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THE FACE OF THE EARTH.

Das Antlitz der Erde. Von Eduard Suess. Mit 23 Textabbildungen, 6 Tafeln und einer Karte der Scheitel Eurasien's. Dritter Band. Erste Hälfte. Pp. iv + 508. (Wien : Tempsky, 1901.) Price 25*s.* net.

La Face de la Terre. Par Eduard Suess. Traduit avec autorisation de l'Auteur et Annoté sous la Direction de Emmanuel de Margérie. Tome II. Pp. 878. (Paris : Colin, 1900.)

SINCE the publication of Lyell's "Principles" no general treatise on geology has aroused more interest or exercised a more important influence on the evolution of geological ideas than "Das Antlitz der Erde," the first two volumes of which were reviewed in NATURE of April 25, 1889. Thirteen years have elapsed since the second volume appeared. It left the plot—if we may be allowed to use that expression—in a somewhat complicated condition, but the interest was maintained and not a little curiosity was aroused as to how the distinguished author would weave the various threads together. The first part of the last volume is now before us, but the mystery is not solved. We must wait with such patience as we can command until the conclusion appears.

As the leading ideas which run through the entire work may not be familiar to all readers of NATURE, a brief account of them will be given before proceeding to the review of the new volume. It must, however, be remembered that the work contains a careful and elaborate statement of facts relating to the structure of almost every part of the world, and is, therefore, of great value as a work of reference, quite apart from the truth or error of the theoretical views of the author.

A study of the structure of the earth's crust proves that it has been affected by two types of movement—the one characterised by a compression of the stratified rocks along certain zones, the other by a separation of the crust into blocks, some of which have sunk down relatively to others. The first type is best illustrated in modern mountain ranges, such as the Alps and Himalayas, the second in districts which have not recently been affected by folding movements.

One and the same area cannot be simultaneously affected by these two types of movement, but a folded zone may, after the folding stresses have ceased to act, be broken up by more or less vertical faults and by the sinking down of certain portions. It is probable that no part of the earth's surface has escaped the action of lateral pressure, but large tracts—as, for example, the north of Russia—have not been affected by it since pre-Cambrian times.

By the sinking of certain areas ocean basins are formed, enlarged or deepened, and terrestrial features like the Great Rift Valley of Central Africa are produced. When the sinking process takes place those parts of the crust which remain stationary, or which do not sink so much as the others, are termed "horsts." According to the author, the continents are of the nature of "horsts"; they have not been formed by elevation, but by the sinking of the intervening tracts.

In support of such a view he refers especially to the fact that no proofs of the presence of a Mesozoic sea are to be found over southern India or the corresponding portion of Africa. On the contrary, the continental deposits of the Gondwana and Karoo series end off abruptly against the ocean. Such facts as these are, he considers, incompatible with the view that continents have been formed by elevation.

But although the existing oceans have been formed by depressions, it must not be supposed that all parts of any one ocean are of the same age, any more than that he continents have been formed by one simple or continuous process. The modern Atlantic, for example, has probably been produced by an enlargement in a northern and southern direction of Neumayr's Centrale Mittelmeer.

The geologist, however, has not only to deal with movements of the earth's crust, but also with changes in the relative level of land and sea. In speaking of such movements Prof. Suess considers that we should adopt a phraseology independent of theory. A rise of sea-level he terms a positive movement and a sinking of the sea-level a negative movement. The Black Sea and the Ægean Sea are both of quite recent date. If no water occupied these areas before the sinking took place, a lowering of the sea-level all the world over to the extent of about four metres must have been produced when they were formed. The crust of the earth breaks in and the sea follows; but whilst the depressions of the lithosphere are limited in extent the lowering of the sea-level is universal.

If we study the succession and distribution of sedimentary deposits we find, over large areas, clear evidence of transgressions or, in other words, of positive movements; these must have been of great extent and duration. Comparative stratigraphy shows that the positive and negative movements are too widely extended to be due to local movements of elevation and depression affecting the solid crust. Thus the Upper Cretaceous transgression, which forms such a striking feature in the geology of southern England, makes itself felt on the Amazon, on the Athabaska and on the Elbe, on the banks of the Nile and in the Tarim Basin, in the valley of the Narbudda and in Borneo, in the island of Sachalin and on the banks of the Sacramento.

