded or retained in the form of bubbles, is further being investigated by Chernoff,[3] Müller,[4] and others.

M. Nyst, of the Brussels Mint, has lately found that the presence of $\frac{15}{100}$ per cent. of silicon in standard gold will so affect its molecular grouping as to render it possible for a thin strip to bend by its own weight, as zinc would, in the flame of a candle.

The growing importance of physical research in connection with metallurgy is shown by the fact that physical methods are now constantly appealed to by those interested in metallurgy, more especially in the case of iron and steel. We are told, for instance, that the hardness of steel may be correctly inferred from a numerical determination of its coercive force;[5] it is sought to establish the actual nature of the change in the mode of existence of the carbon in steel that accompanies hardening by determining its thermo-electric properties;[6] and the hope is held out[7] to us that the time will soon come when boiler-makers will electrically test their plates, possibly by the aid of the induction-balance, just as they now test them for ductility and tenacity. I can only add the expression of a belief that this powerful weapon of molecular research which Prof. Hughes has given us will yield good results in the hands of some of you.

The results of mechanical tests are also of the highest importance. Not long since the appearance of the fracture of a sample of metal was considered to afford trustworthy and sufficient evidence as to its nature and properties; but such rough methods have given place, in the hands of Kirkaldy and others, to the rigorous physical and mechanical investigation to which metals must now be submitted as a matter of ordinary routine. The results, tabulated or plotted into curves, which mark the influence of each constituent or impurity, form permanent records of the greatest value.[8]

It has only been possible for me to indicate the more important conditions affecting the successful practice of metallurgy. I have traced the relation between technical and scientific workers; but there is yet another condition of somewhat recent growth. The enormous scale on which operations are now conducted renders it more necessary than formerly for those engaged in metallurgical enterprise to seek the aid of capitalists. The result is that a large share in the control of many important works falls to the non-scientific members of the Board of Directors, men of high commercial ability, but whose knowledge of the importance of scientific work is necessarily limited. It is true that they may recognise the necessity for scientific aid in the works with which they are connected, but they are too often unconscious of the labour and difficulty that are involved in the attainment of accurate scientific knowledge. I am convinced, however, that facts are gradually compelling them to recognise that the value of a metal may entirely depend on whether it does or does not contain a trace of impurity, and that the exact method of treatment to be adopted depends much on the character of the materials employed; they will therefore examine more carefully than they have hitherto done the qualifications of men to whom important duties are entrusted, and will insist that the services of only adequately trained metallurgists shall be secured.

I shall have to direct your attention to the minute care with which details affecting commercial interests are now investigated;[1] and your success will further depend on the facility with which you are able to use the "tools of thought" furnished by chemistry, physics, and mechanics. Whether you will ever possess the tact and judgment necessary to direct such works as Dowlais with an army of 10,000 people, obviously depends on personal qualifications which I can but little influence.

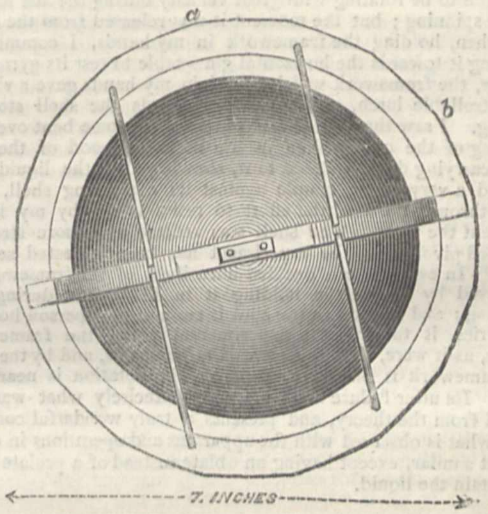
I venture to hope that you will, by original research, add to the general advance of science, for, as the late Prof. Clifford has reminded us, what have often proved to be the most useful parts of science have been investigated for the sake of truth, and not for their usefulness.

Dr. Percy found metallurgy practised in this country mainly as an empirical art. He may well feel, to borrow the words of an old writer, that in his hands "the business of metallurgy and essaying has not only been illustrated but also improv'd, amended, and enrich'd"; for his works contain a record of its progress, his teaching and researches have secured it a scientific basis, and he has trained a body of scientific workers, in whose hands the immediate future of metallurgy to a great extent rests. Bearing in mind how much the progress of our science means to England, I cannot but be conscious that, in attempting to continue this work, I undertake a grave responsibility.

