THURSDAY, FEBRUARY 26, 1874

THE ROTHAMSTED AGRICULTURAL INVESTIGATIONS

IT has become a trite remark, that while both the progress and teaching of Science are fostered in most educated countries by the care of the State, they mainly depend in our own country on the exertions of private individuals; this fact is perhaps, however, more strikingly seen in the case of agriculture than in any other instance. The traveller in Germany will find scattered over the country, some forty Experimental Stations and Agricultural Academies, establishments which are devoted to the investigation and teaching of scientific agriculture and are maintained by their respective States. The German farmer has thus the means of becoming acquainted with the true science of his business, and provision is at the same time made for the investigation of the various problems with which his work abounds. In England the state of things is, alas, wholly different. We have just one college—that at Cirencester, devoted to the teaching of scientific agriculture, and one Experimental Station—that at Rothamsted. There is indeed some experimental work done by local Farmers' Clubs, but this is generally only with the object of comparing the effects of the various manures that are in the market, and with no scientific aim or result. Yet England pre-eminently needs the help of Science to direct economically her vast system of agriculture. The art of agriculture is here in a higher state of development than on the continent. More capital is here invested in the land; more attention has been paid to tillage, to artificial manures, and to the breeding and feeding of stock. The British farmer succeeds because he is a practical man, and has good common sense, and the enterprising spirit of his race; what might he not do if he thoroughly understood the principles which underlie his art?

If we have but one agricultural station in England we have at least reason to be proud of it. The work done at Mr. Lawes' estate at Rothamsted is not to be equalled by that of any of the foreign stations; indeed, in several departments of investigation it might safely challenge a comparison with their united efforts. This excellence has arisen from the systematic and thorough manner in which the subjects taken up have been treated. We cannot better illustrate this than by referring to the last contribution from Rothamsted, a report by Messrs. Lawes and Gilbert on the growth of barley.*

In one of the experimental fields barley has been grown for twenty years, and the experiment is still progressing. The field is divided into plots of about one-fifth of an acre; some of these have never received any manure during the twenty years; the others receive some one or more of the food constituents which barley requires. Thus one is manured with phosphates, a second with alkalies, a third with ammonia, a fourth with ammonia and phosphates, a fifth with ammonia, phosphates, and alkalies, &c. The same manures are always applied each year to the same plot. At harvest the crops are carefully weighed, and are then analysed in the laboratory under the superintendence of Dr. Gilbert, the amount of dry matter, ash, and nitrogen being determined. The advantages of this systematic mode of experimenting are very great. Carried on in the same manner for so many years, these experiments answer questions relating to the exhaustion of soil, to the permanent effect of manures, to the effect of season upon the produce. With the aid of the laboratory investigations they teach us what proportion of the various ingredients supplied in the manure is recovered in the crop, and how the composition of the plant is affected by the various conditions of the soil. In conjunction with analyses of the soil and of the drainage water, we learn what becomes of the manures applied, how deeply they have penetrated into the soil, what is the loss suffered through drainage, &c. A single field experiment thus thoroughly and patiently carried out touches half the domain of agricultural chemistry, and supplies information of the most solid and valuable kind.

The value of every trustworthy investigation is increased as others are completed which compare with it; the work at Rothamsted thus derives an additional value from its extent. During the last thirty years Messrs. Lawes and Gilbert have investigated in the manner described all the principal farm crops, experimenting both on each singly, and also on their behaviour when grown in rotation. As the results are gradually published, and we are able to compare the behaviour of different crops grown on the same soil, with the same manures, and in the same seasons, the special characteristics of each crop become plainly shown by contrast with its fellows, and we gradually learn the part which each is fitted to play in a scientific system of agriculture.

Nitrogenous manures are of primary importance if luxuriant cereal crops are to be raised, the natural supply of combined nitrogen from the atmosphere being very small, and the crops in question having little power for assimilating the forms of nitrogen chiefly present in the soil. Nitrogenous manures are, moreover, as every farmer knows, very expensive, and it is a matter of great importance to employ them in the most economical manner. Messrs. Lawes and Gilbert, knowing the composition of the manure that has gone on to their fields, and the composition of the crops that have been carted off, can tell exactly what proportion of the nitrogen applied has been assimilated by the plant. They find, on an average of twenty years, that wheat assimilates about 45 per cent. of the nitrogen in a spring dressing of nitrate of sodium, and about 33 per cent. in the case of an autumn dressing of sulphate of ammonium, and only 14½ per cent. of the nitrogen supplied by farm-yard manure. With barley, the proportion assimilated is rather greater, being 49 per cent. for a spring dressing of ammonium salts. The question as to what becomes of the large proportion of unused nitrogen is clearly of the highest importance. Analyses of the soils, and of the drainage water, throw much light on the subject. The soils of the wheat field have been analysed down to a depth of 27 inches. A considerable part of the missing nitrogen is found to be actually present in the soil, but since it has scarcely any effect on the crops, it is apparently in some state of combination unsuitable for the plant's use. A still larger portion of the nitro-

* "Report of Experiments on the Growth of Barley for twenty years in succession on the same land," by J. B. Lawes, F.R.S., F.C.S., and J. H. Gilbert, Ph.D., F.R.S., F.C.S.—*Journal of the Royal Agricultural Society*, 1873, 89 and 275.

gen is, however, not to be found in the soil, but the examination of the drainage waters from the different plots exhibits so large a content of nitrates, that calculation leads to the belief that in the case of ammonium salts and nitrate of sodium the loss of nitrogen chiefly takes place in this manner. Chemists knowing that ammonia is readily absorbed and firmly held by soil, had never anticipated that so considerable a loss might occur by drainage. It plainly appears, however, from these results, that ammonia when applied to the soil is quickly converted into nitric acid, and in heavy rains may be easily washed out. During autumn and winter there is little evaporation from the soil, and no consumption of water by a growing crop; as soon therefore as the surface soil is saturated most of the subsequent rain-fall will pass into the subsoil, or find its exit through the drains. The authors calculate that if the drainage water contains 1 part of nitrogen in 100,000, and many of the waters analysed were much richer, there will be a loss of 2·26ths of nitrogen (equal to about 23 lbs. of guano) for every inch of rain that passes beyond the reach of the roots. It is evident, among other conclusions from these important facts, that ammonia should only be applied to the land in the spring, when the crop is able to make immediate use of it. It may also be found that on gravelly and sandy soils, which have little power of holding water, organic forms of nitrogen, as rape cake and farm-yard manure, may be more certain in their effects than ammonia or nitrates. The organic manures being only slowly rendered soluble in the soil, can suffer comparatively little loss from sudden rain. The subject of the economic application of nitrogen is being further investigated at Rothamsted.

We have no space to do more than allude to the researches which have been conducted at Rothamsted in the department of animal chemistry: the experiments on the fattening of stock, and on the composition of the carcase produced, have been equally important in their results with those field experiments we have referred to. Of the indebtedness of Science to Mr. Lawes' unique and costly experiments we need not speak, the facts are so plain that they speak for themselves. Nor need we state the moral. The addition to the national wealth which has accrued from the discoveries made by Mr. Lawes is already enormous. It must be borne in mind that this benefit has arisen from *accidental* researches, for Mr. Lawes was not compelled to take them up, nor is he bound to continue them. Now if such work is not national work, The Royal Observatory ought to be shut up to-morrow, for the work done there is not one jot or tittle more important.

DR. LIVINGSTONE

THE telegram, dated at Aden on the 23rd of this month, announces that Lieut. Murphy is bringing the body of Dr. Livingstone down to Zanzibar, while Lieut. Cameron has passed onwards to Ujiji to recover Dr. Livingstone's papers and to continue his work. The story of those faithful negroes having carried the body of their beloved chief over hundreds of miles is one of the most romantic in history, and is a fitting close to the noble life of the great explorer. Dean Stanley, we are informed, has proposed that the remains of Livingstone shall find a last resting-place in Westminster Abbey. Yesterday (the 25th) was the last day on which instructions could be sent out by telegram touching the disposal of the body. We cannot believe that the necessary orders have not been despatched; for the wishes of the country are well known, and have been sufficiently expressed. With the body will arrive all Livingstone's faithful followers, who were engaged on the understanding that they were to receive a certain fixed monthly payment. There were Chumah and the two or three other men who had been with him since 1865. There were Jacob Wainwright and the other Nassick boys, and the men sent up to Unyanyembe in the summer of 1872; and there were the men engaged in the interior by Dr. Livingstone himself. A sum of about 1,000*l.* will be required to pay off these loyal and faithful servants of Her Majesty's Consul. Yesterday was the last day on which an order for the payment could be sent out. Has this been done? The people of England have a right to an answer, and an immediate answer, for if the Government hesitates, the country will never allow this disgrace to come upon it.

As soon as the full details arrive by the next mail, it will be fitting that we should give our readers a memoir of the illustrious martyr to Science who has passed away. But now we desire to know—and all England will join with us in the inquiry—whether orders were sent out by telegram on the 25th, respecting the disposal of Dr. Livingstone's body, and the payment of his followers, the devoted servants of Her Majesty's Consul?

Lieut. Cameron, in conducting the search expedition, has suffered terribly from fever and ophthalmia, and has been obliged to incur heavy expenses. But he has displayed the best qualities of an explorer. He is a good manager of natives, an excellent walker, an accurate astronomical observer, a linguist, and a man of indomitable perseverance. He is now pressing forward on a perilous and important duty, and we trust he will carry with him the generous sympathy of the Geographical Society, and of the public generally.

POST-TERTIARY GEOLOGY

The Great Ice-Age and its relation to the Antiquity of Man. By James Geikie. (W. Isbister and Co. 1874.)

I.

EVERY field-geologist, who works in northern latitudes, soon comes to know what is meant by Drift. In his attempts to trace the superposition and run across the country of the solid rocks, he is always sooner or later brought up by coming across masses of stony clay, gravel, and sand, which bury them to greater or less depths, and more or less completely hide them from view. These superficial accumulations lie indifferently on all members of the bedded formations; they occur now in detached patches, and now spread like a pall over vast tracts of country.

In the latter case it is clear that they would soon make their presence felt by the way in which they effectually mask the geological structure of the ground they cover; it was impossible, therefore, that they could be for long ignored altogether, but they seem for a time to have been looked upon as something very inferior in interest and importance to the older and more regular formations, in some cases, perhaps, as little more than troublesome hindrances to the making of a good geological map. Thus it came about that deposits of this class were lumped together under the comprehensive title of Diluvium or Northern Drift: and that, in the few cases where any geologist thought them worthy of more than a simple recognition, the explanations offered of their origin were crude and unsatisfactory. Some of these explanations we may just glance at. In the days when evolution and continuity were doctrines yet undreamed of, it was imagined that between any two consecutive geological epochs there intervened a period of chaotic turmoil, one result of which was, that a clean sweep was made of the life of the epoch that had just closed, and the ground prepared for the introduction of the life of that which was to follow. Supposing this to have been the general course of past events, some referred diluvial accumulations to the series of convulsions which came in like a great gulf between the age of man and the last of geological eras. It could not be reasonably objected to such an hypothesis that it called to its aid agencies the like of which we had never seen, and the like of which, as far as our knowledge of the economy of nature went, it was most improbable had ever been in operation; there was the ready answer, that during periods which were essentially abnormal, anything was possible. This made such explanations easy to frame and easy to uphold, and they commended themselves readily to the indolence of mind and impatience of accurate thought from which few of us are altogether free. The same may be said of the notion suggested by, but we cannot say based upon, the phenomena of the great ocean wave of earthquakes, "that somehow and somewhere in the far north a series of gigantic waves was mysteriously propagated," which "were supposed to have precipitated themselves madly on over mountain and valley alike, carrying along with them a mighty burden of rocks, stones, and rubbish," and that by this means the piles of diluvium had been heaped up. Again, the name diluvium was founded on the idea that its deposits were the relics of Noah's flood; and the notion that we had in them a proof of the accuracy of the Biblical record was so very welcome, that it was accepted and stuck to in spite of the absence of evidence in its favour, and so contributed, perhaps as much as anything else, to postpone the true solution of the problem.

But by degrees light began to dawn on the subject. Playfair had attempted to turn the attention of geologists to the proper quarter, when he suggested that the most powerful agents which Nature employs for the moving of rocks are the glaciers; but his hint lay for a while unheeded. In 1837, Agassiz arrived at the conclusion that the glaciers of the Alps had been formerly far larger than at present. He had studied the smoothed and furrowed surfaces which occur everywhere below glaciers, and had found that the rocks displayed markings exactly identical with these far beyond the range of the present ice. He explained his views to Buckland, who then saw the meaning of certain surface features which he had observed, but had not previously understood, in the British Islands. The two geologists visited Scotland together in 1840; found over the length and breadth of the land scorings and polishings which ice—and, as far as their knowledge went, nothing but ice—could have made, and came to the conclusion that the whole country had been once swathed in one widespread ice-covering. About the same time Sir Charles Lyell attributed the formation of portions of the Scotch drift to the action of land-ice.

The right clue was now found, and it only remained for others to follow it up. A great step was made by Prof. Ramsay when, some ten years later, he deciphered the story written on the Drift-beds of North Wales, and determined the broad succession of physical changes that had led to their formation. He pointed out that there had been two periods of cold, the first of intense severity, and the second less rigorous, and that between the two there came a milder interval, during which depression brought the sea up the flanks of the mountains to a height of 2,300 feet above its present level.

Still however the importance of the Drift was far from being fully recognised. For many years no notice whatever was taken of it on the maps of the Government Survey; and when at last it met with a tardy recognition, Drift was still for a while Drift "and it was nothing more," a something agriculturally important and therefore not to be passed over by the economic geologist, but hardly a great formation with a story to tell as long, as varied, and as interesting, as any that geology had hitherto revealed to us. It is significant that even so eminent a pioneer as Prof. Ramsay did not deem these deposits worthy of more than incidental notice in his otherwise exhaustive Memoir on the Geology of North Wales. The Drift in fact was somewhat on the position of a *nouveau riche*, who is trying to work his way into "society," and it had up-hill work before it was admitted into the exclusive circle of the old respectable formations.

But its turn came at last, and amid the band of geologists, who have helped in the work of securing for it the attention to which it is fairly entitled, the brothers Geikie occupy prominent places. The one gave us in 1863 his paper on the phenomena of the Glacial Drift of Scotland, in which he offered a masterly summary of all that was known on the subject up to the date of its publication, and settled for ever the claim of land-ice against ice-bergs to have been the agent that formed the Scotch Till; and now the other comes before us with the goodly volume, whose title stands at the head of this article, and which can be cordially recommended both to the geologist and the general reader. Its account of the labours and conclusions of previous workers is all but exhaustive, but it is far more than a mere *résumé*; a long practical acquaintance with Drift-deposits has enabled the author to add materially to our knowledge of the course of events that accompanied their formation, and in some cases has led him to demur to views hitherto all but universally accepted; and his own contributions and criticisms are as remarkable for the boldness of their originality as for the soundness of the reasoning by which they are upheld. At the same time the explanations are so full, and the method of handling so free from technicality, that with a moderate amount of attention the book may be understood, and its reasoning followed, by those who had previously little or no geological knowledge.

A large part of the work is taken up by a careful and detailed description of the Drift-beds of Scotland, which country the author has chosen as a typical area. A better selection could not have been made, for in no country perhaps are these deposits so largely developed, and nowhere have they been so elaborately worked out as by the distinguished band of geologists who have made Scotch glacial formations a special study.