The very fact that we are able to employ the same terminology to distinguish the broader sedimentary groups in all parts of the world is a proof that the limits of these groups have been determined by general and not by local causes. England is peculiarly well adapted to furnish the basis for a general classification, because the more important negative movements are here clearly marked out by the intercalation, in the marine series, of continental or fresh-water formations; and the limits established by William Smith and his successors correspond, for the most part, to these movements. At the commencement of a negative phase portions of the oceanic areas become isolated, saline and gypsiferous deposits are formed and the marine fauna becomes impoverished, but its final disappearance only takes place after the negative phase has reached its maximum.

It must not be supposed that the movements are continuous. Just as the actual limit of the water is continually oscillating backwards and forwards during the rise and fall of the tide, so it is with the positive and negative

movements which are recorded in the rocks; the positive movements appear to last much longer than the negative movements which follow them. From the Rhætic to the Callovian in Europe there was an encroachment of the sea upon the land subject only to minor regressions, but the succeeding negative phase which is marked by the Portlandian and Purbeckian was of comparatively short duration.

How are these slow positive movements to be accounted for? The deposition of sediment necessarily tends to produce a continual rise of the sea-level. The formation of the Black Sea and the Ægean Sea, as we have pointed out, would account for a general lowering of the sea-level to the extent of 4 metres; but to produce a corresponding movement in the opposite direction by denudation and deposition would require the transference of an amount of solid rock equivalent to the lowering of the general surface of the land by as much as 10 metres.

The author, however, hesitates to draw the conclusion that the principal positive movements are the result of this cause, and favours the idea that, in some unknown manner, the waters of the ocean have been alternately heaped up at the equator and the poles.

We turn now to the volume which forms the more immediate subject of this review. It deals mainly with those portions of Asia on which so much light has been thrown during the last decade by the indefatigable researches of Russian geologists; the method of treatment is that with which all readers of the first two volumes are familiar. Broad generalisations are suggested in a few words, and then follows a mass of local detail which it is impossible to understand fully without better maps than those which illustrate the work or which are to be found in any ordinary atlas. We look forward with interest to the publication of the French translation, for in the matter of maps and illustrations the French editions of the first two volumes are superior to the original German work. We owe a deep debt of gratitude to M. Margérie and the other distinguished French geologists who have taken so much pains in the translation of this remarkable work and in the selection of additional maps and illustrations.

Different observers have taken different views as to the structure of Asia, but all are agreed as to the existence of a certain uniformity of plan. Prof. Suess calls attention to the predominance of bow-like forms. Such forms are seen on the shores of the Pacific and in the festoon-like arrangement of the adjacent islands, on the Ganges, the Indus and in Iran. The bows may be strongly or weakly bent, crowded together or separated from each other, but they are always arranged in such a way as to suggest a relation to some central nucleus. This nucleus the author finds in the neighbourhood of Irkutsk and Lake Baikal. It is a region of Archæan gneisses and schists which has been broken up into "horsts" and "sinkings." The great amphitheatre of Irkutsk which is drained by the Angara forms a notch in "the old nucleus" (der alte Scheitel). It has been formed by sinking and is bordered by powerful faults.

As the nucleus is approached, the forms of the mountains change. In the neighbourhood of the sea volcanoes occur; further inwards the snow-clad peaks of the giant mountains form the dominant features; to these succeed the rock-walls of the Gobi, which rise above the lower ground formed of horizontally stratified deposits. From the Altai to the region south of Lake Baikal and onward to the Upper Amur, the features are characteristic of an old mountain land which has been more or less completely worn down by denudation. The mountains here have rounded summits, and rest on broad bases. The river systems are fully developed, and when rapids occur they can be traced to comparatively recent changes, such as the outpouring of basalt. These are the characteristic features of the old nucleus. To the north of this nucleus the elevations are tabular and are often formed of flat-lying Palæozoic strata capped by later basalts. In the tundra region of the extreme north, marine horizontal strata give evidence of the Mesozoic transgression.