¹ *Phil. Trans.* 1866, p. 438.
² First Report of the Committee on the Hardening, Tempering, and Annealing of Steel, 1879.
³ "On the Structure of Cast Steel Ingots." Translated for the Institution of Mechanical Engineers by W. Anderson, C.E. (1879).
⁴ *Berichte der deutschen chemischen Gesellschaft*, 1879, No. xii. 93; *Glaser's Annalen für Gewerbe und Bauwesen*, August, 1880, p. 138.
⁵ Trève and Durassier, *Comp. rend.*, t. lxxx. (1875), p. 799; Watten hofen, *Journal* of the Iron and Steel Institute, 1879, No. 1, p. 305.
⁶ Barus, *Phil. Mag.* [5], vol. viii. p. 341.
⁷ W. H. Johnson, *Chemical News*, vol. xlii. (1880), p. 70.
⁸ V. Deshayes, "Classement et Emploi des Aciers" (Paris, 1880); also *Bull.* Chem. Soc. tom. xxxi. (1879), p. 166.

ON AN EXPERIMENTAL ILLUSTRATION OF MINIMUM ENERGY[2]

THIS illustration consists of a liquid gyrostat of exactly the same construction as that described and represented by the annexed drawing, repeated from NATURE, February 1, 1877, p. 297, 298, with the difference that the figure of the shell is prolate instead of oblate. The experiment was in fact conducted with the actual apparatus which was exhibited to the British Association at Glasgow in 1876, altered by the substitution of a

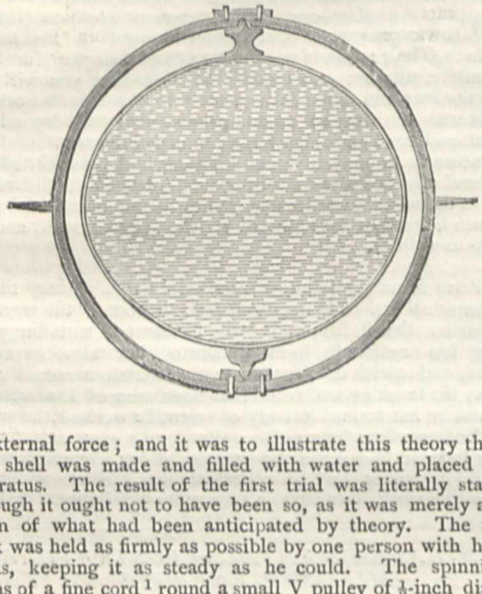


shell having its equatorial diameter about $\frac{9}{10}$ of its axial diameter, for the shell with axial diameter $\frac{9}{10}$ of equatorial diameter which was used when the apparatus was shown as a successful gyrostat.

¹ In illustration of this see an exhaustive mathematical paper on the values of iron ores, by Prof. A. Habets: *Cuyper's Revue Universelle des Mines* (1877), t. i. p. 504.
² By Sir William Thomson, F.R.S. British Association, Swansea, Section A.

The oblate and prolate shells were each of them made from the two hemispheres of sheet copper which plumbers solder together to make their globular floaters. By a little hammering it is easy to alter the hemispheres to the proper shapes to make either the prolate or the oblate figure.

Theory had pointed out that the rotation of a liquid in a rigid shell of oval figure, being a configuration of maximum energy for given vorticity, would be unstable if the containing vessel is left to itself supported on imperfectly elastic supports, although it would be stable if the vessel were held absolutely fixed, or borne by perfectly elastic supports, or left to itself in space unacted on