The first seven chapters are devoted to a description of the Till, the lowest member of the Scotch Drift; and an explanation of the line of reasoning that has led geologists to acquiesce almost unanimously in the opinion that it was formed on land beneath a sheet of ice, which, during a period of intense cold, overspread the whole country, and pushed its way far out over the shallow bed of the surrounding sea.

So far the author has only been repeating and enforcing the conclusions of his predecessors, but in chaps. 11—14 he enters on ground which is all but his own. It has been long known that layers of well-bedded sand and gravel occur in the heart of the Till, and between it and the older rocks. These deposits however are local and of small extent, or had been detected only in borings or underground workings, and had had comparatively little attention paid to them. Mr. J. Geikie has for the first time pointed out that in spite of their small development they are full of meaning; and that, when this meaning is realised, the fragmentary nature of their occurrence is only what is to be expected, and that the wonder is, not that there is so little of them left, but that any of them should have survived to tell the tale which he has so ably extracted from them. And the story they tell us is this. They are evidently the products of running water, alluvial or lacustrine deposits mostly; now former observers had realised in a vague sort of way that they were a proof of changes of climate, which permitted water to flow over what had been before an ice-bound waste, but we have now clearly brought before us that the abatements of the intense cold, which these beds indicate, were not local and temporary, but wide-spread and of long duration, and that they recurred several times during the period of the first great glaciation. Thus we are led to see that the first subdivision of the great ice-age was not one dreary unbroken lapse of Polar winter, but that it included mild intervals, when the ice shrank back, possibly disappeared altogether, when vegetation reappeared, and when herds of the great mammals returned from the southern retreats into which they had been driven during the most intense phases of the cold. And these facts enable us to realise more vividly the immense lapse of time represented by one division alone of the Glacial Formation. For if "we consider that the succession of changes happened not once only, but again and again, we cannot fail to have some faint appreciation of the lapse of time required for the accumulation of the Till and the Interglacial Deposits." Lastly Mr. Geikie has pointed out that these alternations of intense glaciation and comparative mildness are fully in accordance with the theory so ably expounded by Mr. Croll, that changes in climate are due to the combined effect of the Precession of the Equinoxes and variation in the eccentricity of the earth's orbit, a theory which he has lucidly expounded in chaps. 8—10.

We next come to certain deposits, the meaning of which seems first to have been clearly read by the author of the present work. At last the conditions which gave rise to the Till began to pass away and the climate to improve slowly, and the great glaciers ceased to be confluent; a depression of the land ensued so that the sea followed the retreating margin of the ice; but after a while, perhaps owing to an upward movement, the glaciers terminated on dry land. Mountain peaks now began to rise above the ice, and showered down on to its surface loads of *débris* torn from their exposed faces by frost. As the burden was shot over the ends of the glaciers, it gave rise to huge heaps of morainic rubbish, which at first fell into the sea, and afterwards, as the ice drew back, was shed upon the land. In this way were formed the subdivisions of the glacial formation which the author has distinguished as Boulder Clay and Morainic Rubbish. During this period the author believes that many of the erratic blocks, which form so conspicuous a feature among glacial deposits, were stranded from the ice-sheet as it drew back; and he gives good reasons for preferring this explanation to the older notion, which supposed these travellers to have been dropped from ice-bergs during the submergence which came a little later on.

As the climate gradually improved, the melting of the ice swelled the rivers and gave rise to mighty floods, which thundered down the narrow mountain glens, sweeping before them portions of the Till and Morainic rubbish, and, when they emerged on the open valleys of the lowlands, spread out the worn and rounded materials in broad sheets of gravel. One point here we must pause specially to call attention to. Geologists had long been aware of the disappearance of the great ice-sheet and of a gradual submergence of the land which followed it, but we now learn that the first of these events had made considerable progress, perhaps had been completed, before the second had fairly set in.

The first act of the drama we are looking at may be said to close here; the second opens with the commencement of the submergence just mentioned. The land began to sink and went down till the sea reached to some 1,200 feet, perhaps in some cases to nearly double that amount, above its present level; and as each of the previously formed Drifts, Till, Boulder Clay, Morainic Rubbish, and Gravel, was brought under the action of the waves, they sifted and sorted it, washing out the fine dirt, and rounding and reducing in size the pebbles; and in many cases the clean gravel and sand so formed were piled up along each successive coast line in mounds and long ridges, which still retain the distinctive outline originally impressed on them by wave- and tidal-action. These hummocky piles and ridges are known as Kames or Eskers. That many Kames owe their present shape in the main to the direct action of the sea alone there can scarcely be a doubt; we find them sometimes for instance enclosing hollows *without any outlet*, a little tarn or peat moss occupying in some cases the central depression, and in such a case they must have been piled up by shifting currents, for in no other way could the closed basin in the middle have been produced. But many so-called Kames are only the remnants of large sheets of gravel, the greater parts of which have been carried away by denudation. It would be better perhaps to restrict the term to those mounds which were piled up originally very much as they stand now. Even with this limitation, however, Kames are plentiful enough, and they are found in greatest abundance at the spots where the currents tending to their formation must have prevailed as the land went down; in cols, then straits connecting opposite firths from which tides would flow in on either side; at the openings of mountain valleys, where the stream with its gravel burden was then met by the incoming tide; on low plateaus lying between what were then estuaries, over which opposing currents would sweep each high tide; and in other similar situations.

But were the Kames formed as the land sunk, or during its subsequent emergence? One would be inclined to say during the latter period, for any heaps piled up by the incoming sea would be liable to be swept away when they again became exposed to wave-action as the sea retreated. Nevertheless, Mr. Geikie—and he is supported by other observers in his opinion—holds that it was during the period of depression that kame-building went on, for the following reasons. The material of the Kames is, for the most part, fine and well rounded, and it is a very rare thing to find a large angular boulder in the heart of a Kame; hence it is believed that during the formation of the Kames the climate had so far mended that glaciers no longer existed, and that therefore there were no icebergs to strew the sea-bottom with travelled blocks. Erratics are, however, common perched on the outside of the Kames, and hence it is concluded that at some point in the period of the submergence cold again began to come on, that glaciers reappeared and gave rise to icebergs which bore away these blocks and dropped them where they are now found. That there was a return to cold conditions we know from other evidence, and with the exception of the difficulty just mentioned, which after all is not very serious, for the Kames we have may be only the relics of a body originally much more numerous, the explanation accords well enough with our knowledge of the facts. But the thought crosses the mind that it is not very often that we have an opportunity of seeing into a Kame, or rather, that we see the outside much oftener than the inside, and that this possibly may be the reason why erratics seem to be more plentiful in the one place than the other.

A. H. GREEN

(*To be continued.*)

OUR BOOK SHELF

Mineralogische Mittheilungen, 4th Heft. (Vienna, 1873.)

THE present number of the *Mineralogische Mittheilungen* forms the 4th volume of the series, commenced in 1870. It is published under the auspices of the K. K. Geol. Reichsanstalt, and in connection with their quarterly Jahrbuch, but forms properly in itself an independent journal. It is probably the only periodical devoted exclusively to mineralogy, and thus already occupies an important place among German scientific serials. The list of papers which appear in this number will give a good idea of the position which the journal occupies:—Mineralogical observations in the Argentine Republic, by H. Stelzner (embracing—minerals occurring in the granite quartz masses of Cordoba; minerals associated with the granular limestone; also analyses and special description of Triplite, Jamesonite, Enargite, Linarite, &c.); eruptive rocks of Banat, Hungary, by Niedzwiedzki; crystallised magnesite from the Northern Alps, by J. Rumpf; mineral observations from the Bohemian Forest, by Helmhacker; brief notices of various minerals, Grunochite, an optically uni-axial diamond, native copper, Roselite, &c. The number opens with a short obituary notice of Naumann.

The Mittheilungen are under the charge of Prof. Tschermak, so well known through the scientific world for his many and valuable contributions to mineralogy and lithology.

Prof. Tschermak occupies the position of Director of the Royal Mineralogical Museum of Vienna, a collection which in beauty and completeness is not inferior to that of the British Museum, while it surpasses the latter in the arrangement of the objects exhibited, especially in reference to the good of the general public. The Museum has been much enriched within the last four months by the acquisition of a number of interesting things from the Vienna Exposition. The collections are opened two mornings in the week, for the benefit of the public, opportunities which are well made use of, while the Cabinet is accessible on every week-day to those who are there engaged in regular work. The results accomplished in the Mineralogical School thus formed in connection with Prof. Tschermak and Dr. Schrauf do a considerable part toward supporting the *Mineralogische Mittheilungen.*

The Geological Reichsanstalt, now under the direction of Franz Ritter von Hauer, has carried on its work for twenty-seven years. The results are not only of the greatest importance in developing the resources of the Empire itself, but, as the work engages the best talent, and is consequently carried on according to the highest standard of pure science, the yearly labours are adding vastly to the fund of geological knowledge, and helping to solve many of the difficult problems of the science. The building occupied by the Reichsanstalt contains the various working-rooms, and the extensive collections, complete naturally in all matters pertaining to Austrian Zoology. The immediate results of the survey are first made known in the Evening Sessions, which are held on the first and third Tuesday of each month from November to May. They are attended regularly by some thirty or forty of those interested in such subjects, and form a pleasant opportunity for those of common interests to meet together informally. The stranger is continually impressed with the active spirit, and especially with the community of feeling, among the scientific men of Vienna; the latter has undoubtedy great influence in giving the city the prominent position which it occupies among the different scientific centres.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Zoological Nomenclature

FROM time to time an idea is started that Zoology is breaking down under the weight of its synonymy. With entomologists I have frequently contended that so far from this being the case, there is, on the contrary, an almost marvellous agreement in the generic and specific names used, especially when we consider the extent of the bibliography and the vast number of the species. After reading in NATURE, vol. ix. p. 258, Mr. Wallace's review of Dr. Sharp's pamphlet, I bethought myself of comparing the two best known catalogues of European Coleoptera, viz., Schaum's, published at Berlin, in 1862, and De Marseul's, at Paris, in 1866. Perhaps the results of the examination of the first six families in the two works will suffice. It must be premised that Schaum's is strictly confined to European species, while De Marseul's embraces as well those of the "basin of the Mediterranean in Asia and Africa." As to the genera, in the Cicindelidæ there are two in each. In the Carabidæ, Schaum has 98 genera and de Marseul 118; of the latter four are not adopted by Schaum and the remainder are extra-European. In the Dytiscidæ Schaum has 15 genera, De Marseul 17. In the Gyrinidæ there are two genera in Schaum, and three in De Marseul, the third being extra-European. Hydrophilidæ not having the same limitation in the two works, I take the Palpicorn families in which that group and the Sphæridiidæ are included. There are 22 genera in each catalogue, but Schaum and De Marseul each ignore a genus adopted by the other, and a third name, Cyllidium, is preferred by the French author to the earlier one of Chætarthria. As to the species, seeing that Schaum has about 1,580 in the families mentioned above, and De Marseul 2,640, it would not be easy to compare them in a definite form; but taking Cicindela, the second genus of the two catalogues, the first having only one species, which is, I conceive, a fair example of the others, if indeed it has not had more than its share of varieties elevated to the rank of species, we find the 26 species in Schaum identical in names with the same species in De Marseul, except two varieties or species, and a synonym given with a ? by Schaum, which is the right name according to De Marseul.

I would venture to suggest that the synonyms which look so formidable to some of our friends, are principally due to the writers of local faunas, or in some cases to specialists, and that such names have, as a rule, never been adopted, and practically offer no hindrance whatever to the naturalist. A species may be described by an author who is ignorant that it has been previously described, but this is an evil which it is sometimes impossible to avoid, as in the case of almost simultaneous publication; but in due time the later name is relegated to the list of synonyms and gives little further trouble. It does not seem to me that any change or additions to the present rules of nomenclature are needed. Naturalists very soon decide on the relative value of names, but always with due regard to the law of priority; it is a misfortune, perhaps, that this law is sometimes pushed too far, as in the case either of forgotten authors, or of doubtful descriptions. The alteration of trivial names from two authors using the same word is a case of very rare occurrence.

FRANCIS P. PASCOE

The so-called "Meteor-cloud" of Feb. 5

YOUR correspondent, Captain S. P. Oliver, appears to have been mistaken as to the character of the phenomenon seen by him on February 5, and noticed in NATURE (vol. ix. p. 313). At the hour he has indicated, the somewhat rare phenomenon an auroral arch was formed, which remained visible for about half an hour, and is doubtless the luminous "meteor cloud" seen by him. The description Captain Oliver has given of it is sufficiently accurate, though he does not mention that it drifted slowly southward, a well-known characteristic of the phenomenon. Its direction was of course at right angles to the magnetic meridian, and its position in the heavens, as seen from this locality, was more northward than that observed by your correspondent. During the whole time that I observed it, the arch crossed some portion of the constellation Ursa Major, the star δ Ursæ Majoris being in its midst when first seen, and the entire arch having retreated southward as far as ζ Ursæ Majoris before it disappeared. It was of uniform breadth and intensity, and spanned the sky from west to east (magnetic), passing not much to the north of the zenith. Although I have been fortunate enough to have seen auroral arches upon several occasions, and once succeeded in obtaining the spectrum, I have never seen a brighter or more complete arch than this one; but what made it quite unique, at least as far as my experience goes, was the fact that the ordinary aurora with a well-defined "dark segment" was visible in the north-north-west at the same time, from which, at an earlier period, brilliant streamers had proceeded. There were therefore two parallel arches of light at an interval of perhaps 50° from one another, which the slow movement of the upper one gradually increased. The night was remarkably clear, and the zodiacal light had been plainly visible earlier in the evening.

JOHN J. PLUMMER

The Observatory, Durham, Feb. 21

Aboriginal Australian Artists

I NOTICED, in one of your latest papers, that some of your readers doubted the ability of Australian, or other low savages, to sketch in the manner of the Vezère people, and I made a copy of a few sketches still found in this neighbourhood engraved on rocks. They consist chiefly of fishes, whales, birds, and a few men; the execution is not so good as when the figures are scratched on blackened bark. I also send you a photograph of a carving in fossil coral from New Guinea. H.M.S. *Basilisk* has not long ago returned from New Guinea, and brought some splendid weapons, &c.; also one of the Papuan pigs, which they brought for our collection. It is the most intelligent pig I have ever seen, follows me like a dog, and goes up to the very top of the Museum building, which is about 80 feet high.

I noticed the, to me, wonderful remark about a scarcity of skeletons of large carnivora in European museums, and I am glad to say that we possess two tigers, two lions, wolf, hyæna, three grey seals, two large sperm whales, 70 and 35 feet in length, many small birds, dugongs, &c. &c. The sum total of our skeletons, all mounted, is more than 150; with few exceptions all articulated on the premises by one man, who has never been out of Sydney in his life. If our Government grant some extra money for cabinets, I think we shall be able to astonish the people on board the *Challenger* when they come here, because half our Australian fossils and minerals cannot be exhibited for want of the necessary cases.