So far we have been referring only to the introduction. The second section deals with Siberia, which is divided into two well-marked areas, the west Siberian plain and the east Siberian tableland. The only eminences which rise above the alluvial flats in the western plain, between the Yenesei and the Obi, are relics of a once extensive sheet of soft Tertiary sandstone. The Middle Jurassic transgression, which is traceable from the Arctic regions over the Petchora to Cracow, extends from Russia through the low grounds of Turan to Baluchistan and round the shores of the Indian Ocean, but has not as yet been recognised in western Siberia. The only traces of the widespread Upper Cretaceous transgression occur in western Siberia at Ajat, in the south-west corner. Marine deposits with characteristic European fossils here lie on folded Palæozoic strata.

The Tertiary seas (Upper Eocene and Lower Oligocene) gained access to Siberia through the Straits of Turgai (south of the Urals), and reached as far as Semipalatinsk and Sosswa. About the middle or end of the Oligocene period, all connection with the European seas was cut off and the flora of the amber forests spread over the regions vacated by the sea. This great negative movement led to the isolation of oceanic areas both in Europe and Asia, and to the formation of extensive salt-deposits.

The east Siberian tableland is bounded on the south by the old nucleus, on the north-east by the bow of the Werchogan Mountains, on the north-west by the mountains of the Taimyr Peninsula and on the north by the frozen sea. The Lena belongs to the tableland, and flows in a valley which is often 300 metres deep. Four elements take part in the structure of this plateau region. The first is the Palæozoic floor, which probably underlies the whole. The lowest beds belong to the *Olenellus* zone. They are horizontal except on the borders of the amphitheatre of Irkutsk. This amphitheatre has already been referred to as a sunken portion of the old nucleus which is bordered by powerful faults. Folding and even overfolding are associated with these faults, and the direction of overfolding, as so frequently happens under similar circumstances, is directed towards the centre of the sunken tract.

The second element consists of plant-bearing beds, which often contain workable coal. *Asplenium whithyense* is common, and the deposits were referred by Heer to the Middle Jura. The rocks are sandstone and conglomerate. Plant-bearing beds of the same general type

are widely distributed in Central Asia, and it is practically certain that they are not all of the same age; thus Zeiller has recognised affinities with the Gondwana flora and has referred certain deposits occurring in the Altai Mountains to the Permian period. From a consideration of these plant-bearing deposits the author is led to an interesting generalisation. They indicate a Mesozoic continent on the north comparable with Gondwanaland on the south. Between the two lay Neumayr's Centrale Mittelmeer (the author's Tethys), the marine deposits of which are now traceable in a broad zone stretching from Timor and Sumatra through Tonkin, Yunnan, the Himalaya, Pamir and Hindu Kush to Asia Minor and Europe. Modern Asia owes its origin, therefore, in great measure, to the disappearance of Tethys, the rucking up of its sediments into mighty mountain ranges and the consequent union of Angaraland on the north with the Indian fragment of Gondwanaland on the south.

The third element which enters into the structure of the east Siberian tableland consists of Mesozoic marine deposits, indicating encroachments of the sea from the north at various periods. They have not as yet been traced further south than 62° N. lat., but as the plant-bearing beds of the Angara series have been found in higher latitudes it is certain that the northern boundary of Angaraland must have oscillated backwards and forwards during the Mesozoic period. The marine deposits include representatives of the Middle Lias, Oxfordian, the Volga series and the Neocomian.

The fourth element consists of widespread sheets of basaltic lava. One of these sheets extends from latitude 60° 15′ on the Lower Tunguska to the mouth of the Yenesei. It covers about 6° of latitude and 9° of longitude. These basalts do not stand related to definite volcanic cones. They are of the true plateau type and are thus brought into connection with the basalts of Franz Josef Land and of the Brito-Icelandic province.

On the Lower Tunguska they are associated with deposits of the Angara series, and, although true lavas occur, it is not improbable that the sediments were invaded and sometimes broken up by vast intrusions of a sill-like character, which separated and floated off large masses.