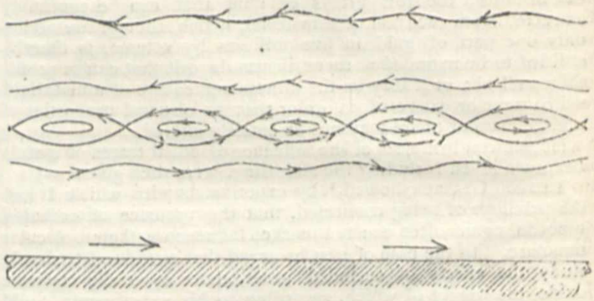


by external force; and it was to illustrate this theory that the oval shell was made and filled with water and placed in the apparatus. The result of the first trial was literally startling, although it ought not to have been so, as it was merely a realisation of what had been anticipated by theory. The framework was held as firmly as possible by one person with his two hands, keeping it as steady as he could. The spinning by means of a fine cord[1] round a small V pulley of ½-inch diameter on the axis of the oval shell, and passing round a large fly-wheel of 3 feet diameter turned at the rate of about one round per second, was continued for several minutes. This in the case of the oblate shell, as was known from previous experiments, would have given amply sufficient rotation to the contained water to cause the apparatus to act with great firmness like a solid gyrostat. In the first experiment with the oval shell the shell was seen to be rotating with great velocity during the last minute of the spinning; but the moment it was released from the cord, and when, holding the framework in my hands, I commenced carrying it towards the horizontal glass table to test its gyrostatic quality, the framework which I held in my hands gave a violent uncontrollable lurch, and in a few seconds the shell stopped turning. I saw that one of the pivots had become bent over, by yielding of the copper shell in the neighbourhood of the stiff pivot-carrying disk, soldered to it, showing that the liquid had exerted a very strong couple against its containing shell, in a plane through the axis, the effort to resist which by my hands had bent the pivot. The shell was refitted with more strongly attached pivots, and the experiment has been repeated several times. In every case a decided uneasiness of the framework is perceived by the person holding it in his hands during the spinning; and as soon as the cord is cut and the person holding it carries it towards the experimental table, the framework begins, as it were, to wriggle round in his hands, and by the time the framework is placed on the table the rotation is nearly all gone. Its utter failure as a gyrostat is precisely what was expected from the theory, and presents a truly wonderful contrast from what is observed with the apparatus and operations in every respect similar, except having an oblate instead of a prolate shell to contain the liquid.

[1] Instead of using a long cord first wound on a bobbin, and finally wound up on the circumference of the large wheel as described in NATURE, February 1, 1877, p. 297, I have since found it much more convenient to use an endless cord little more than half round the circumference of the large wheel, and less than half round the circumference of the V pulley of the gyrostat; and to keep it tight enough to exert whatever tangential force on the V pulley is desired by the person holding the framework in his hand. After continuing the spinning by turning the fly-wheel for as long a time as is judged proper, the endless cord is cut with a pair of scissors and the gyrostat released.

ON A DISTURBING INFINITY IN LORD RAYLEIGH'S SOLUTION FOR WAVES IN A PLANE VORTEX STRATUM

IN the paper in last week's NATURE under this heading by Sir William Thomson, the lower part of the illustration was inadvertently turned round at the last moment by the printer; the cut should stand as follows:—



SARGASSUM[1]

THIS paper opens with a discussion of the value of the species *Sargassum bacciferum*, the particular species of this genus which is well known as the Gulf-weed. The author considers that the floating plants to which this name has been given are simply fragments of many varieties or species of Sargassum, more particularly of *S. vulgare*. In support of this view he points out that, from the accounts of nearly all authors who have examined specimens, it appears that the lower part of the stem had been broken across, and that it is therefore fair to conclude that they belong to plants which are rooted under ordinary circumstances. This conclusion had been already arrived at by Rumphius, C. Agardh, Rennell, Humboldt, and more recently by G. von Martens; but of these writers Rennell and Humboldt are of opinion that the floating fragments continue to grow, and in this they agree with Thunberg, Meyen, and Harvey. Dr. Kuntze contends that there is not sufficient evidence forthcoming to establish the correctness of this view. He urges that, even admitting that some growth takes place, it is only temporary, and that it therefore affords no ground for regarding these as pelagic plants. The only other cases of growth of Fuci when floating are offered by *Macrocystis pyrifera* (Sir Joseph Hooker, "Flora Antarctica," vol. i.), and by *Fucus vesiculosus* (Mr. Moseley, "Notes by a Naturalist on the *Challenger*"), and doubtless Dr. Kuntze's objections apply to these also. The question naturally arises as to whether these floating plants are actively living, or are dying, or dead.