GERARD KREFFT

P.S. The trustees have had so many applications for *Ceratodus* specimens, and they have been so often disappointed when exchanging them with other museums, that they have now determined to sell their duplicates in London to the highest bidders. Five of these fishes, in spirits (males and females) will be despatched to Messrs. P. W. Flower and Sons, and I hope that a good price will be obtained for them. Up to the present time all efforts to obtain more of the *Ceratodus* have been in vain, and I believe that they are not so common as some people think. Mr. George Masters has too much to do here; and besides, we have no funds, travelling being very expensive in the Wide Bay district, otherwise another Expedition would be sent by the Board. Mr. Masters knows *how* to catch them, and I hope that when the *Challenger* arrives he will be able to accompany a party from that ship to Gayndah.

Rainbow and its Reflexion

A FEW weeks ago I had the pleasure of seeing a rainbow and its reflexion, or at least a reflexion of one from the same shower at the same time, in smooth water.

The base of the bow in the cloud seemed but a few hundred yards from me, and the reflexion evidently did not belong to it, as the two bases did not correspond, the reflected bow lying inside the other, the red of the one commencing where the violet rays of the other disappeared.

Balbriggan, Ireland, Feb. 2 GEORGE DAWSON

Remarkable Fossils

THE letter by Mr. T. W. Cowan in NATURE, vol. ix. p. 241, confirms the truth of the statements contained in my "Appeal to our Provincial Scientific Societies" which appeared in NATURE, vol. ix. p. 162. Collections of the kind described by Mr. Cowan are "kicking" about the country in all directions, valued merely as temporary possessions by the owners, few of whom, as far as my experience goes, appear to possess sufficient public spirit or intelligence to realise their public and scientific importance; otherwise these collections would be more frequently localised and preserved for the district museum.

Jan. 31 S. G. P.

Volcanoes and the Earth's Crust

MR. HOWORTH, in NATURE, vol. ix. p. 201, advances the following opinions:—That volcanoes are found neither in regions of elevation nor of subsidence, but on the boundaries between them; that the great continents are on the whole rising, and the beds of the great oceans on the whole sinking; and that the centres of elevation are in the circumpolar regions.

It seems to me that the last two statements cannot be reconciled with each other. The southern hemisphere is for by far the greater part oceanic. According to Mr. Howorth, the ocean-beds are subsiding, and yet the southern circumpolar region contains a focus of elevation. Further: if volcanoes are not found in areas of elevation, and if the circumpolar regions are regions of elevation, what does he make of the volcanoes of Jan Mayen (between Norway and Spitzbergen), and of the Antarctic continent?

Were there any such laws of elevation and subsidence as Mr. Howorth maintains, the respective regions of elevation and of subsidence would have continued the same since the consolidation of the earth: but this is contradicted by the commonest facts of stratification, which show that elevation and subsidence have everywhere alternated with each other.

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, co. Antrim

The Use of Terms in Cryptogamic Botany

As no specialist in Algology has replied to the inquiry of your correspondent "D. R.," in NATURE for January 15, I may be permitted to quote for his information the following from the article "Nucleus," in the "Treasury of Botany" from the pen of the author of the "Introduction to Cryptogamic Botany":—"In Algæ the term is applied to the fructifying mass of the Rhodosperms, whether contained in a single cell or in a compound cyst or conceptacle, the word *nucleoli* being used when there is a group of nuclei." The instance alluded to by your correspondent is, unfortunately, not the only one in which the terminology of cryptogams is in a state of most perplexing confusion.

ALFRED W. BENNETT

A Lecture Experiment

THE condensation of liquid in the form of vapour into minute globules, and the production of a shower of rain, may be very well illustrated for class purposes in the following manner:—

Place about an ounce of Canada balsam in a Florence flask, and let it boil. At the top of the flask clouds of globules of turpentine will be seen hovering about, altering in shape very much like sky-clouds, and the globules are large enough to be visible by the naked eye. If a cold glass rod be gradually introduced into the flask, these clouds may be made to descend in showers. By the adaptation of a lime-light the whole process could be shown on a screen.

LAWSON TAIT

TODHUNTER ON EXPERIMENTAL ILLUSTRATIONS

Segnius irritant animos demissa per aurem,
quam quæ sunt oculis subjecta fidelibus, et quæ
ipse sibi tradit spectator.

THE following is, as nearly as I can recollect, the substance of a few remarks which I felt myself compelled to make to my class in a recent lecture. I had exhibited and described Hope's apparatus for showing the maximum density point of water, and proceeded to say:—

Now that the freezing mixture has been applied, my assistant will from time to time record on the black-board the simultaneous indications of the two thermometers, and will recall our attention to the experiment as the critical period approaches. You must, however, in this form of experiment take for granted his fidelity and accuracy in reading and recording. By means of a somewhat cumbrous application of optical processes, it would be easy to project upon a screen images of the thermometers, in such a way that each of you might see for himself the course of the phenomenon. But the thermo-electric method, whose principle I have already explained to you, is at once far easier of application, and in its indications more directly expressive. This I will show on another occasion. For the present you must rely on the observations to be made for you by my assistant. Yet I have no doubt that all of you will allow that the exhibition of the experiment, even in this imperfect manner, wonderfully assists you in understanding its nature.

This leads me to mention that a very decided opinion against the use of experimental illustration has been recently pronounced by one of the most erudite and voluminous of British mathematicians; my own former tutor, Mr. Todhunter, whose name and many of whose works must be familiar to most of you. Such a man speaks, deservedly with authority, on many points; and therefore his dicta upon a point with which he shows himself to be totally unacquainted are especially dangerous. And I feel that it is my duty to point out to you, and warn you against, errors or absurdities connected with physics, whenever they come from one whose statements are, on other grounds, worthy of attention. I shall not trouble you with the whole passage I refer to in Mr. Todhunter's "Conflict of Studies," but merely read to you a sentence or two of the most astounding part of it. I premise that though he is speaking of the teaching of physical science in schools, his observations apply (if they have any basis whatever) to science-teaching in general.

"It may be said that the fact makes a stronger impression on the boy through the medium of his sight, that he believes it the more confidently. I say that this ought not to be the case. If he does not believe the statements of his tutor—probably a clergyman of mature knowledge, recognised ability, and blameless character—his suspicion is irrational, and manifests a want of the power of appreciating evidence, a want fatal to his success in that branch of science which he is supposed to be cultivating."

Verbal comment on this would be altogether superfluous, and the only practical comment I am disposed now to make is to proceed at once to farther *experimental* illustrations of the subject before us.

P. G. TAIT

POLARISATION OF LIGHT *

V.

THE conversion of plane into circularly polarised light may also be effected by total reflexion. If plane-polarised light traversing glass be incident upon the inner side of the limiting surface at any angle at which total reflexion takes place, it may be considered as resolved into two plane-polarised rays, the vibrations of one being parallel and those of the other perpendicular to the plane of reflexion; and there is reason to believe that in every such case a difference of phase is brought about which for a particular angle in each substance (in St. Gobain glass it is 54° 30′) it has a maximum value of one-eighth of a wave-length. And if the original plane of vibration be inclined at an angle of 45° to that of reflexion the amplitudes of the two vibrations, into which the reflected vibrations are supposed to be resolved, will be equal. A full discussion of the mechanical causes which may be considered to effect this difference of phase would carry us deeper into the more difficult parts of the Wave Theory than would be suitable in this place. But if we accept the fact that the above-mentioned effects result, when polarised light (whose plane of vibration is inclined at 45° to that of reflexion) is reflected at a proper angle; then the following construction will be readily understood. Take a rhomb of glass, *a, b, c, d*, Fig. 14, whose acute angles are 54° 30′; a ray incident perpendicularly to either end will undergo two total internal reflexions at the sides, say at *p* and *s*, and will emerge perpendicularly to the other end. These two reflexions will together produce a retardation, as described above, of one-fourth of a wave-length. And if the ray be originally polarised and its plane of vibration be inclined

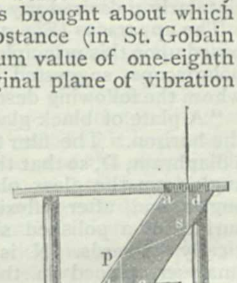


FIG. 14.

* Continued from p. 285.

at an angle of 45° to that of reflexion (that of the paper in the figure) the amplitudes of the two vibrations will be equal; and all the conditions will be fulfilled for the production of circular polarisation. Such an instrument was invented by Fresnel, and is called in consequence Fresnel's rhomb. On account of its length and its displacement of the ray, it is not so convenient as a quarter-undulation plate; but on the other hand it affects rays of all wave-lengths equally, while the quarter-undulation plate can strictly be adapted to rays of only one wave-length.

If either of these instruments be introduced and suitably placed between a selenite plate and the analyser, the chromatic effects will be similar to those due to a plate of quartz cut perpendicularly to the axis.

Another important property of these instruments consists in their effect upon circularly polarised light. Such light may be considered to arise from two plane-polarised rays whose vibrations are perpendicular to one another, and which present a difference of phase equal to a quarter of a wave-length. If, therefore, either a quarter-undulation plate or a Fresnel's rhomb be suitably placed, it will either increase or diminish the difference of phase by a quarter of a wave-length. In the one case the difference of phase will amount to a half wave-length, in the other it will vanish. And in either case the vibration will be converted into a rectilinear one; but the directions of vibration in the two cases will be perpendicular to one another.

Reflexion from a metallic surface may also be employed for converting plane into circular polarisation. If a ray of plane-polarised light fall upon a metallic reflector it is divided into two, whose vibrations are respectively parallel and perpendicular to the reflector; and the latter is retarded behind the former by a difference of phase depending upon the angle of incidence. If the plane of vibration of the incident ray be inclined to the plane of incidence at an angle (nearly 45°) which varies with the metal employed, but which is perfectly definite, the intensities become equal. And further, if the angle of incidence have a particular value dependent upon the nature of the metal (for silver 72°) the retardation will amount to a quarter of a wave-length. And the result will be a circularly polarised ray as in the case of total reflexion.

The apparatus (Fig. 15) best adapted for experiments based upon this principle is a modification of Norremberg's polariscope, suggested by Sir Charles Wheatsone, from whom the following description is quoted:—

"A plate of black glass, G, is fixed at an angle of 3° to the horizon. The film to be examined is to be placed on a diaphram, D, so that the light reflected at the polarising-angle from the glass plate shall pass through it at right angles, and, after reflexion at an angle of 18° from the surface of a polished silver plate S, shall proceed vertically upwards. N is a Nicol's prism, or any other analyser, placed in the path of the second reflexion. The diaphragm is furnished with a ring, moveable in its own plane, by which the crystallised plate to be examined may be placed in any azimuth. C is a small moveable stand, by means of which the film to be examined may be placed in any azimuth and at any inclination; for the usual experiments this is removed.

"If a lamina of quartz cut parallel to the axis, and sufficiently thin to show the colours of polarised light, be placed upon the diaphragm so that its principal section (*i.e.* the section containing the axis) shall be 45° to the *left* of the plane of reflexion, on turning the analyser from left to right, instead of the alternation of two complementary colours at each quadrant, which appear in the ordinary polarising apparatus, the phenomena of successive polarisation, exactly similar to those exhibited in the ordinary apparatus by a plate of quartz cut perpendicularly to the axis, will be exhibited; the colours follow in the order R, O, Y, G, B, P, V, or, in other words, ascend as in the case of a right-handed plate of quartz cut perpendicularly to the axis. If the lamina be now either inverted, or turned in its own plane 90°, so that the principal section shall be 45° to the right of the plane of reflexion, the succession of the colours will be reversed, while the analyser moves in the same direction as before, presenting the same phenomena as a left-handed plate of quartz cut perpendicularly to the axis. Quartz is a positive doubly refracting crystal; and in it consequently the ordinary index of refraction is smaller than the extraordinary index. But if we take lamina of a negative crystal, in which the extraordinary index is the least, as a film of Iceland spar split parallel to one of its natural cleavages, the phenomena are the reverse of those exhibited by quartz: when the principal section is on the *left* of the plane of reflexion the colours descend, and when it is on the *right* of the same plane the colours ascend, the analyser being turned from left to right.

"It has been determined that the ordinary ray, both in positive and negative crystals, is polarised in the principal section,* while the extraordinary ray is polarised in the section perpendicular thereto. It is also established that the index of refraction is inversely as the velocity of transmission. It follows from the above experimental results, therefore, that when the resolved ray whose plane of polarisation is to the left of the plane of reflexion is the quickest, the successive polarisation is right-handed, and when it is the slowest, the successive polarisation is left-handed—in the order R, O, Y, G, B, P, V and in the second case in the reverse order.

"The rule thus determined is equally applicable to laminæ of bi-axal crystals.

"As selenite (sulphate of lime) is an easily procurable crystal and readily cleavable into thin laminæ capable of showing the colours of polarised light, it is most frequently employed in experiments on chromatic polarisation. The laminæ into which this substance most readily splits contain in their planes the two optic axes; polarised light transmitted through such laminæ is resolved in two rectangular directions, which respectively bisect the angles formed by the two optic axes; the line which bisects the smallest angle is called the intermediate section; and the line perpendicular thereto which bisects the supplementary angle is called the supplementary section. These definitions being premised, if a film of selenite is placed on the diaphragm with its intermediate section to the left of the plane of reflexion, the successive polarisation is direct or right-handed; if, on the contrary, it is placed to the right of that plane, the successive polarisation is left-handed. The ray polarised in the intermediate section is therefore the most retarded; and as that section is considered to be equivalent to a single optic axis, the crystal is positive.

"In one kind of mica the optic axes are in a plane perpendicular to the laminæ. They are inclined 22½° on each side the perpendicular within the crystal, but, owing to the refraction, are seen respectively at an angle of 35°·3 therefrom. The principal section is that which contains the two optic axes. If the film is placed on the diaphragm with its principal section inclined 45° to the left of the plane of reflexion, the successive polarisation is right-handed. The ray, therefore, polarised in the section which contains the optic axes is the one transmitted with the greatest velocity.

"Films of uni-axal crystals, whether positive or negative, and of bi-axal crystals, all agree therefore in this respect:—that if the plane of polarisation of the quickest ray is to the left of the plane of reflexion, the successive polarisation is right-handed when the analyser moves from left to right; and if it is to the right of the plane of reflexion, other circumstances remaining the same, the successive polarisation is left-handed.

* The plane of polarisation is, throughout these pages, taken to be perpendicular to that of vibration.

"It must be taken into consideration that the principal section of the film is inverted in the reflected image; so that if the plane of polarisation of the quickest ray in the film is to the left of the plane of reflexion, it is to the right of that plane in the reflected image.

"It may not be uninteresting to state a few obvious consequences of this successive polarisation in doubly refracting laminæ, right-handed and left-handed according to the position of the plane of polarisation of the quickest ray. They are very striking as experimental results, and will serve to impress the facts more vividly on the memory.

"1. A film of uniform thickness being placed on the diaphragm with its principal section 45° on either side the plane of reflexion, when the analyser is at 0° or 90° the colour of the film remains unchanged, whether the film be turned in its own plane 90°, or be turned over so that the back shall become the front surface; but if the analyser be fixed at 45°, 135°, 225°, or 315°, complementary colours will appear when the film is inverted from back to front, or rotated in its own plane either way 90°.

"2. If a uniform film be cut across and the divided portions be again placed together, after inverting one of them, a compound film is formed, which, when placed on the diaphragm, exhibits simultaneously both right-handed and left-handed successive polarisation. When the analyser is at 0° or 90° the colour of the entire film is uniform; as it is turned round the tints of one portion ascend, while those of the other descend; and when the analyser is at 45° or $n90° + 45°$, they exhibit complementary colours.