The third section of the work deals with the old nucleus (der alte Scheitel). This extends from the Yenesei above Krasnoyarsk eastwards to the Great Chingan range and as far south as the Gobi Altai. East of Lake Baikal the dominant strike is south-west or west-south-west, west of Lake Baikal it is south-east or east-south-east. These two dominant strikes were produced by pre-Cambrian earth-stresses, but they have determined the directions of the later folding and faulting on the borders of the amphitheatre of Irkutsk and in other regions.

In addition to granites, gneisses and schists, the only rocks entering into the composition of the area in question are fresh-water Tertiary formations and basalts—the latter are allied to those occurring in the tableland of east Siberia. The period of eruptions must have been of great duration, for basalt is found, not only capping the ancient hills of gneiss and schist in horizontal sheets, but occurs also in the beds of existing valleys. The district has been broken up into "horsts" and "sinkings," which are described in great detail from the writings of Russian geologists. Many of the "sinkings" are shown to be of the rift-valley type (Gräben).

The fourth section treats of the Great Chingan range, the plain of the Upper Amur, the Aldan mountains, the Lesser Chingan, Manchuria, Sichoto-Alin, Hokkaido, Sachalin and the Japanese islands. Over the whole of this vast area the author recognises a common type of structure. We will give his views as nearly as possible in his own words.

"In the fruitful plain of the Amur, through the dark primeval forests of the Turkana mountains and the Lesser Chingan as far as the deserts of Sachalin and the great oceanic depths off the Japanese coast, a common arrangement of the leading lines (Leitlinien) finds expression in the convergence of all the curved mountain ranges towards the north of the Sea of Okhotsk. . . . Could we remove the waters of the ocean we should then see the curved rows of islands standing out as mighty mountain ranges. Curve follows curve (Bogen reiht sich an Bogen), and the wonderful agency by which all these curved chains have been produced appears to have proceeded outwards from the central nucleus and to have extended its operations beyond the limits of the modern coast-line."

As the Pacific Ocean is approached, marine deposits of Mesozoic age are met with and traces of the Middle Cretaceous transgression are found in the island of Sachalin. But the plant-bearing beds of the Angara series occur in the plain of the Amur and in Manchuria, thus indicating an extension of Angaraland which has been dropped down in successive steps towards the east by faults and flexures. In spite of this, however, the land area must have increased where the marine Mesozoic strata occur. This increase may have been caused in part by folding, but is probably due, in the main, to a draining off of the sea-waters to fill oceanic depressions formed elsewhere.

Angaraland, which in some parts of Asia goes back to the Carboniferous and in others at least to the Rhætic periods, furnishes an illustration of the permanence of continental areas, though not in the sense in which that expression is usually employed. Since life first appeared on the planet, the phylogenetic thread has never been broken, although evolution has not been continuous and uniform. For the dwellers on the land and in fresh-water the continuity of this thread requires the permanence of continental areas for long periods. Angaraland must, therefore, have been of great importance from a biological point of view. Throughout a large portion of geological time it must have been, not only a retreat for terrestrial and fresh-water forms of life, but also a land capable of sending out colonists as occasions arose.

Enough has now been said to give an idea of the nature of the book and of the method of treatment adopted by the author. The contents of the remaining sections will only be indicated. The fifth and sixth deal with the Altai and the more or less related chains which the author groups under the name of the Altaides; the seventh with the Yarkand-arc and with Iran and Turan; the eighth with the principal ranges of Asia Minor; the ninth and last treats of northern Europe.

Geologists may differ on many points discussed by the author, but no one can complain of the way in which he has presented his views. He is never dogmatic. His

method is to marshal the facts and suggest the conclusions to which they point. One of the most delightful characteristics of the book is the sympathetic interest which the author shows, on almost every page, in the labours of other workers. His sympathies are as all-embracing as the views which he has formed as to the origin of terrestrial features.