In the case of Sargassum Dr. Kuntze considers that their bright yellow colour is due to changes taking place, either preliminary to or in consequence of death, in the brown colouring-matter of the attached forms to which he believes the floating fragments belong. Mr. Moseley, however, is of opinion that this is the natural colour of these plants whilst living. It does not appear that any such difference in colour has been noticed in attached and floating specimens of Macrocystis or of Fucus, and this is a fact which is not in harmony with Dr. Kuntze's views respecting Sargassum. Again, the general observation that these floating Fuci have no reproductive organs offers a further difficulty which they do not explain. Dr. Kuntze endeavours to meet the difficulty by stating that he has found receptacles occasionally in free-swimming individuals, and he gives figures of two plants bearing them; but neither from the figures nor from his account of them is it possible to conclude with certainty that the bodies in question are really of a reproductive nature; and he explains the usual absence of these organs in the floating individuals by suggesting that the receptacles, being the most fragile parts of the plant, are the most readily destroyed, and further that, owing to the small number of air-chambers with which they are provided, they would sink on becoming detached. In this case, as in that of the colour, these explanations respecting Sargassum will only become valid when they are found to hold good of Macrocystis and of Fucus also. It is apparent that the

[1] "Revision von Sargassum und das sogenannte Sargasso-Meer." Von Dr. Otto Kuntze (*Engler's botanische Jahrbücher*, Bd. i. Heft iii., 1880). Leipzig, Engelmann.)

evidence offered in support of Dr. Kuntze's views is at present incomplete, and that further researches into the life-history of these plants must be made before these views can be generally accepted.

After an elaborate systematic revision of the genus, Dr. Kuntze goes on to discuss the Sargasso Sea. He draws attention to the wide divergences which exist between the accounts given of it by different travellers. Thus Humboldt and Maury speak of it as a mass of gulf-weed having an area of thousands of square miles, whereas others—Sir Wyville Thomson, for instance—describe it as consisting of small scattered patches. Dr. Kuntze concludes that there is no reason for assigning a definite and constant area to it. It appears that the patches of weed occur more frequently in the region of calms, but at times it is either absent or present only in small quantities even there. A wind blowing for a considerable time in one direction might, under certain circumstances, cause the aggregation of patches into a mass of some extent, such as is to be found, for instance, in the neighbourhood of the Bermudas in spring after the equinoctial gales, but even this would be but small when compared with Humboldt's estimate.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The following gentlemen have been nominated by the Vice-Chancellor as examiners for the Degree of Bachelor of Medicine. In the first examination for M.B. :—S. H. West, M.A., M.B. Christ Church; J. A. Dale, M.A. Balliol; A. G. Vernon Harcourt, M.A. Christ Church. In the second examination for M.B. :—T. K. Chambers, M.D., Christ Church; James Andrews, M.D., Wadham; T. P. Teale, M.A., M.B., Brasenose. In the examination in Preventive Medicine :—W. Ogle, M.D. Corpus; G. W. Child, M.D. Exeter; W. F. Donkin, M.A. Magdalen; Douglas Galton, Capt. R.E., Hon. D.C.L.

A Fellowship will shortly be offered by University College for proficiency in biology. The details are not yet announced.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 10.—On the influence of curvature of the wall on the constants of capillarity in wetting liquids, by P. Volkmann.—Constructions for anomalous dispersion, by E. Ketteler.—On Newton's dust-rings (continued), by K. Exner.—On calculation of the correction for temperature in calorimetric measurements, by L. Pfundler.—Chemical energy and electromotive force of various galvanic combinations, by J. Thomsen.—On the photo- and thermo-electric properties of fluor spar, by W. Hankel.—On electrical elementary laws, by E. Riecke.—Remarks on some recent electro-capillary experiments, by E. Lippmann.—Experimental researches on weakly magnetic substances (third part), by P. Silow.—Researches on the height of the atmosphere and the constitution of gaseous heavenly bodies (continued), by A. Ritter.—Reply to Herr Herwig "On the Heat-Conductivity of Mercury," by H. F. Weber.—Reply to Herr Winckelmann's remarks in a recent number, by the same.