"3. A film increasing in thickness from one edge to the other is well suited to exhibit at one glance the phenomena due to films of various thicknesses. It is well known that such a film placed between a polariser and an analyser will show, when the two planes are parallel or perpendicular to each other and the principal section of the film is intermediate to these two planes, a series of parallel coloured bands, the order of the colours in each band from the thick towards the thin edge being that of their refrangibilities, or R, O, Y, G, B, P, V. The bands seen when the planes are perpendicular are intermediate in position to those seen when the planes are parallel; on turning round the analyser these two systems of bands alternately appear at each quadrant, while in the intermediate positions they entirely disappear.

"Now let us attend to the appearances of these bands when the wedge-form film is placed on the diaphragm of the instrument, Fig. 15. As the analyser is moved round, the bands advance toward or recede from the thin edge of the wedge without any changes occurring in the colours or intensity of the light, the same tint occupying the same place at every half revolution of the analyser. If the bands advance toward the thin edge of the wedge, the successive polarisation of each point is left-handed; and if they recede from it the succession of colours is right-handed: every circumstance, therefore, that with respect to a uniform film changes right-handed into left-handed successive polarisation, in a wedge of the same substance transforms receding into advancing bands, and *vice versâ*. These phenomena are also beautifully shown by concave or convex films of selenite or rock-crystal, which exhibit concentric rings contracting or expanding in accordance with the conditions previously explained.

"4. Few experiments in physical optics are so beautiful and striking as the elegant pictures formed by cementing laminæ of selenite of different thicknesses (varying from $\frac{1}{2000}$ to $\frac{1}{50}$ of an inch) between two plates of glass. Invisible under ordinary circumstances, they exhibit, when examined in the usual polarising-apparatus, the most brilliant colours, which are complementary to each other in the two rectangular positions of the analyser. Regarded in the instrument, Fig. 13, the appearances are still more beautiful; for, instead of a single transition, each colour in the picture is successively replaced by every other colour. In preparing such pictures it is necessary to pay attention to the direction of the principal section of each lamina when different pieces of the same thickness are to be combined together to form a surface having the same uniform tint; otherwise in the intermediate transitions the colours will be irregularly disposed.

"5. A plate of rock-crystal cut perpendicular to the axis loses its successive polarisation, and behaves exactly as an ordinary crystallised film through which rectilinear polarised light is transmitted.

"By means of the phenomena of successive polarisation it is easy to determine which is the thicker of two films of the same crystalline substance. Place one of the films on the diaphragm E of the instrument (Fig. 15) in the position to show, say, right-handed polarisation, then cross it with the other film; if the former be the thicker, the successive polarisation will be still right-handed; if both be equal, there will be no polarisation; and if the cross film be the thicker, the successive polarisation will be left-handed. In this manner a series of films may be readily arranged in their proper order in the scale of tints.

"In the experiments I have previously described the planes of reflexion of the polarising mirror and of the silver plate were coincident; some of the results obtained when the azimuth of the plane of reflexion of the silver plate is changed are interesting.

"I will confine my attention here to what takes place when the plane of reflexion of the silver plate is 45° from that of the polarising reflector.

"When the principal sections of the film are parallel and perpendicular to the plane of reflexion of the polarising mirror, as the whole of the polarised light passes through one of the sections, no interference can take place, and no colour will be seen, whatever be the position of the analyser.

"When the principal sections of the film are parallel and perpendicular to the plane of reflexion on the silver plate, they are 45° from the plane of reflexion of the polarising mirror.

"The polarised ray is then resolved into two components polarised at right angles to each other; one component is polarised in the plane of reflexion of the silver plate, the other perpendicular thereto; and one is retarded upon the other by a quarter of an undulation.

"When the analyser is at 0° or 90° no colours are seen because there is no interference; but when it is placed at 45° or 135°, interference takes place, and the same colour is seen as if light circularly polarised had been passed through the film. The bisected and inverted film shows simultaneously the two complementary colours.

"But when the film is placed with one of its principal sections $22\frac{1}{2}°$ from the plane of reflexion of the polarising mirror, on turning round the analyser the appearances of successive polarisation are reproduced exactly as when the planes of reflexion of the silver plate and of the polarising mirror coincide. In this case the components of the light oppositely polarised in the two sections are unequal, being as cos $22\frac{1}{2}°$ to sin $22\frac{1}{2}°$; these components respectively fall $22\frac{1}{2}°$ from the plane of reflexion of the silver plate and from the perpendicular plane, and are each resolved in the same proportion in these two planes. The weak component of the first, and the strong component of the second, are resolved into the normal plane, while the strong component of the first and the weak component of the second are resolved into the perpendicular plane.

"The apparatus (Fig. 15) affords also the means of obtaining large surfaces of uncoloured or coloured light in every state of polarisation—rectilinear, elliptical, or circular.

"It is for this purpose much more convenient than a Fresnel's rhomb, with which but a very small field of view can be obtained. It must, however, be borne in mind that the circular and elliptical undulations are inverted in the two methods: in the former case they undergo only a single, in the latter case a double reflexion.

"For the experiments which follow, the crystallised plate must be placed on the diaphragm E, between the silver plate and the analyser, instead of, as in the preceding experiments, between the polariser and the silver plate.

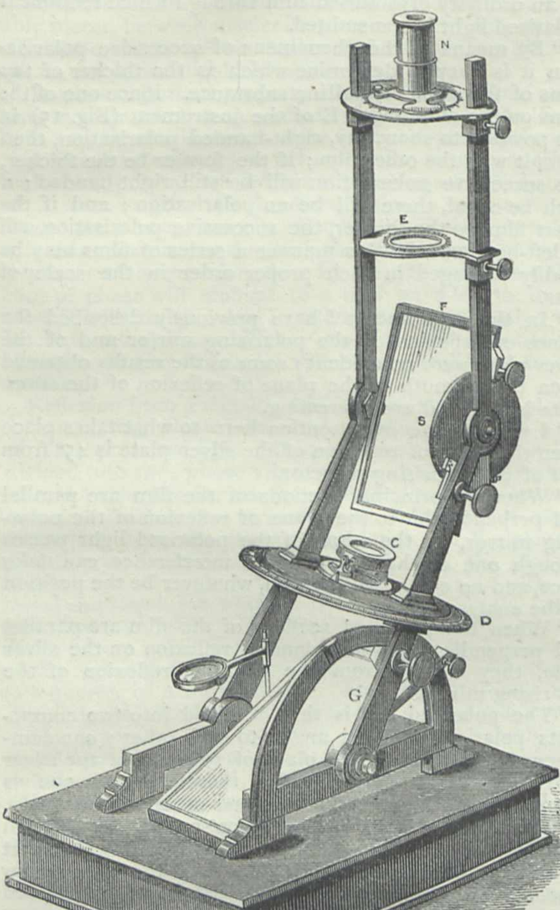


FIG. 15.—Wheatstone's modification of Norremberg's Polariscope.

"By means of a moving ring within the graduated circle D, the silver plate is caused to turn round the reflected ray, so that, while the plane of polarisation of the ray remains always in the plane of reflexion of the glass plate, it may assume every azithumal position with respect to the plane of reflexion of the silver plate. The film to be examined and the analyser move consentaneously with the silver plate, while the polarising mirror remains fixed.

"In the normal position of the instrument the ray polarised by the mirror is reflected unaltered by the silver plate; but when the ring is turned to 45°, 135°, 225°, or 315°, the plane of polarisation of the ray falls 45° on one side of the plane of reflexion of the silver plate, and the ray is resolved into two others, polarised respectively in the plane of reflexion and the perpendicular plane, one of which is retarded on the other by a quarter of an undulation, and consequently gives rise to a circular ray, which is right-handed or left-handed according to whether the ring is turned 45° and 225°, or 135° and 315°. When the ring is turned so as to place the plane of polarisation in any intermediate position between those producing rectilinear and circular light, elliptical light is obtained, on account of the unequal resolution of the ray into its two rectangular components.

"Turning the ring of the graduated diaphragm from left to right, when the crystallised film is between the silver plate and the analyser, occasions the same succession of colours for the same angular rotation as rotating the analyser from right to left when the instrument is in its normal position and the film is between the polariser and the silver plate."

The same principles apply to the case of bi-axal crystals cut parallel to a plane containing the two optic axes. A ray of plane-polarised light transmitted through such a plate is divided into two, whose vibrations respectively bisect the angles formed by the two axes. As mentioned above, the line which bisects the smallest angle is called the intermediate section, and the line perpendicular to it the supplementary section; and the order of the colours depends upon the relative velocity of the two rays. In selenite, the ray whose vibrations lie in the supplementary section is the slowest; in mica it is the swiftest. Hence these two crystals, all other circumstances being alike, give the colours in opposite orders, and may be regarded as positive and negative, like quartz and Iceland spar. And a test similar to that indicated for uni-axal may be applied to bi-axal crystals.

Some interesting and varied experiments may be made by using two circularly polarising instruments, *e.g.*, two quarter undulation plates (say the plates A and B), one between the polariser proper and the crystal (C) under examination, the other between the crystal and the analyser. The light then undergoes the following processes. If the plate A be placed so that its axis is at 45° on one side or other of the original plane of vibration, and the plate B with its axis parallel or perpendicular to that of A, then on turning the analyser we shall have the phenomena of circular polarisation described above. Again, if, the plates A and B retaining the positions before indicated, the crystal C be turned round in its own plane; then, since the light emerging from A and B is circularly polarised, it has lost all trace of direction with reference to the positions of polariser and analyser, and consequently no change will be observed.

Again, if the plates A and B have their axes directed at 45° on either side of the axis of C, and the three plates be turned round as one piece, the colour will remain unchanged, while if the analyser be turned, the colours will follow in the regular order. If the plates A and B have their axes directed at 45° on the same side of the axis of C, and the pieces be turned round bodily as before, the colours change in the same order as above, and go through their cycle once in every right angle of rotation; and if the analyser be turned in the same direction, the colours change, but in the reverse order. The explanation of this is to be found in the fact that when the plates A and B are crossed, the retardation due to A is compensated by that due to B; so that the only effective retardation is that due to the crystal C. But upon the latter depends the rotation of the plane of vibration; if, therefore, the polariser and analyser remain fixed, the colour will remain unaltered. When the plates A and B have their axes parallel, there is no compensation, and the colour will consequently change. It should be added that the rotation of the plane of vibration, and consequently the sequence of colours, does not follow exactly the same law in these cases as in quartz.

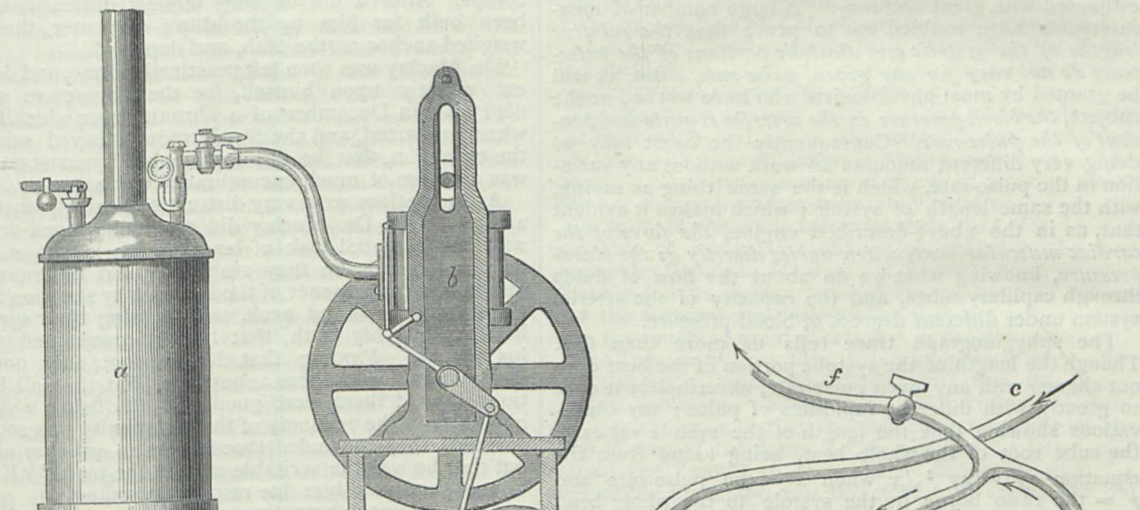
W. SPOTTISWOODE

(*To be continued.*)

THE HEART AND THE SPHYGMOGRAPH*

IN the same way that by the spectroscope much can be learned as to the chemical constitution and the physical changes going on in the sun, so by the sphygmograph applied to the artery at the wrist many of the most important phenomena occurring in the heart can be studied with a facility that cannot be otherwise attained. Till the introduction of the sphygmograph of Marey the pulse was considered to be little more than a simple up and down movement, because the instruments employed to register it, such as those of Herisson, Ludwig, and Vierordt, developed so much momentum that the details of the true trace were disguised. In the instrument as at present employed, the substitution of counterbalancing springs instead of weights has so far improved its efficiency, that the pulse is now known to form a decidedly complicated curve if its movements are allowed to record themselves on a moving paper. The sphygmograph trace, as thus produced, gives indications in two directions; first, as to the action of the valves of the heart; and secondly, as to the manner in which the muscular walls of the ventricles perform their work. It is to the former of these subjects that most physiologists have directed their observations in employing the instrument; but it is to the latter, the more important of the two, that it is my intention to direct attention on the present occasion.

The heart being nothing more than a pump of a peculiar construction, much may be learned by comparing it with other artificially constructed machines for the same purpose. In most such machines the force which keeps the pump at work is constant in power, in other words it does not vary automatically in efficiency with the amount of work that is expected of it. In the locomotive engine, however, there is an arrangement by which the furnace becomes hotter as the speed at which it moves is increased, the waste steam pipe opening into the funnel and so varying the amount of the draught through the boiler tubes. With this arrangement it is nevertheless evident



Automatically Working-engine, when supplied with coal-gas.

that there is a great waste of fuel in the construction of the furnace.

It is quite possible to construct a steam-engine on much more economical principles, and the accompanying figure illustrates the manner in which the small engine on the table is at present working (see Figure). The boiler (*a*) being sufficiently heated, drives the engine (*b*), which performs work by pumping *coal-gas* from the tube *c* through the pump *d*, into the elastic reservoir *e*. From this elastic bag most of the coal-gas escapes, through the tube *f*, into an ordinary gas bag, but a tube (*g*) carries some of it to supply the Bunsen's burner (*h*) which heats the boiler. It is evident that with this arrangement the size of the flame of the Bunsen's burner (*h*), and therefore the pressure of steam in the boiler, which is the same as saying the efficiency of the engine, varies with the amount of work required of that engine; for the greater the pressure in the elastic bag, the harder is it for the engine to perform the work required of it, and the greater is the burner-flame. With a certain proportion between the sizes of the orifices of the taps and the extensibility of the elastic bag and tubes, it would be possible to arrange this engine in such a manner that, within certain limits, the velocity of the fly-wheel would not vary with the pressure in the elastic bag; in other words, with the work to be done. That the heart is a pump constructed on the same principle as this engine is the teaching of the sphygmograph, as far as it is in my power to interpret its curves, the proof resting on the following considerations.