The French translations of the first two volumes have already been referred to. The extensive knowledge and great literary skill of M. E. de Margérie, under whose direction the translation has been carried out, are a sufficient guarantee of the excellence of the work. It has evidently been a labour of love with the translators, who have treated their author with that respect which should always be shown in such cases. In two respects the translations are better than the original work. The number of maps and illustrations has been greatly increased (128 as against 43 for the second volume), and the notes, which are voluminous and often very important, are given at the foot of the page to which they refer instead of at the end of each section. Moreover, the notes and references have been brought up to date, but all additions are indicated by the use of square brackets. J. J. H. T.

THE CHEMISTRY OF DYEING.

A Dictionary of Dyes, Mordants and other Compounds used in Dyeing and Calico Printing. By Christopher Rawson, F.I.C., F.C.S., Walter M. Gardner, F.C.S., and W. F. Laycock, Ph.D., F.C.S. Pp. 372. (London: Charles Griffin and Co., Ltd., 1901.) Price 16*s.* net.

THE technology of dyestuffs and dyeing materials has acquired in recent years such a degree of complexity that a dictionary of the subject has become almost a necessity. This want is now supplied by the handy volume before us. Although essentially a dictionary and not to be regarded in the light of a text-book, it nevertheless contains many excellent articles on the chemistry and technology of textile fibres and colouring matters, and should be a most valuable work of reference for all engaged in the arts of dyeing, bleaching, calico printing, paper staining, &c. The book is issued as a companion volume to the well-known "Manual of Dyeing," by Knecht, Rawson and Loewenthal, to which in some respects it serves as a supplement. The methods for the commercial analysis of the various chemicals, mordants and dyeing materials are treated with considerable detail. With regard to colouring-matters a careful system of classification is employed, each group being given a special article, *e.g.*, acid colours, basic colours, direct cotton colours, mordant dyes, &c., and under each of these headings we find a fairly complete list of all the colouring-matters of the particular group at present in use. For further information with regard to individual dyestuffs, each name must be separately consulted. Excellent general articles are also to be found upon indigo, tannin matters, action of light upon dyes, and upon the analysis, valuation and detection of coal-tar colours.

On the other hand, besides a few superfluous articles having little or no bearing on the subject of dyeing (*e.g.*, the headings Acetaldehyde, Acetanilide, Antifebrine, &c.), there are some serious omissions. Thus no method is given for examining the quality of commercial betanaphthol, a matter of much greater importance to the dyer or printer than the isomerism of the sulphonic acids of dioxynaphthalene or of alphanaphthylamine, the reference to which might well be omitted. Again, there is no article upon paranitraniline, but only a cross reference under "Paranitraniline red" to "Azo colours on cotton," where no description is to be found of the properties or methods to be employed in examining for purity this most important product. The same remark applies to dianisidine, only "Dianisidine blue" being referred to under "Azo colours on cotton." The heading of the last-mentioned article should surely have been "Insoluble azo colours on cotton" or "Azo colours produced on the cotton fibre," since all the substantive benzidine colours when applied to cotton might equally be styled "Azo colours on cotton." We also fail to find any reference to sodium sulphide, bronze colours, discharges, persulphates or titanium mordants.

Under the individual colouring-matters there might have been given in some cases a rather fuller account of the special tinctorial properties and degree of fastness to reagents (soap, alkalis, acids, &c.) To provide for these additions considerable space might have been saved by the omission of the names of obsolete colouring-matters and of obsolete names of colouring-matters still used (for instance, aldehyde green, azuline, canelle, heliochrysine, and many others).

A few errors are noticeable in the text, as, for instance, in the article "Janus colours," which latter are stated to be sulphonated basic dyes, whereas in fact they contain no sulphonic group, but are azo-compounds, which owe their solubility and peculiar dyeing properties to the presence of strongly basic ammonium or azonium groups. Again, thioflavine T is given as a derivative of primuline, whereas it is the methylated ammonium compound of dehydrothiotoluidine. The list of manufacturers of colouring-matters given on p. 94 and also opposite to p. 1 is scarcely up-to-date, one of the firms mentioned having ceased to exist, whilst two others have been reconstituted under new names. In spite of the above defects, which can readily be rectified in subsequent editions, the work may be confidently recommended to all engaged in the textile and tinctorial industries as an invaluable lexicon of the subject.

ANIMAL LIFE OF THE CONGO FOREST.