Archives des Sciences Physiques et Naturelles, October 15.—Contributions to a study of the colouring-matters of plants, by J. B. Schnetzler.—Practical study of marine zoology; the zoological station of Naples, by E. Yung.—Sixty-third session of the Helvetic Society of Natural Sciences, held at Brigue on September 13-15, 1880; Proceedings in the departments of Physics and Chemistry, Geology, Botany, Zoology and Medicine.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, November 4.—Prof. Allman, F.R.S., president, in the chair.—The session opened by Mr. H. C. Sorby showing drawings of some British sea-anemones, with habitat on the upper fronds of long seaweeds in deep water; and he recorded having seen a solitary cream-coloured cetacean on the English coast.—Mr. Arthur Bennett drew attention to a new British Chara (*C. stelligera*), remarkable for the presence of stellate bulbils on the stems.—Mr. E. M. Holmes exhibited two marine algæ new to Britain, viz., *Dasya gibbesii*, from Berwick-on-Tweed, and *Ectocarpus terminalis* from Weymouth; and also species of *Callithamnion*, with antheridia and trichophore on the same branchlet.—Prof. T. S. Cobbold exhibited a remarkable trematode from the horse. It was discovered by Dr. Sonsini at Zagazig during the Egyptian plague, with which outbreak, however, the parasite had no necessary connection. The worm (*Gastrodiscus sonsinonis*) appeared to be an aberrant amphistome furnished with a singular ventral disk, whose concavity was lined with about 200 small suckers having a tesselated aspect. In this respect its nearest approach was a worm infesting a genus of spinny-finned fishes (*Cataphractus*) belonging to the Triglidæ. According to Prof. Leuckart's recent anatomical investigation, however, doubts are thrown on its amphistomoid affinities.—Mr. G. F. Angas showed the leaf of *Hermas giganteæ*, an umbelliferous plant of the Cape used as tinder by the Hottentots.—Mr. E. A. Webb exhibited a monstrous bramble (*Rubus fruticosus*) with flowers represented by elongated axes covered with minute pubescent bracts and apices fasciated.—A communication by Dr. G. Watt was read, viz., contribution to the flora of North-West India. The geographical features of the district are noted. He divides it into three areas: the first range, Ravee-Basin, with magnificent forests of *Cedrus deodara* on its northern slopes, has on the southerly ones vegetation with an Indian facies, being barely outside the humid influence of the tropical rains of the plains; the second range, comprising Pangi, Lower Lahore, and British Lahore, has a flora altogether changed, dry short summers and snow-clad mountains giving a climate and plant-life of quite a different cast; the third range evinces still further change of flora, this assuming a Thibetan type. Some 300 species of plants are noted, four being new.—A paper on the Papilionidæ of South Australia, by J. G. Otto Tepper, was read. The butterflies of this part of Australia are comparatively few in numbers, and sombre colours prevail thus seemingly in harmony with the surroundings of their habitat. The paucity of numbers the author attributes to the dryness of the climate. Notes on the habits accompany the descriptions of the species.—Notes on a collection of flowering plants from Madagascar were read by Mr. J. G. Baker. The flowering plants are less known than the ferns from this interesting island; two new genera are denoted, viz. (1) *Kitchingia*, belonging to the Crassulaceæ, a succulent herb with fleshy sessile leaves and large bright red flowers in lax terminal cymes; (2) *Rodocodon*, a liliaceous plant with red flowers and peculiar spurred bracts: it comes between *Muscaria* and *Urginea*. Thirty new species are described.—Messrs. Edw. Brown, H. E. Dresser, and T. F. Pippe were elected Fellows of the Society.

Mathematical Society, November 11.—Mr. C. W. Merrifield, F.R.S., president, in the chair.—The Treasurer's and Secretaries' reports were read and adopted.—After the ballot had been taken, the gentlemen whose names are given on p. 614 of the last volume were declared duly elected as the Council for the present session.—Mr. S. Roberts, F.R.S., the new president, having taken the chair, Mr. Merrifield read his valedictory address, "Considerations respecting the Translation of Series of Observations into Continuous Formulæ."—On the motion of Prof. Cayley, F.R.S., the address was ordered to be printed in the *Proceedings*.—Mr. H. M. Jeffery, F.R.S., then read a paper on bicircular quartics, with a triple and double focus, and three single foci, all of them collinear.—Mr. Tucker (hon. sec.) communicated parts of a paper by the Rev. C. Taylor, further remarks on the geometrical method of reversion.