First, the analogy between the anatomical distribution of the arteries and the different parts in connection with the engine is not difficult to trace. The coal-gas corresponds to the blood, the boiler (*a*) together with the engine (*b*) to the muscular tissue of the heart, whose left ventricular

* Abstract of a lecture delivered by Mr. A. H. Garrod at the Royal Institution on the evening of Friday, Feb. 6.

cavity has its analogue in that of the bellows (*d*). The elastic reservoir, together with the tubes, corresponds to the systemic arteries, the gas-bag connected with the tube *f* (the capillaries) to the systemic veins; and the tube *g* to the coronary arteries, which supply the muscular tissue of the heart with nutrient blood, just as it does the boiler by means of the burner *h*. This, however, does not show that the pumping power of the heart varies directly as the blood-pressure; that such is the case depends on the opportunity offered by the sphygmograph-trace for the estimation of the length of the ventricular systole under different circumstances. Each beat or revotion of the heart is divided into two main parts—(1) the period of contraction or systole, and (2) the period of repose or diastole. The former of these occupies the interval between the commencement of the primary rise and that of the dicrotic rise in the sphygmograph trace; the latter from the dicrotic rise to the commencement of the succeeding primary rise. In all good tracings from healthy pulses these two points, the primary and dicrotic rises, are readily found; and their relative lengths can be estimated with great accuracy. A large number of measurements have enabled me to prove that *the relative lengths of the systolic and diastolic portions of the pulse-trace do not vary for any given pulse-rate*. But, as will be granted by most physiologists who have worked at the subject, *the blood-pressure in the arteries is quite independent of the pulse-rate*. Consequently the heart may be doing very different amounts of work without any variation in the pulse-rate, which is the same thing as saying, with the same length of systole; which makes it evident that, as in the above-described engine, *the force of the cardiac muscular contraction varies directly as the blood-pressure*, knowing what we do about the flow of fluids through capillary tubes, and the capacity of the arterial system under different degrees of blood-pressure.

The sphygmograph trace tells us more than this. Though the length of the systolic portion of the beat does not change with any given pulse-rate, nevertheless it does so greatly with different rapidities of pulse; my observations showing that the length of the systole varies as the cube root of the whole beat, being found from the equation $xy' = 47\sqrt[3]{x}$ when $x =$ the pulse-rate and $y' =$ the ratio borne by the systole to the whole beat. From this no other inference can be drawn than that the length of the diastole, or period of cardiac rest, during which fresh blood is circulating through the ventricular walls, must modify the contractile force of its muscular substance. The exact extent of this influence can be more readily estimated by a study of the cardiograph trace, which is obtained by applying the sphygmograph to the side of the chest at any spot where the pulsations of the heart are to be felt. It may, from the thus obtained curves, be demonstrated that if not exactly, approximately, at least, *the nutrition of the heart's walls must vary as the square-root of the length of the diastolic period*.*

There is much, therefore, as I hope I have been able to show, to be learned respecting the action of the heart from measurement of sphygmograph tracings, and it is scarcely too bold to extend the generalisation to the properties of muscular tissue generally; for the fact that each beat depends entirely for its efficiency on the peculiarities in the blood-pressure and the duration of the previous diastole, removes all complications as to incompleteness of exhaustion, and all doubts as to the exact amount of work done by the muscular fibres themselves of that most perfect of engines, whose extreme perfection enables it to complete in most of us something like 750,000 beats in a week, and nearly thirty thousand million revolutions in a person by the time he is seventy years of age.

* *Journal of Anatomy and Physiology*, May and November, 1873.

DR. VON MIKLUCHO MACLAY'S RESEARCHES AMONG THE PAPUANS *

WHEN lately at Buitenrovg—the scarcely euphonious equivalent of the "Sans Souci" of a former English Governor of Java—we had the good fortune to make the acquaintance of the owner of a name, whose peculiarity, no less than fame, has rendered it familiar to every biologist.

The friends—and we are sure they must be numerous—of Dr. Miklucho Maclay will regret to hear that he is determined, in spite of an aguish fever which still clings to him, and of, it is feared, some serious implication of the liver, to start again in a few days for the scene of his recent labours—the east coast of New Guinea, where he had previously spent fifteen months in close intercourse with the natives.

On September 19, 1871, the Russian corvette *Vitias* cast anchor in Astrolabe Gulf, and Dr. Maclay landed with two servants, one a Polynesian, the other a Swede. After a hut of very modest dimensions† had been built for him by the ship's carpenter, the *Vitias* weighed anchor on the 26th, and departed.

Dr. Maclay was soon left practically alone, and dependent entirely upon himself, for the Polynesian servant died early in December of a chronic fever which he had when he started, and the Swede soon followed suit, with the exception, that he did not die, but by constant ailing was a source of much encumbrance to his master.

As the natives were very distrustful, scarcely answering any questions, Dr. Maclay did not make much progress with the essential task of learning the language. Not only, however, were they suspicious, but determined to discourage the presence of the stranger by shooting arrows close to his head and neck, and pressing their spears so hard against his teeth, that he was constrained to open his mouth. Finding that he did not only not take the least notice of these annoyances, but that all his actions toward them were good (for, he being a doctor, his utility in the economy of the community was soon discovered), they concluded that he was no ordinary mortal, but that he was the veritable man-in-the-moon ("Kâramtâmo"), and paid him due respect accordingly.

As there were footpaths only in the neighbourhood of the villages, and as these latter were never found at a greater elevation than 1,500 feet, Dr. Maclay had some difficulty in making expeditions without guides, which at first were difficult to procure.

During his stay in New Guinea Dr. Maclay studied the inhabitants of the whole coast of Astrolabe Gulf; the people of the mountains round the gulf, and the dwellers on the islands near Cape Duperré, one of the boundaries of the gulf, who lived a life of such perfect peace that he called the islands "the Archipelago of Contentment."‡ The inhabitants, too, of Dampier Island (Kar-kar) paid him visits. The inhabitants of "Maclay Coast," by which name Dr. Maclay proposes to call the coast skirting the edge of the Astrolabe Gulf, were of especial interest, as it seems that they have never been in intercourse with any civilised people, for not only were all their tools and weapons made out of stone, wood, or bone, but no trace of any European article could be found among them. These people treasured up, or exchanged as valuable, the smallest trifles which were given them, *e.g.* fragments of broken bottles, with which they shaved themselves, as a substitute for flint, or the sharp edges of grasses.

* "Anthropologische Bemerkungen ueber die Papuas der Maclay Küste in Neu Guinea." Reprint from the *Naturkundig Tijdschrift voor Nederlandsch Indie Deel* xxxiii. *Mijn Verblijf aan de Oostkust van Nieuw Guinea. Ibid.* (Batavia, 1873).

† Only 7 feet broad, and 14 feet long, and divided by a screen of sailcloth into two rooms, one for his servants, the other for himself. The hut was situated on the south coast of Astrolabe Gulf, midway between the two capes, its boundaries.

‡ "Archipel der zufriedenen Menschen."

Dr. Maclay told us of one curious custom which he does not mention in either of the two papers referred to in the note. The Papuans, though they know how to produce fire by rubbing together two pieces of wood, do not do this when they require this agent, but always carry their fire literally about with them, either trailing a lighted stick after them as they walk, or placing the same under their beds when they sleep.

Dr. Maclay, despite much pains, was only able to collect ten skulls, and only two out of these had the lower jaw, for the natives preserve this with great veneration, while the skull itself is thrown into the neighbouring jungle as a thing of no worth. The skull of the Papuans of Maclay coast is "dolicho-cephalic." The superciliary eminences are frequently very strongly developed The maxillary region is prognathous, so that the upper teeth project considerably beyond those of the mandible. The Papuans are of middle stature, the females being considerably smaller than the males, but are strong and well built.

Contrary to what has been written, there is no roughness of skin considerable enough to constitute a race characteristic ; which may be largely accounted for by the custom of smearing the bodies with a kind of earth, and to the frequency of psoriasis ("masso"). The colour of the skin too is in general of a light chocolate brown, and not of a bluish-black colour as has been previously asserted. The inhabitants of New Ireland, an island not far distant, have, on the other hand, a comparatively dark skin. The scars of slight wounds, *e.g.* such as are made with a red-hot coal, are somewhat darker than the surrounding skin, while deep wounds, which are of not infrequent occurrence, leave behind them scars almost white in colour.

After a series of very careful observations, made as well upon shaven as upon well-covered scalps, Dr. Maclay concludes that the hair is not naturally disposed, as has been represented, in tufts or clumps, but grows just as it would upon the head of a European. The length of the hair, too, varies in different individuals, for while one man is fain to cover his bald pate with a cuscus,* another is proud to display a "gatessi," which luxuriantly covers his shoulders.†

The natural colour of the hair is dull black, but this is marked, after the period of childhood, by a black ("kuma") or red ("surru") dye. The hair of children is covered with a wash of ashes and water for protection against lice ; this hardens into a thick crust. In the case of males this is continued till the time of circumcision, after which period much care is bestowed upon the coiffure. The women, oddly enough, expend no pains upon the arrangement of their hair. The eye-brows are generally shaven, and the hairs of the beard are either shaven or plucked out in the young men, but are permitted to grow among adults.

The general hair-growth upon the body seems to be more scanty than it is among the Caucasian races. Though hair is never seen on the back of the hands, it sometimes grows pretty thickly along the line of the vertebral column, and is sometimes so far extended as to cover the whole of the buttocks.

With regard to the physiognomy, the forehead is not high but small, and sometimes retreating ; the nose is broadly flattened out, frequently with dilated nostrils ; the mouth is broad, and has a projecting upper lip ; the chin is retreating, while strongly projecting cheek-bones strikingly contrast with the smallness of the forehead in the temporal region.

The Papuans of Maclay coast bore a hole through the septum of the nostrils, in which a long fragment of stone or piece of shell is worn. The teeth are much worn through the almost exclusive use of a vegetable diet : Dr. Maclay noticed this in his own teeth after a stay of eight months in Papua. The lobules of the ears are pierced at an early age by means of the thorn of a *Dioscorea* and become much elongated by having to support heavy ear-rings.

If the back of a Papuan is seen in profile, there will be noticed a considerable concavity of curve in the lumbar region. This would seem to be a characteristic in which the Papuan differs from the Caucasian race. The Papuans make a greater use of the left hand and arm than of the right, and use the feet to pick up various objects—sometimes very small ones—from the earth. This is done, not by flexion of the toes, but by anadduction of the great toe, which is considerably separated from the rest of the toes. From this use of the,toes, it frequently happens that the two feet are dissimilar in size.

Circumcision is performed at from the ages of 13 to 15 years, and, as Zipporah performed it, with a sharp flint. This custom is general among the Papuans of Maclay coast, and among most of the coast and some of the mountain inhabitants. Those—and among them are the New Irelanders and the inhabitants of one of the Islands of the Archipelago of Contentment—who do not use this rite are looked down upon by their circumcised brethren. The suckling of infants is carried on for a long period, sometimes to the age of four years.

The Papuans are very strict in their sexual relations. The men marry early, soon after circumcision, and have only one wife ; concubinage is almost unknown. The women, probably on account of the hard work in which they are engaged, seldom bear many children.

In spite of the dark colour of their skin, Dr. Maclay was able to recognise a change of colour in the face among the Papuans. He does not, however, state whether blushing follows upon a sense of shame, but only notices that the features are darker when they are overjoyed, or have been making great efforts, *e.g.* in the dance.

The Papuan women, like their European sisters, cultivate the art of which Mr. Turveydrop was the distinguished professor. Readers of the "Arabian Nights may remember how that the seductive wriggling of the sides of one of the damsels "shaped like the letter alif," caused the "world to turn black" before the eye of a susceptible hero, and will therefore fully appreciate the subtle influence of a peculiar and "killing" wriggle which the Papuan maid begins to have at even the tender age of seven years. The half-caste women whom one sees at Batavia seem to have adopted a similar though modified habit.

The favourite position of the Papuan men—as it seems to be among the Malays also—is resting the buttock upon the heels (*das Hocken*), while the whole surface of the soles of the feet is applied to the ground. Dr. Maclay found that he could keep his balance only when the toes alone were in contact with the earth. This position of the Papuan must not only be acquired, but must depend also upon a peculiar relation of proportion in the limbs. Nothing can be said with certainty as to the duration of life among the Papuans. Dr. Maclay never saw an old individual among them.

Dr. Maclay, from the observations which he has at present made, concludes that *the Papuan stock falls into numerous varieties, distinct from one another, which, however, have no sharp lines of demarcation.*

On December 19, 1872, some natives came to Dr. Maclay to inquire the cause of some smoke which had been seen rising from the sea between Vitias and Dampier Islands. This turned out to be the clipper *Izoumroud*, which had been sent out to look for the traveller (whose death, it seems, had been announced in the English journals), at the instance of the Grand Duke Constantine.

Early on the morning of the 24th the *Izoumroua* weighed anchor, and as she steamed away there could

* A small marsupial found in Papua. It is figured in Wallace's "Malay Archipelago."

† The long hair worn at the back of the head is termed "gatessi."

be heard all along the coast the sound of the Bâroem, a great wooden gong, announcing to the islanders the departure of the "man-in-the-moon," who had taken up his abode for more than a year amongst them.

JOHN C. GALTON

MICROSCOPIC EXAMINATIONS OF AIR

A WORK* of the greatest importance on the above subject has just been published in Calcutta by Mr. Douglas Cunningham. The conclusions which he has reached as the result of the experiment are so valuable that we deem it right to give them as great publicity as possible. The following is Mr. Cunningham's description of the aeroscope with which he made his experiments :—

The apparatus employed in obtaining specimens was a slightly modified form of that devised by Dr. Maddox. It consisted of three thin brass tubes, two of which slipped over the third central one and came into contact with the opposite side of a projecting rim on its circumference. This rim was formed by the margin of its diaphragm which divided the centre tube into two chambers. It was of sufficient thickness to allow of a spindle passing up through it. The latter terminated in a pointed extremity, which came in contact with the upper end of the bearing, and provided for the free rotation of the system of tubes. Round the margin of the diaphragm there was a set of perforations, to allow of the passage of air through it, and, on the centre of its anterior surface, there was a square plate of glass with a slightly projecting rim on its lower margin. The anterior of the two lateral tubes was provided with an expanded orifice, and contained a small, finely-pointed funnel in its interior ; the pointed extremity opening immediately in front of the centre of the diaphragm-plate. The posterior tube was quite simple, and had a good-sized fish-tail vane fitted into a slit in its extremity.

The following are Mr. Cunningham's conclusions :—

The most important conclusions to be derived from all the preceding experiments regarding the dust contained in the atmosphere in the vicinity of Calcutta appear to be the following :—

1. The aeroscope affords a very convenient method for obtaining specimens really representing the nature of the true atmospheric dust.

2. Specimens of dust washed from exposed surfaces cannot be regarded as fair indices of the constituents of atmospheric dust, since they are liable to contain bodies which may have reached the surface otherwise than by means of the air, as well as others which are the result of local development.

3. Specimens collected by gravitation also fail to indicate the nature and amount of organic cells contained in the atmosphere, as the heavier amorphous and inorganic constituents of the dust are deposited in relative excess due to the method of collection.

4. Dew also fails to afford a good means of investigating the subject, as it is impossible to secure that all the bodies really present in a specimen of it should be collected into a sufficiently small space, and, moreover, because it is liable to accidental contaminations, and also affords a medium in which rapid growth and development are likely to take place.