The World of the Great Forest; How Animals, Birds, Reptiles, Insects Talk, Think, Work and Live. By Paul du Chaillu. Pp. xv + 323. Illustrated. (London: Murray, 1901.) Price 7*s.* 6*d.* net.

IN the outlandish and almost unpronouncable native names of animals which form the chapter-headings and recur with wearisome iteration in the text, this volume reminds us of Longfellow's "Hiawatha," although, in our opinion, without affording anything comparable to the pleasure which may be experienced in reading the latter. The author appears to have taken as his model that delightful book of Mr. Seton-Thompson's, "Wild Animals I Have Known"; but if so he has, we think, succeeded in producing only a very poor and feeble

imitation. We have submitted Mr. Du Chaillu's volume to several friends of diverse ages and sexes in the hope of obtaining an opinion as to the class of readers for whose benefit it is specially intended, but in no instance have we succeeded in obtaining a definite answer on this point. One thing is perfectly certain, namely, that no scientific naturalist will gain any information worth having from a perusal of its pages. A lady suggested hat it was like a book for very young children, without being sufficiently amusing.

The author, who firmly believes that animals have a definite language by means of which they communicate their ideas, not only to their own fellows, but to the members of other species as well, had a grand subject before him in describing the life of the denizens of the great Congo forest. But, in our opinion, the conversation he has put into the mouths of the animals is the merest drivel. And when animals, such as leopards antelopes and elephants, have familiar English names, we quite fail to see the advantage of alluding to them by their negro titles, apparently for the sake of translating them. When an animal like *Tragelaphus euryceros* has no good English name, it is right and proper that its native title—in this case "bongo"—should be employed; but the substitution of "kambi" for antelope is merely confusing. Neither is the work altogether free from absolute errors, while in several instances statements that have been controverted reappear as though they were undoubted facts. As an example of the former class we may refer to the statement on p. 42 that "large flocks of toucans (a bird with a huge bill)" are among the denizens of the Congo forest! As an instance of the second kind, it may be mentioned that (pp. 154–155) the author revives the old story of the gorilla advancing to the attack in the upright posture, beating his breast with his fists. We thought this story had been disposed of by Winwood Reade, who denies that du Chaillu ever saw a living gorilla in the wild state; and, so far as we are aware, no subsequent traveller, with better information at command, has ever said a word in its support.

Again, several of the incidents related appear absolutely incredible. For instance, on p. 95 we have a wonderful picture of a gorilla struggling to free himself from a porcupine on which he had incautiously trodden in his descent from a tree. Bearing in mind the well-known power in wild animals of detecting the presence of other creatures, such an event requires the most convincing testimony to render it credible, and yet it is related without special comment. In another chapter (p. 160) we are told how a python coiled around a tree-trunk "made a tremendous spring" and in an instant was coiled tightly round the body of an unfortunate antelope, which it squeezed to death. How a python could make the spring in question and at the same time disengage itself from the tree around which it was coiled we are not told. As a minor matter, a small inaccuracy in connection with this anecdote may be mentioned. In the accompanying illustration the antelope, which is evidently one of those species of which the females are unarmed, is represented with horns, and yet in the text it is alluded to as a female.

Although it is certainly incorrect to call a land-tortoise a turtle (p. 101), this confusion in terms may perhaps be excused on account of the author's nationality. A similar excuse cannot, however, possibly be made for the statement on p. 266 that "a pack of ugly-looking striped hyænas" advanced into the moonlight. In the first place, striped hyænas are quite unknown in West Africa; and, in the second, the author is refuted by his own draughtsman, who, in the plate on the opposite page, has figured an unmistakable group of *spotted* hyænas. Moreover, if we mistake not, the illustration in question is based, without acknowledgment, on a picture which has already appeared elsewhere.

Neither can we congratulate the author on his views with regard to the *raison d'être* of the coloration of certain animals. It has, for instance, been almost conclusively proved by Mr. Pocock in this Journal (vol. lxii. p. 584) that the striking type of coloration prevalent among the harnessed antelopes is strictly protective. And yet, when referring to the bongo (a member of the group), the author (p. 223) writes as follows:—

"'My beauty is my curse, dear kambis and ncheris,' replied the bongo; 'my yellow colour and my white stripes are my bane, for my enemies, which are also yours, can spy me further and quicker than they do you.'"