Geological Society, November 3.—Robert Etheridge, F.R.S., president, in the chair.—Bernard Barham Woodward was elected a Fellow of the Society.—The President announced that the original portrait of Dr. William Smith, painted by M. Fourau in the year 1838, had been presented to the Society by Mr. William Smith of Cheltenham.—The following communications were read:—On the serpentine and associated rocks of Anglesey, with a note on the so-called Serpentine of Porthdinlleyn (Caernarvonshire), by Prof. T. G. Bonney, F.R.S., Sec. G.S. Several patches of serpentine are indicated on the Geological Survey map on the western side of Anglesey, near Tre Valley Station, and a considerable one on Holyhead Island, near Rhoscolyn. These really include three very distinct varieties of rocks: (1) compact green schistose rocks, (2) gabbro, (3) true serpentine. The author described the mode of occurrence of each of these, and their relations, the serpentine being almost certainly intrusive in the schist, and the gabbro in the serpentine. The microscopic structure of the various rocks was described in detail, especially of the last. It presents the usual characteristics, and is an altered olivine rock which has contained bronzite. One or two varieties are rather peculiar; an ophicalcite and a compact chloritic schist containing chromite are also noticed.

At Porthdinlleyn there is no serpentine, but a remarkably interesting series of agglomerates and (probably) lava-flows of a basic nature, which may now be denominated diabases.—Note on the occurrence of remains of recent plants in brown iron ore, by J. Arthur Phillips, F.G.S. The fossilising ironstone described by the author occurs at Rio Tinto, in the province of Huelva, Spain, in close proximity to the celebrated copper mines of that name, where it forms a thick horizontal capping of a hill known as the Mésa de los Pinos. In this iron ore Dr. Carruthers has identified the following vegetable remains:—Leaves and acorns of *Quercus ilex*, Linn.; leaves and seed of a two-leaved species of *Pinus*, most probably *Pinus pinea*, Linn.; the cone of *Equisetum arvense*, Linn.; and a small branch of a species of *Erica*. There is also a well-marked leaf of a dicotyledonous plant not yet identified. The plants are evidently all of the same species as are still found growing in Spain. The author attributes this deposit of ironstone to the decomposition, partly by organic agency, of ferruginous salts, derived from the oxidation of iron pyrites, which flowed into a marsh or shallow lagoon. Subsequently to this the valleys of the Rio Agrio and Rio Tinto were eroded, leaving the Mésa de los Pinos with its thick capping of iron ore.—Notes on the locality of some fossils found in the Carboniferous rocks at T'ang Shan, situated, in a north-north-east direction, about 120 miles from Tientsin, in the province of Chih Li, China, by James W. Carrall, F.G.S., with a note by Wm. Carruthers, F.R.S. The author described the locality from which he obtained some plant-remains of apparently Carboniferous age, and stated that mining operations had been carried on by a Chinese company in the district since the year 1878. Several seams of coal occur, varying in thickness from 11 inches to 6 feet. Mr. Carruthers stated in a note that the specimens submitted to him belong to a species of *Annularia*, probably *A. longifolia*, Brough, abundant in the British coal-measures, and found both on the Continent and in North America.