5. Distinct infusorial animalcules, their germs or ova, are almost entirely absent from atmospheric dust and even from many specimens of dust collected from exposed surfaces.

6. The cercomonads and amœbæ appearing in certain specimens of pure rain-water appear to be zoospores developed from the mycelial filaments arising from common atmospheric spores.

7. Distinct bacteria can hardly ever be detected among the constituents of atmospheric dust, but fine molecules of uncertain nature are almost always present in abundance ; they frequently appear in specimens of rain-water collected with all precautions to secure purity, and appear in many cases to arise from the mycelium developed from atmospheric spores.

8. Distinct bacteria are frequently to be found amongst the particles deposited from the moist air of sewers, though almost entirely absent as constituents of common atmospheric dust.

9. The addition of dry dust, which has been exposed to tropical heat, to putrescible fluids is followed by a rapid development of fungi and bacteria, although recognisable specimens of the latter are very rarely to be found in it while dry.

10. Spores and other vegetable cells are constantly present in atmospheric dust, and usually occur in considerable numbers : the majority of them are living and capable of growth and development ; the amount of them present in the air appears to be independent of conditions of velocity and direction of wind ; and their numbers are not diminished by moisture.

11. No connection can be traced between the numbers of bacteria, spores, &c., present in the air and the occurrence of diarrhœa, dysentery, cholera, ague, or dengue ; nor between the presence or abundance of any special form or forms of cells, and the prevalence of any of these diseases.

12. The amount of inorganic and amorphous particles and other *débris* suspended in the atmosphere is directly dependent on conditions of moisture and of velocity of wind.

If these results be compared with those obtained by other observers, and detailed in the first section of this report, it will be seen that they agree very closely with those of M. Robin, only differing from them in indicating the presence of a somewhat larger number of spores than appeared in his observations. They differ almost equally from those arrived at by Pouchet and Ehrenberg. It is somewhat difficult to understand how the former observer so constantly failed to detect the presence of spores in his experiments, but there is an apparent reason for Ehrenberg's observation of the predominance of animal forms in the atmosphere. His conclusions appear to have been almost entirely founded on the results of the examination of specimens of dust not directly obtained from the air, but from surfaces on which it had been previously deposited from the air, such as leaves, tufts of moss, &c. Now, as has already been indicated, it is certainly quite unwarrantable to assume that all organisms found in such specimens existed as such in the air, or were even derived from the air in any way. All such surfaces are more or less liable to contact-inoculation ; leaves and moss, for example, are liable to this through the agency of insects or birds. Moreover, with regard to many of the organisms detected in such situations, it must be recollected that there is no reason why they should not have arrived there by means of active progression over the surface. When surfaces are wet with rain, there is no reason why Tardigrades, Rotifers, Anguillulæ, and many infusoria should not travel over them from one point to another. The journey accomplished at any one time may be small, and its progress soon arrested by defective moisture ; but, unless they are deprived of vitality in the interval by desiccation, they are ready for a fresh start when favourable conditions are again presented to them.

It is hardly safe to venture on the vexed questions regarding the origin of bacteria, but it may, at all events, be stated that the results of the present experiments are certainly not opposed to the belief in the transmission of these organisms in some way or other by means of the atmosphere ; for they were actually observed among the particles in moist air, the addition of dry dust to putre-

* "Microscopic Examinations of Air," by D. Douglas Cunningham, M.B. Surgeon H.M. Indian Medical Service (Calcutta).

scible fluids was followed by their rapid development, and they appeared in specimens of pure rain water.

Although these observations may not appear to encourage the hope of success in discovering the presence of atmospheric particles connected with the origin of disease, it must not be forgotten that they only refer to bodies distinguishable from one another *whilst in the air*, the possibility remaining that many of the finer molecules present in it are really of different natures, and may yet be distinguished from one another by means of their actions or developments. Many interesting questions are suggested in connection with the fact of the presence of such considerable numbers of living cells in the air. What becomes of them when drawn into the respiratory cavities of animals? Is their vitality destroyed, and, if so, how are they got rid of? Are they ever capable of undergoing any development within the organism, and do they then exert any prejudicial influence on the recipient? These and similar questions can only be answered by means of patient and extended experiment, but even such imperfect and superficial observations as the present will, I trust, serve a useful purpose in clearing away a few of the preliminary obstacles from the path of investigation.

NOTES

A SPECIAL General Meeting of the Linnean Society is to be held on Thursday, March 5, at 8 P.M., "to consider alterations in the Bye-laws of the Society;" when it is expected a full explanation will be given of the reasons which induced the Council to make the alterations recently adopted by the Society, which met with such violent opposition from a small section of the Fellows. It is understood that Mr. Bentham, who has occupied the chair of the Linnean Society for the past eleven years, will not offer himself for re-election at the ensuing anniversary. The custom of the Society requires that the next president shall be a Zoologist, but students of both branches of Biology will be glad to learn that Prof. Allman has allowed himself to be nominated. Few naturalists would bring to the office a wider, and none a more sympathetic knowledge.

MR. HIND writes to the *Times* that he has received from Prof. Winnecke, Director of the Observatory at Strasburg, the following position of a comet discovered by him in the Constellation Vulpecula on the morning of Saturday last:—February 20, at $17^h\ 16^m\ 40^s$ mean time—right ascension, $20^h\ 35^m\ 34{\cdot}2^s$; north declination, 26 deg. $0^m\ 46^s$. The diurnal motion in right ascension is 9^m increasing, and in declination 1 deg. 30^m towards the south.

PROF. ASA GRAY has been appointed to fill the Chair in the Board of Regents of the Smithsonian Institution, previously occupied by the late Prof. Agassiz.

THE Rev. Dr. Thomas William Jex-Blake, Principal of Cheltenham College, has been elected Head-Master of Rugby School, in succession to Dr. Hayman.

A BARONETCY has been conferred upon Dr. George Burrows, F.R.S., President of the Royal College of Physicians.

WE would direct the attention of Palæontologists and others who are specially interested in the Cephalopoda, to a paper by M. Munier-Chalmas, in the *Comptes Rendus* for Dec. 29, 1873, which is translated in the current number of the *Annals and Magazine of Natural History*, in which, from a study of their earliest stages, the generally accepted systematic position of the Ammonitites and Goniatites is stated to be inaccurate, they being shown to be dibranciate decapoda allied to Spirula, and not tetrabranchiata at all.

THERE are two islands named St. Paul in the ocean: one close to the Equator was visited lately by the *Challenger;* the other, south of the Cape of Good Hope, is to be visited by a French expedition under Capt. Mouchez, for observing the forthcoming transit of Venus, as we stated in our last number. The identity of name has created a singular confusion. The French administration having decided that no naturalist was needed for St. Paul, the *Challenger* having explored the island a few months since, M. Mouchez had some trouble, it is said, to get the decision reversed by the authorities. Both islands, southern and northern, are almost of the same microscopical size and equally barren. They are of volcanic formation, with no trace of vegetable earth, and consequently of vegetation.

A TELEGRAM from Melbourne, dated February 17, states that Colonel Egerton Warburton has reached Perth, in Western Australia, overland from Adelaide, having thus accomplished the object of the exploring expedition on which he left Tennant's Creek, north of Adelaide, in the centre of Australia, about twelve months ago. Colonel Warburton's explorations embrace a portion of the interior of Western Australia hitherto unknown. The distance traversed is over 1,000 miles of longitude, the expedition having been conducted by means of camels, and was fitted out by the munificent liberality of the Hon. Thomas Elder, M.L.C., and Mr. W. W. Hughes. Another expedition under Mr. Gosse, conducted with horses at the expense of the Government of South Australia, has not been so successful. Mr. Gosse, amid many difficulties caused by want of water and the barren nature of the country through which he passed, managed to reach as far as E. long. 129° 59′ in lat. 26° 32′ S., the total distance traversed irrespective of numerous turnings and windings, being not less than 600 miles. His most notable discovery was made in lat. 25° 21′, long. 131° 14′, being a hill consisting of one solid rock (fine conglomerate) or huge natural monolith two miles long, one wide, and 1,100 feet high, with a spring coming from its centre; Mr. Gosse named it "Ayres Rock." Both expeditions are highly creditable to the enterprise of South Australia, which, as our readers know, has succeeded in carrying a line of telegraphy right across the country, from Port Augusta to Port Darwin.

THE enterprise of the Australian Colonies is producing really valuable scientific results, as will be seen from the following telegram, dated Dec. 22, published in the *Brisbane Courier*, from Mr. G. Elphinstone Dalrymple, commander of the Queensland North-east Exploring Expedition:—"The coasts, harbours, inlets, navigable rivers, and creeks have been examined from latitude 18° 15′ to 15° 15′ S. The Bellenden Kerr mountain range has been successfully ascended, and found to be a complete 'razor back' of granite. Palms were found on the summit; but although the botanical discoveries were interesting, they have not borne out all that was anticipated from them; 144 miles of soundings and 371 compass cross bearings have been taken in 19 navigable rivers and creeks of which the North and South Johnstone, the Mulgrave and Russell, drain the Bellenden Kerr range; the Mossman and Daintree drain the Arthur Palmer range inside the Schnapper Island. This range is nearly as lofty as the Bellenden Kerr, and is 25 miles in length. New rivers have been discovered penetrating a jungle-clad country of thoroughly tropical character, covered with a new rich soil suitable for sugar and other tropical cultivation. The extent of this country is roughly estimated at, in the aggregate, half a million acres, thus at once placing Queensland on a par with other favoured tropical countries. Mr. Hill has collected 3,000 botanical specimens, roots, and blocks of timber; 130 shells of five genera and eight species; 42 specimen bags of soils. Mr. Johnstone has collected 30 specimens of interesting birds, insects, and reptiles; and I have obtained 93 geological specimens."

THE French Society of Geography and the Commission delegated by the Syndical Chambers of Commerce of Paris have instituted a "Commission of Commercial Geography." This Commission has for its object—1. To spread in France, either by education or by publications, information relating to commercial geography; 2. To pursue the organisation or development, from an industrial and commercial point of view, of explorations in all quarters of the globe; to take part in researches relative to existing routes or to create new ones; 3. To point out the natural riches and the manufacturing processes which may be utilised by commerce and industry; 4. To inquire into all questions relating not only to the development of French colonisation, but also to the colonial systems of the various civilised nations. The Commission is divided into four sections corresponding to the above, and in the interval between the general meetings these sections hold stated *séances* for discussing questions, their decisions being submitted to the approbation of the Commission.

THE Paris Jardin d'Acclimatisation has just received a flock of six magnificent male ostriches and twelve females presented to it by General Lacroix-Vaubors, who holds a high command in Algeria. All attempts to breed these birds have hitherto proved futile, but a new attempt is to be made under the sun of Provence. The six ostriches will not remain long in Paris, and are to leave soon for Hyeres, where the Acclimatisation Society possesses a large estate.

THE Meteorological Society of France has decided upon holding its next Biennial Exhibition at the Palais de l'Industrie, Champs Elysées: it is to be an International one. The expenses being paid by the Government, no charge will be made for exhibiting. A special circular will be sent to the English Society this year.

THE *New York Tribune* in calling attention to the unauthentic character of a story to the effect that the non-existence of the companion star of Procyon, and of all except two of the satellites of Uranus, had been determined by the new telescope at Washington, announces the first important result obtained from this instrument. The recent observations have resulted in the rediscovery of the two smallest moons of Uranus, which have been not only distinctly seen on several occasions, but have actually been measured by Prof. Newcomb and his assistant, Prof. E. L. Holden. The two larger moons of Uranus, first discovered by Sir Wm. Herschel, are well-known objects, and can be seen under favourable circumstances with any telescope of 12 in. aperture. The two smallest were first discovered by Lassell, about twenty years ago, through the fine instrument attached to his private observatory near Liverpool; but his observations were very unsatisfactory (scarcely, indeed, determining the exact number of moons), and it was not until he renewed his researches at Malta that he obtained any accurate indications. Since that time, and until this re-discovery, no one has seen these satellites, and their detection and accurate observation through the Washington instrument is gratifying evidence of its superior power.

MRS. MARY TREAT publishes in the *American Naturalist* for December 1873 a remarkable contribution to our knowledge of the sensitiveness of the leaves of the sundew, her experiments being chiefly made on the large American species *Drosera filiformis*, the leaves of which capture and kill moths and butterflies two inches across. Her observations are in accordance with those already recorded on English species, that the motion of the glands is excited only by organic substances, or if for a very short time by mineral substances, that the excitement passes off almost immediately. The most astonishing of her observations is, however, that when living flies are pinned at a distance of half an inch from the apex of the leaf, the leaf actually bends towards the insect until the glands reach it and suck its juices. In the *Naturalist* for January is an account of Roth's observations on the irritability of the sundew, made nearly a century ago.

WE have before us the first number of what seems to us likely to be a most useful work—"Insects of the Garden; their habits," &c., by Dr. A. S. Packard. The present number contains 32 pp. with woodcuts and a coloured plate, and is published at 25 cents. It forms part of a work called "Half hours with Insects," to be completed in 12 parts.

AN advance sheet of the forthcoming number of Petermann's *Mittheilungen* contains an official account of the voyage of Count Wiltschek in the summer of 1872 to Spitzbergen and Novaya Zemlya in the yacht *Isbjörn*, the chief object of which was to plant a provision depôt in the Arctic Sea for the Austro-Hungarian expedition under Weyprecht and Payer in the *Tegethoff*. The account contains some valuable observations on the ocean-currents, temperature, weather, wind, &c., of the region, and the geology of Novaya Zemlya; collections of the fauna and flora of that island were made, and photographic views were taken. Nothing is known at present of the Austro-Hungarian expedition in the *Tegethoff*, though it is probable that she may be wintering somewhere on the coast of Siberia.

THE Government of Peru have for some years been expending vast sums of money in exploring the little known portions of Peru which lie to the west of the Andes, and Señor Raimondi, a scientific man of the highest character, has, in the service of the Government, been also exploring the remote valleys between the Cordilleras, and at the head waters of many of the rivers which flow down the northern slopes to the eastern plains, a work in which he has been engaged for twenty years. The announcement is now made that the labours of Señor Raimondi are to be utilised in the publication, by the Government, of a magnificent illustrated work, which is to embrace a narrative of his explorations, and the result of all his researches upon the geography, natural history and climate of Peru.

IN a "Note Additionelle," by Mr. Albert Lancaster, of the Belgian Academy, to Mr. W. T. Brigham's memoir on "Volcanic Manifestations in New England, 1638—1870," published by the Boston Society of Natural History, the author records a number of earthquakes omitted in Mr. Brigham's memoir. Taking all the recorded earthquakes in New England during the last three centuries, the author finds that ·2 occurred yearly during the seventeenth century, 1·2 during the eighteenth, and 2·0 during the nineteenth, though on account of the imperfect data of the seventeenth and eighteenth centuries, he thinks that 2·0 per annum may be taken as the average annual number of earthquake phenomena in New England. If the number of earthquakes during the three centuries be examined in reference to the months in which they occurred, it will be found that there are two distinct maxima and minima, both showing an equality almost to a unit; the former fall in February and November, the latter in April and September, and they are to each other as 3·6 : 1. Dividing the number of earthquakes according to the seasons in which they occurred, it is found that eighty-seven occurred in winter, forty-three in spring, forty-three in summer, and ninety-one in autumn. Enough is not yet known of the geological constitution of New England to enable us to explain these remarkable results, though it is hoped that the researches at present carried on by the U.S. geological officials may ere long enable us to do so.

THE existence of gigantic Cephalopoda in American waters has long been suspected, and at last a large specimen of a "squid," or sepia, has been captured and preserved. The measurements, as given by the Rev. M. Harvey, of St. John's, Newfoundland, are, length of body, 7 ft.; circumference, 5 ft.;

length of two tentacular arms, 24 ft. each; eight pedal appendages, 6 ft. in length, and 9 in. in circumference nearest the head; the sucking-discs are denticulated, and in some instances measure 1¼ in. in diameter. This individual has been preserved, and its measurements are therefore authentic; but still larger specimens are believed to exist, and an account is given of an encounter between some fishermen and a huge creature which, on being struck by them, attacked their boat by twining its arms round the vessel. Two of the arms were cut off by a fisherman, when the squid moved off, ejecting a large quantity of inky fluid to cover its retreat. A portion of one of these arms, measuring 19 ft., has been preserved, but it is said that 6 ft. of it were destroyed, while the fishers estimate that they left 10 ft. more on the body of the squid. This would bring its length to 35 ft. It is to be hoped that more care will in future be taken to prevent the mutilation of specimens; and the capture of the first-mentioned one will, no doubt, excite the fishermen and others to greater care and exertions in looking out for still larger examples. The first squid was caught in Logy Bay, Newfoundland. The encounter with the second took place off Portugal Cove, Conception Bay, about 9 miles from St. John's.

AT a recent meeting of the Essex Institute (Salem, Mass.), Mr. Byron Groce of Peabody read a paper on "The Study of Natural History in Schools," in which he advocated its introduction by substituting it for some of the less useful studies now pursued. He also gave an account of the method he had followed in the High School of Peabody, stating that during the summer he took his school into the woods and fields for a half day each week, taught the scholars to collect specimens and preserve them properly; then had the specimens arranged in the school cabinet, and on unpleasant days in the winter they were used for instruction. In this way a lively interest had been created in the school, and a Natural History Club had been formed among the scholars for the purpose of carrying on the study.

A NEW illustrated weekly newspaper is announced for first appearance on March 7. The title is the *Pictorial World*. We trust the projectors will be wise enough—to take the word in its largest sense—to let its readers know something of what is being done in the world of Science.

WE have received a map (published by the U.S. Geological Survey) of the sources of the Snake River, with its tributaries, together with portions of the head waters of the Madison and Yellowstone, from surveys and observations of the Snake River Expedition, by G. R. Bechler, Chief Topographer, and James Stevenson, Director. The scale is five miles to an inch, and all the remarkable features of the extensive district, which includes the Yellowstone National Park, and the nature and products of the ground, are clearly indicated.

WE have received the third volume, for 1873, and the commencement of the fourth volume of the "Procès-verbaux des Séances de la Société Malacologique de Belgique," showing the activity with which this department of Natural History is pursued in Belgium.

THE additions to the Zoological Society's Gardens during the past week include a Crested Agouti (*Dasyprocta cristata*), from Mexico, presented by Mr. C. H. M. de Lichtacbel; a Pennant's Parakeet (*Platycercus pennanti*), and a Cockateel (*Calopsitta novæ-hollandiæ*), from Australia, presented by Dr. H. Wheeler; a Common Gull (*Larus canus*), British, presented by Mr. W. K. Stanley; a Malayan Hornbill (*Buceros malayanus*), from Malacca, purchased; and a hybrid Pheasant (between *Thaumelia amherstiæ* and *T. picta*), received in exchange.

SCIENTIFIC SERIALS

Justus Liebig's Annalen der Chemie u. Pharmacie, Band 170, Heft 1 und 2. This number contains the following papers:—On the chlorides and oxy-chlorides of sulphur, by A. Michaelis. The author describes the compound SCl_4 and other chlorides, also an oxy-chloride of the formula $S_2O_5Cl_2$. He gives tables and curves showing the dissociation of SCl_4 which is very rapid between − 20° when 100 per cent. of that body exists and + 6°·2 when only 2·43 per cent. exists as SCl_4, the rest consisting of SCl_2 and chlorine. SCl_2 dissociates much less rapidly, 5·44 per cent. existing at a temperature of + 120°. Researches on the nature and constitution of gallic acid, by H. Schiff. A correction of the formula of carbazolin, by C. Gräbe.—On capronic acid contained in the crude butyric acid of fermentation, by A. Lieben—On the salts of capronic acid derived from fermentation, by F. Kottal.—On a condensation product of oxybenzoic acid, by L. Barth and C. Senhofer. The author's obtained a body of the formula $C_{14}H_8O_4$; two of the hydrogens of this formula are replaceable by metals. The Ba Ca, K and Na salts thus formed are described. On treating the original body with zinc, anthracene was obtained. They propose to call this body Anthraflavon; it is useles as a dyestuff.—On phenol-trisulphuric acid, by C. Senhofer. The acid is prepared by acting on sulphuric acid with phosphoric anhydride in the presence of phenol; it is a tribasic acid of the formula $C_6H_6S_3O_{10}$ crystallising with 3½ molecules of water. Several of its salts are described.—On orthoxylol prepared from liquid brom-toluol, by P. Jannasch and H. Hübner.—On the action of ozone on carburetted hydrogen, by A. Houzeau and A Renard. This is a translation from a paper in the *Comptes Rendus*, vol. lxxvi., 572.—On dichlorglycide, by A. Claus. This body is prepared by the action of potassic hydrate on trichlorhydrin. On the action of potassic cyanide on dichlorglycide, by the same author.—On œnanthylic acid and normal heptyl alcohol, by Harry Grimshaw and C. Schorlemmer.—On trimethyl acetic acid, by A. Butlerow.—On the dichlor propionic ether from glyceric acid, by Messrs. Werigo and Werner.—Contributions to our knowledge of citric acid; and On baric citraconate, by H. Kämmerer.—On dissociation, by A. Horstmann.—The number concludes with a short reply to Butlerow's paper on trimethyl carbinol, by E. Linnemann.

Bulletin de la Société Imperiale des Naturalistes de Moscou. No. 2. 1873.—This number commences with a paper by Dr. Koch on malformations in the embryos of species of salmon and Coregonus; the various monstrosities being treated under the headings of (1) Dicephaly; (2) Diplomyelia (duplicity of spinal cord, total or partial; (3) Divergences of body from its long axis; (4) Defects in organs of locomotion; (5) Anomalies in the vegetative sphere; (6) Defects in organs of sense. As to the disputed point how double monsters arise, Dr. Koch finds confirmation of I. Müller's view, according to which they are produced through union of two organised embryos arising from an imperfect fission. He also asserts that double monsters, where both bodies are formed alike, never live after leaving the egg, and when the yolk has been absorbed; other monsters may, if the form permits of food being procured. From experiments made on production of monsters, it seemed well established, that unfavourable conditions, such as shaking, were peculiarly apt to cause them; even double formations, but only of a certain kind, viz. *Diplomyelia partialis*, not *D. totalis*. The influence of temperature was also seen in the fact, that, with embryos in these unfavourable conditions, a difference of three degrees R. (above the normal cold temperature), made a difference of twelve days in the time of development, which was to this extent retarded. The paper is accompanied with numerous illustrations.—M. Wolkenstein continues his account of anthropological researches on the ancient cemeteries of Waldaï, named "Jalnikis;" giving here detailed measurements of the skeletons found in these peculiar tombs.—M. Becker describes a journey he made in 1872 to several places in the neighbourhood of the Caspian and in South Daghestan; apppending a list of plants and animals found there.—M. Truntschold furnishes some measurements of *Elasmotherium sibericum*; M. Motschoulsky a list of new species of Coleoptera; and there are one or two notes, in Russ, on botanical subjects.

Astronomische Nachrichten, No. 1973. In this number Dr. Stein gives an account of an apparatus for astronomical photography, with which the negatives are taken without the use of a dark room or tent, and if useful in practice, it justly deserves credit. It consists practically of a sort of flat box of glass, one side of which is the collodionised plate which fits water-tight against the other sides by means of india-rubber packing. There is a tube passing into this box through which first the ordinary silver solution is poured, and then by laying the collodionised plate downwards it is covered by the solution and sensitised; this is then drawn off, and the box, which is contained in a suitable holder, placed on the telescope and exposed by drawing away the non-actinic glass cover in front. After exposure the coloured glass is replaced, the box removed and developed by pouring in the solution in the same manner as the silver, in the meantime watching the plate through the coloured glass; the washing is then proceeded with in the same manner.—Dr. Stein proposes to use this method for photographing the transit of Venus.—Prof. Schmidt contributes a paper on the rotation of Jupiter, in which he discusses all the old observations of Cassini and others. From his list we gain that these observers differed to the amount of 6^m, the minimum being $9^h\ 50^m$, and the maximum $9^h.56^m$. From Prof. Schmidt's observations in 1873, he obtains a period of $9^h\ 56^m\ 7{\cdot}2^s$.

Archives des Sciences Physiques et Naturelles, Dec. 15, 1873.—In this number a short opening notice of M. de la Rive is followed by an article by M. Wiedemann, being an extract from his recent work on elliptic polarisation of light, and its relations with the superficial colours of bodies. The author shows that superficial colours change considerably with the nature (indices of refraction) of the substances in contact with which they are produced; and colours the most strongly reflected present generally the most intense elliptic polarisation, provided the reflection occurs in air or in vacuo. The principal angles of incidence undergo the most rapid modifications for wave-lengths corresponding nearly to the bands of absorption. M. Wiedemann's work elucidates the connection between the phenomena of bodies with superficial colours and the principal angles of incidence and relations of amplitude.—Dr. Hermann Müller's recent interesting work on fertilisation of flowers by insects is reviewed in a paper which gives a succinct *résumé* of the principal results.—M. Plantamour furnishes an account of the proceedings of the Meteorological Congress held at Vienna in 1873, and the circumstances which led to it.—There is also a note on the early development of Geryonides, by M. Fol; and this is followed by the usual scientific summary.

Ocean Highways, February.—About one-third of this number is occupied by a paper by Captain R. F. Burton, describing "Two Trips on the Gold Coast," the first being to the Beaulah Gardens and Agrimanti Hills, and the second along the shore to the Volta River. The paper, which is written in Captain Burton's characteristic and attractive style, and illustrated by two maps, is full of information, and will no doubt prove interesting to many at the present time. An article on the Bengal Famine recounts the principal Indian famines from 1661 to the present time, and shows how much could be done to foresee and obviate the consequences of famine by a more scientific investigation of the laws which regulate meteorological phenomena. The article is accompanied by a map showing the extent of the famine districts. In a short article on "Wyche's Land," called by the Germans after King Karl of Wurtemburg, it is shown satisfactorily, we think, that the honour of the discovery, by right, belongs to Edge's expedition in 1617, and that the name then imposed should remain unchanged. Some interesting details are given of Richard Wyche or Wiche, the London merchant, who did much to encourage early discovery. Other articles are on "European Emigration to the Argentine Republic," and on the "Provindah Trade," or trade of the Lohani merchants, who are the channels of communication between India and Central Asia.

SOCIETIES AND ACADEMIES

Royal Society, Feb. 12.—"On the Division of Sound by a layer of flame or heated gas, into a reflected and a transmitted portion," by John Cottrell, Assistant in the Physical Laboratory of the Royal Institution; communicated by Prof. Tyndall, F.R.S.

A vibrating bell contained in a padded box was directed so as to propagate a sound-wave through a tin tube and its action rendered manifest by its causing a sensitive flame placed at a distance in the direction of the sound-wave to become violently agitated.

The invisible heated layer immediately above the luminous portion of an ignited coal-gas flame issuing from an ordinary bat's-wing burner was allowed to stream upwards across the end of the tin tube, from which the sound-wave issues. A portion of the sound-wave, issuing from the latter, was reflected at the limiting surfaces of the heated layer; and a part being transmitted through it, was now only competent to slightly agitate the sensitive flame.

The heated layer was then placed at such an angle that the reflected portion of the sound-wave was sent through a second tin tube (of the same dimensions as the above), and its action rendered visible by its causing a second sensitive flame placed at the end of the tube to become violently affected. This action continued so long as the heated layer intervened; but upon its withdrawal the first-mentioned sensitive flame, receiving the whole of the direct pulse, became again violently agitated, and at the same moment the second sensitive flame, ceasing to be affected, resumed its former tranquillity.

Feb. 19.—"On the Number of Figures in the Period of the Reciprocal of every Prime Number below 17,000," by William Shanks, Houghton-le-Spring, Durham.

"On an Instrument for the Composition of the Harmonic Curves," by E. A. Donkin, Fellow of Exeter College, Oxford.

"On the Absorption of Carbonic Acid by Saline Solutions," by J. Y. Buchanan, chemist on board H.M.S. *Challenger*.

Linnean Society, Feb. 19.—J. Gwyn Jeffreys in the chair.—The chairman announced that a Special General Meeting of the Society would be held on Thursday, March 5, at 8 P.M., to consider alterations in the Bye-laws of the Society." The following papers were read:—Systematic list of the Spiders at present known to inhabit Great Britain and Ireland, by the Rev. O. P. Cambridge.—Some observations on the vegetable productions and rural economy of the province of Baghdad, by Surgeon-major W. H. Colvill.—Note on the Bracts of Crucifers, by Dr. M. T. Masters.

Zoological Society, Feb. 17.—George Busk, F.R.S. vice-president, in the chair. Mr. Busk exhibited some skulls of the tiger and leopard from China, procured by Mr. R. Swinhoe, and showed that those from the northern and southern provinces did not appear to be specifically distinct.—A communication was read from Mr. L. Taczanowski, Conservator of the Museum of Warsaw, containing the descriptions of twenty-four new birds, obtained by Mr. Constantine Jelski in Central Peru. Amongst these was a new Cotingine form, proposed to be called *Dolyornis sclateri*, and four new humming-birds named respectively *Metallura hedvigæ*, *Helianthea dichroura*, *Eriocnemis sapphiropygia* and *Lampraster branickii*.—A communication was read from Sir Victor Brooke, Bart., describing a new species of Gazelle, founded on two specimens living in the Society's Menagerie, which he proposed to call *Gazella muscatensis*.—A communication was read from Dr. T. Schomburgh, Director of the Botanic Gardens, Adelaide, containing an account of the habits of the Australian Coote (*Fulica australis*) as observed in the Gardens under his charge.—Mr. E. Ward exhibited the head of a supposed new species of Wild Sheep, from Ladak, which he proposed to name *Ovis brookei*, after Sir Victor Brooke.—Dr. J. E. Gray, F.R.S., communicated some notes on the Crocodile of Madagascar, which he proposed to distinguish from *Crocodilus vulgaris* of Continental Africa, and to call *Crocodilus madagascariensis*.—A communication was read from Mr. W. N. Lockington, of Humboldt County, California, containing some notes on the mammals and birds met with in that part of the State of California.