Paris

Academy of Sciences, November 8.—M. Edm. Becquerel in the chair.—The following papers were read:—On the heat of formation of dimethyl, and on its relation with the methylic and ethylic series, by M. Berthelot.—Researches on the Upper Cretaceous of the northern slope of the Pyrenees, by M. Hébert.—Observations on phylloxera, by M. Henneguy. From over three years' observations he is quite convinced that vines not attacked may be saved, and those which have not suffered too much be restored. Vine-growers have three efficacious modes of treatment: sulphocarbonates, sulphide of carbon, and submersion. But the treatment must be repeated each year (at least for a time), and must extend over the whole vineyard. To destroy the winter egg in the bark, decortication and treatment with sulphide of carbons has proved good; also application of flame to the stock with a "pyrophore" (the latter is more effectual than application of boiling water, also easier and more economical). The spontaneous recovery of seemingly dead vines is only temporary; new roots form after abundant rain, and supply sap for fresh shoots. If the insects (which persist) be destroyed before they reach these roots, the vine may quite recover.—Observations on the influence of last season on the development of phylloxera; on insecticides, by M. Boiteau. August and September were so rainy as to be very unfavourable to the insect. Most of the vines that still exist will be saved. Sulphide of carbon is largely used by all kinds of proprietors. Among other directions as to its use, he says, the quantity per square metre should be 15 to 20 gr.—Preparation of a new alimentary substance, *nutricine*, by M. Moride. Raw meat, freed from bones and tendons, is passed into suitable machines with nitrogenised alimentary substances (bread, *e.g.*), which absorb its water, and form perhaps organic combinations with it. The whole is dried in air or a mild stove, then pulverised and sifted. The powder got is grey or yellowish, and has an agreeable taste. With albumen, fats, or gummed water, solid cakes or cubes may be made of it, to be afterwards divided for soups, sauces, &c. The substance is very nutritive, and keeps indefinitely if not exposed to moisture or too great heat.—The Secretary stated that a great many applications had been made for seeds of the vines of Soudan. M. Lécard has published a *brochure* on this vine, and is collecting all the seeds he can to send home.—On algebraic equations; examination of the propositions of Abel, by M. West.—Researches on the transformation of oxygen into ozone by the electric *effluve* in presence of a foreign gas, by MM. Hautefeuille and Chappuis. Even a very little chlorine hinders the transformation, and when introduced destroys ozone previously formed. Nitrogen occasions a larger transformation than if the oxygen were unmixed, and had the same pressure as in the mixture. The formation of ozone in presence of hydrogen is greater than in that of nitrogen. With fluoride of silicium a large proportion of ozone is formed (the *effluve* becoming a luminous rain of fire). The authors theorise on these results.—Action of chlorine and hydrochloric acid on chloride of lead, by M. Ditte.—On the combinations of ammonia gas with chloride and iodide of palladium, by M. Isambert. The tensions of dissociation are weaker at the same temperature the greater the heat of combination.—On the formation of chloroform by alcohol and chloride of lime; equation of the reaction and cause of the liberation of oxygen manifested, by M. Béchamp. *En résumé*, the chloroform is produced without liberation of gas; the swelling is due exclusively to the chloroform, which is in a medium the temperature of which is higher than its boiling point, and to the tension of its vapour; the gaseous liberation only commences when it has completely distilled, and the temperature rises so as to reach that which is necessary to make the mixture of chloride of lime and water boil.—On the organisation and the development of the Gordians, by M. Villot.—M. de Treux described a bolide observed at Amiens on November 2, at 4.58 p.m. Its diameter seemed about a sixth of that of the moon. Visible 10 to 15 sec. the bolide was successively blue, yellow, and red; bright sparks being given out at each change of colour.—A geological map of Spain, by M. de Botella, was presented.

Vienna

Imperial Academy of Sciences, November 4.—On the theory of so-called electric expansion or electrostriction, by L. Boltzmann.—Measurements of co-vibration for the case of strong deadening, by C. Laske.—On cells and intermediate substances, by S. Stricker.—The psychic activity of the coating of the brain, considered from a physiological standpoint, by L. Schneeder.—Description and sketch of a steerable balloon, by W. Bosse.—On mesitylendisulpho-acid, by J. Barth and T. Herzig.—On the absorption of solar radiation by the carbonic acid of our atmosphere, by E. Lecher.—On some properties of the capillary electrometer, by J. Hepperger.

November 11.—On the Tsubra deer (*Cervus Lüdorffii*, Bohlan), by L. T. Fitzinger.—On the question as to the nature of galvanic polarisation, by F. Exner.—On the latent heat of vapours, by C. Puschl.—Theory of acceleration-curves, by F. Wittenbauer.—On derivatives of cinchonin acid and of chinolin, by H. Weidel and A. Cobenzel.—On croton-aldehyde and its derivatives, by A. Lieben and T. Yeisel.—On reduction of croton chloral, by the same.

CONTENTS