Mathematical Society, Feb. 12.—Dr. Hirst, F.R.S., president, in the chair.—Prof. Clifford gave in some detail a statement of the views advanced in his paper on the foundations of dynamics.—A discussion ensued, in which Messrs. Wilkinson, Moulton, Cayley, Roberts, and G. H. Lewes took part.—Mr. Clifford having answered questions and replied to objections, proceeded next to give an account of a paper on the free motion of a solid in elliptic space.—Owing to the lateness of the hour a paper by Mr. C. J. Monro, entitled "Note on the Inversion of Bernoulli's Theorem in Probabilities," was taken as read. Under the name of Bernoulli's Theorem are comprehended two theorems; which, with a little licence, we may distinguish as the deductive and the inductive. The deductive theorem assumes the constant probability p of a given result on a single trial, and determines the probability P that on m trials the result will be produced from $mp - l$ to $mp + l$ times, or from $x - l$ to $x + l$, if x is the greatest integer in $mp + p$. The inductive theorem assumes that the given result is produced mp times on m trials, which give a constant facility for its production (that is, are made under definable circumstances, which, if defined, would give a constant probability for the same), and determines P′, the probability that this facility lies between $p \pm \frac{l}{m}$. In the deductive theorem it is supposed that $\frac{1}{m}$ may be neglected; and in the inductive $\frac{1}{\sqrt{m}}$. (The author here refers to Mr. Todhunter's "History," p. 555, and to Mr. De Morgan's treatise in the "Enc. Metr.," § 77.) The object of the paper was to show, first that there is an oversight in Laplace's statement of the inversion (see Todhr., § 997), the correction of which removes the inconsistency of the results; and secondly, that upon the hypothesis of equally probable values within equal ranges, the inversion is so far legitimate that either theorem may be inferred from the other with little calculation, and in particular without the approximate evaluation of a general integral, and accordingly that the two solutions are identical in principle.

Chemical Society, Feb. 19.—Prof. Odling, F.R.S., president, in the chair.—Mr. James Bell delivered his lecture "On the Detection and Estimation of Adulteration in Articles of Food and Drink." The lecturer, after some preliminary remarks on the fiscal regulations with regard to adulteration, began with a description of the microscopic appearance of the various kinds of starch, as many of them, from their cheapness, are largely employed for the purposes of adulteration; he then considered the characters of pure coffee and of the various substances used to adulterate it, pointing out the most convenient methods for their detection. Tea, pepper, and mustard, were afterwards treated of in the same way. Owing to want of time, Mr. Bell was unable to complete the lecture, so that the adulteration of cocoa, tobacco, and beer was not touched upon. This admirable and instructive lecture was copiously illustrated by the most beautifully executed drawings of the structure of the various substances as exhibited under the microscope. After the lecture many of the Fellows availed themselves of the opportunity afforded them of looking over the extensive collection of microscopic preparations connected with the subject.

Entomological Society, Feb. 2.—Mr. J. W. Dunning, vice-president, in the chair.—Mr. Müller exhibited a blind Myriapod and others found in a limestone cave in the Jurassian Mountains; he believed them to be the first found in the caves of Switzerland.—Mr. Kirby exhibited *Lycæna phœbe* from Australia, which had been described by the Rev. R. P. Murray.—Specimens were exhibited of *Monohammus leuconotus*, a Longicorn beetle which was very destructive to the coffee plantations in Natal. The only remedy that appeared to have been tried was the application of Stockholm tar to the roots of the trees; but handpicking was suggested on the first appearance of the insect in the imago state. This was the practice usually adopted on the continent of Europe with regard to *Melolontha*. Also it was desirable to protect the insectivorous birds, which were frequently shot for the sake of their plumage.—Mr. Butler forwarded some corrections of the synonymy with regard to *Apatura herse* and *A. lycaon* of Scudder and Riley, which were equivalent to *A. clyton* and *A. celtis*, Boisduval; whereas *A. herse* and *A. lycaon*, Fabricius, were sexes of one species = *A. alicia*, Edwards.—A paper was communicated by Mr. Herbert Druce, entitled "Descriptions of fifteen species of Diurnal Lepidoptera, chiefly from South America."

Meteorological Society, February 18.—The papers read were:—"General Remarks on the West Indian Cyclones, particularly those from the 9th to the 21st Sept., 1872," by Mr. F. H. Jahncke, harbour-master of St. Thomas; "New Forms of Alcohol Thermometers," and "An Improved Vacuum Solar Radiation Thermometer," both by Mr. James J. Hicks; and "Note on a Waterspout which burst on the Mountain of Ben Resipol, in Argyleshire, in August, 1873," by Mr. Robert H. Scott, F.R.S. A very interesting discussion followed the reading of each paper. That upon Mr. Jahncke's led to expressions of opinion on the origin, form, tracks, and general characteristics of West Indian Hurricanes, and of the best means of improving and increasing the records of weather phenomena in those parts. The special feature in Mr. Hicks's second paper was the application of an electric current as a test for the perfection of the vacuum, which principle was very beautifully illustrated by experiments.

Edinburgh

Scottish Meteorological Society, Jan. 29.—Mr. M. Home, of Wedderburn, in the chair.—From the report of the council it appears that two new stations, viz., Broadlands, Peebleshire, and Ochtertyre, Crieff, have been added to the society's stations, and that Kettisis and Cairndow have ceased to be stations. Thus the number of stations in connection with the society is the same as at last meeting, viz., 92 in Scotland, 5 in England, 4 on the Continent, 2 in Iceland, 1 in Faro, and 1 in South America. Observations have also been begun to be made for the society at Melstad, in the north of Iceland, and at Fairlie Plains, Paroo River, near the northern watershed of the River Darling, Australia. The council had had offers of many more stations, some in most eligible districts; but the establishment of these would have entailed additional expenditure which the society's funds would not justify. Teachers of several schools had also made known their wish to observe for the society, provided they were furnished with instruments, at the same time proposing to introduce into their schools some instruction in meteorology. The council, however, had been obliged to decline these applications for want of funds. The membership of the society is at present 560. In room of the three members of council who retired, Prof. Alexander Dickson, Dr. J. Robson-Scott, and Mr. George Hope, of Broadlands, were elected.—An application has been made to the council by Mr. Colin McVean on behalf of the Government of Japan for advice regarding the establishment of a system of meteorological observations in Japan. In answer to this application, the council has forwarded a memorandum regarding suitable instruments, their position, hours of observation, the establishment of a central observatory, inspection of stations, publications, and special observations of storms.—Mr. Buchan submitted a second report of the committee appointed to carry out the Marquis of Tweeddale's proposal to investigate the relations of the herring-fisheries to meteorology. The committee had, with the assistance of the Hon. Bouverie F. Primrose, of the Fishery Board, obtained complete returns of the daily catch of herrings and state of the weather from all the fishing districts of Scotland during the past season. Thirty-five weather maps at 9 P.M., specially constructed with reference to this question, and showing the number of boats out fishing in each district each day and the average catch of each boat, were shown to the meeting. Some interesting relations between the catches of the different districts and the prevailing weather were pointed out; and as these were in general accordance with the results stated in the first report, presented in July last, it is highly probable that when the statistics of three or four years' fishings similar to the very satisfactory returns of the past year have been collected, valuable conclusions will be arrived at.—Mr. Thomas Stevenson, in bringing before the meeting a proposed inquiry regarding storms, remarked that the barometric gradients hitherto ascertained having been deduced from readings at stations many miles apart, necessarily could not give more than a rough approximative gradient. What is wanted in order to get a formula for computing the velocity of the wind due to a given gradient is, as he (Mr. Stevenson) suggested in NATURE, vol. ix. p. 103, to have a string of stations at short distances apart. It is now proposed to establish such storm stations, arranged in lines radiating from Edinburgh for a distance of about twenty miles, and it is believed that in addition to the existing stations of the Scottish Society many farmers and others possess good barometers, which could be compared with the society's standard. It is proposed that observations of the instruments and of the weather should be limited to the periods during which storms last, and a special schedule for the observations had been prepared.—Mr. Buchan gave an account of the proceedings of the Meteorological Congress held at Vienna in September last, to which he and Mr. Scott, of the Meteorological Office, London, had been sent as delegates from the British Government.

Geological Society, Feb. 12.—A paper was read by Mr. John Horne, of the Geological Survey of Scotland, on "The Geology of the Isle of Man." The chief points of interest in the paper were the correlation of the red sandstones and Breccias with the Lower Carboniferous series of Scotland, and the proofs adduced that the volcanic rocks were probably on the same horizon as the upper limestone shales of England. Detailed evidence was given to show that the Isle was glaciated by a confluent ice-sheet from the north-west of England, south of Scotland, and the north-east of Ireland. The two submarine hollows lying between the Portpatrick coast and the north-east of Ireland, and between Anglesea and the coast south of Dublin, were attributed to the increased erosive action of the ice-sheets due to the narrowness of the channel at these points.—Mr. Andrew Taylor gave a description of the course of the River Almond, near Edinburgh, and stated that that river followed, at various places, which he specified, lines of "faults."

MANCHESTER

Literary and Philosophical Society, Feb. 3—*Physical and Mathematical Section.*—Alfred Brothers, F.R.A.S., President of the Section, in the chair.—"On the Theory of the Tides," by David Winstanley.

Feb. 10.—R. A. Smith, F.R.S., V.P., in the chair.—"The Northern Range of the Basques," by W. Boyd Dawkins, F.R.S. The northern extension of the Basque race from their present boundary, in ancient times, is demonstrated by the convergent testimony of history, ethnology, and the researches into caves and tombs. In the Iberian peninsula the Basque populations (Vascones) of the west are defined from the Celtic of the east by the Celtiberi inhabiting modern Castille. In Cæsar's time, the Aquitani were surrounded on every side, except the south, by the Celtæ, extending as far north as the Seine, as far to the east as Switzerland and the plains of Lombardy, and southwards, through the valley of the Rhone and the region of the Volscæ, over the Eastern Pyrenees into Spain. The district round the Phocæan colony of Marseilles was inhabited by Ligurian tribes, who held the region between the river Po and the Gulf of Genoa, as far as the western boundary of Etruria, and who probably extended to the west along the coast of Southern Gaul as far as the Pyrenees. The ancient population of Sardinia is stated by Pausanias to be of Libyan extraction, while that of Corsica is described by Seneca as Ligurian and Iberian. The Basques, or Ligurians, are the oldest inhabitants, in their respective districts, known to the historian; while the Celts appear as invaders. We may be tolerably certain that the Basques held France and Spain before the invasion of the Celts, and that the non-Aryan peoples were cut asunder, and certain parts of them left—Ligurians, Sikani, and in part Sardinians and Corsicans—as ethnological islands, marking, so to speak, an ancient Basque non-Aryan continent which had been submerged by the Celtic populations advancing steadily westwards. The Celtic and Belgic invasion of Gaul repeated itself, as might be expected, in Britain. Just as the Celts pushed back the Iberian population of Gaul as far south as Aquitania, and swept round it into Spain, so they crossed over the Channel and overran the greater portion of Britain, until the Silures, identified by Tacitus with the Iberians, were left onlyin those fastnesses that formed subsequently a bulwark for the Brit-Welsh against the English invaders. The Basque non-Aryan blood is still to be traced in the dark-haired, black-eyed, small, oval-featured peoples in our own country in the region of the Silures, where the hills have afforded shelter to the Basque populations from the invaders. The small swarthy Welshman of Denbighshire is, in every respect, except dress and language, identical with the Basque peasant of the Western Pyrenees, at Bagnères de Bigorre. The small dark-haired people of Ireland, and especially those to the west of the Shannon, according to Dr. Thurnam and Professor Huxley, are also of Iberian derivation, and, singularly enough, there is a legendary connection between that island and Spain. The human remains from the chambered tombs as well as the river-beds prove that the non-Aryan population spread over the whole of Ireland as well as the whole of Britain. The evidence offered by an appeal to history and ethnology, as to the former northern extent of the Basque peoples, is confirmed by an examination of the human remains in the Neolithic caves and tombs, scattered throughout the area under consideration. The discoveries in the caves of Gibraltar and of the Spanish mainland prove that a small long-headed race, with delicate features and orthognathic profile identical with the Basques who buried their dead in the modern cemetery of Guipuscoa, ranged throughout the Peninsula, using with indifference caves and chambered tumuli for their tombs. And on the same grounds their former range through France, Britain, and Ireland is demonstrated, and as far to the east as Belgium. At the present time the Basque blood asserts itself in the physique of certain isolated populations, and within the historic period is demonstrated to have been more strongly defined, and to have occupied larger areas, and lastly in the prehistoric period to have formed one continuous race from the Pillars of Hercules, as far north as Scotland, and as far to the east as Belgium.

NEW HAVEN, U.S.

Connecticut Academy, Dec. 17, 1873.—Prof. Lyman, president, in the chair.—Prof. Marsh, of Yale College, gave an account of the explorations of his party in the Rocky Mountains and on the Pacific Coast during the past season. The first explorations this year were made in the Pliocene deposits near the Niobrara River. Owing to hostile Indians, the explorations of the party here were attended with much difficulty and danger, but were on the whole quite successful. Many new animals were discovered, and ample material secured for a full investigation of those previously known from that region. A second expedition was made in August from Fort Bridger, Wyoming, and large collections of Eocene fossil vertebrates were obtained, especially of the *Dinocerata*, *Quadrumana*, and *Chiroptera*, which had first been brought to light by the researches of the party in previous years. A third trip was made in September to the tertiary beds of Idaho and Oregon, where some interesting discoveries were made.

PARIS

Academy of Sciences, Feb. 16.—M. Bertrand in the chair.—The following papers were read:—On the acid waters which flow from the volcanoes of the Cordilleras, by M. Boussingault.—On a mechanical equation corresponding to the equation $\int \frac{dQ}{T} = 0$, by M. R. Clausius. This was a paper relating to those of M. A. Ledieu on the same subject which have recently been read.—Report on a memoir, by M. Marey, on the point of action of a wing on the air, M. Tresca, reporter.—Experiments to determine whether all the vascular nerves have their focus of origin and their vaso-motor centre in the rachidian bulb, by M. A. Vulpian.—New topographical chart of Mont Blanc on a scale of $\frac{1}{40,000}$, by M. E. Viollet-Leduc.—M. Ad. Chatin advanced his paper On androgenesis compared with organogenesis another stage.—On the action of soft waters on metallic lead, by MM. Mayençon and Bergeret. Electrolysis was used by the authors to detect the lead, as they considered sulphuretted hydrogen not sufficiently delicate. They found galena slightly soluble in water by long boiling.—On the preservation of wood by means of cupric sulphate, by M. Boucherie.—Facts illustrating the history of yeast, by M. P. Schutzenberger.—On a transformation of Taylor's formula, by M. Jourgon.—On a method of determining vapour densities, by M. Croullebois. This method is a modification of that which depends on observing the tension of the vapour in a barometer tube.—Observations on the efflorescence of the two hydrates of sodic sulphates, by Dr. L. C. de Coppet. This was an answer to a late paper by M. Gernez.—On the "antifermentescible" and antiputrid properties of solutions of chloral hydrate, by MM. Dujardin-Beaumetz and Hirne.—On the method of respiration in certain fish having a labyrinthiform pharynx, by M. Carbonnier.—On the fossils brought from Cape Verde Islands by M. de Cessac, by M. P. Fischer.—On the movements of the chlorophyll in the *Selaginaceæ*, by M. Ed. Prillieux.—On the relations between thermoelectric properties and crystalline form, by M. C. Friedel.—On a method of quickly re-forming vineyards threatened by phylloxera by the introduction of American vines, by M. H. Bouschet.—On anesthesia produced by the injection of chloral, by M. Oré.

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