Quite apart from the misapprehension of the object of the bongo's colouring, it may strike the reader of this marvellous book that animals thus endowed with the "knowledge of good and evil," as indicated by their conversation, might have been trusted to have devised some artificial mode of concealing themselves from their enemies! R. L.

OUR BOOK SHELF.

Roads; their Construction and Maintenance. By A. Greenwell, A.M.I.C.E., and J. V. Elsden, F.G.S. Pp. vii + 280. (London: Whittaker and Co., 1901.) Price 5*s*.

THIS is a very practical and useful treatise on roads and their maintenance and may be read with great advantage by any intelligent road surveyor. After the dissolution of the turnpike trusts and the handing over of the roads to the charge of the ordinary highway surveyors the main roads of this country became much neglected. The power acquired by County Councils over the main roads, and of District Councils over other highways, has to a certain extent revolutionised the system of road management and a marked improvement has taken place. The use of the cycle and the motor-car, however, demands a much higher standard of efficiency than was ever before required. There is no doubt that the motor-car, as a means of locomotion and transport, has come to stay and will in future fulfil in many cases functions for which now it is deemed necessary to provide light railways and suburban tramways. For these machines to be used with comfort a clear and even road surface, free from mud and loose stones at all times of the year, is indispensable. The best steam-rolled macadamised roads do not fulfil these conditions. In this respect what are termed tar macadam roads, which have been adopted in a great many suburban districts, not only afford a good surface for traction but, being impervious to wet and not acted upon by frost, are clean and more economical than macadamised roads; they are easily repaired and there is an entire absence of loose stones, equally dangerous for horses and deleterious to rubber tyres. The authors speak favourably of this class of road and describe the system as growing in favour, but the cost as given in

the book is higher than that at which they can be laid in the neighbourhood of provincial towns.

Nearly half the book is devoted to a description of the materials used in the maintenance of roads and to their petrology, a subject which should be carefully studied by road surveyors. The authors very clearly show that it is more economical to procure suitable material from a distance than to employ local stones because the first cost is less. There is a very considerable difference in the wearing qualities of different kinds of stone, the reasons for which are clearly shown in the book.

The chapter on the construction of roads gives information which is now little required in this country, but would be of service to a surveyor in the colonies; those on maintenance and cost contain a great many useful and practical hints. The observations under the last head are well worth the consideration of all authorities having charge of the roads of this country. The authors emphasise what has often been pointed out—that good roads can only be obtained by their being placed under skilled management and by maintaining a high standard of efficiency; that roads maintained in good condition cost less to keep up than those which are allowed to be rutty, uneven and covered with loose stones and mud; and that while unnecessary expenditure is to be avoided, the community ought to understand that money well spent in skilled labour and good material is often saved over and over again in time and convenience.

Morphology of Spermatophytes. By John M. Coulter, Ph.D., and Charles J. Chamberlain, Ph.D. Pp. x+188. (New York: D. Appleton and Co., 1901.) Price 1·75 dollars.

FOR a long time past a comprehensive account of the gymnosperms has been greatly needed, for within recent years many important memoirs have appeared which have thrown much light on the structure and relationships of this interesting family of plants. It is, then, with an anticipatory feeling of pleasure that one opens the first instalment of Messrs. Coulter and Chamberlain's book on the morphology of the spermatophytes, seeing that it is entirely devoted to the gymnosperms. And it may at once be said that the authors have done their work well. The book is more than a critical exposition of our present knowledge, for it embodies also the results of a considerable amount of original research on the plants in question. The illustrations are many and good, and include a large proportion of new figures.

The main groups into which the authors divide the family are dealt with in separate chapters, and *Ginkgo* is treated as the representative of a division coordinate with that of the Cycadales or of the Coniferales. The chief fossil types are also considered, and a somewhat detailed and illustrated description is given, based on a study of Dr. Wieland's preparations, of the structure of the strobilus of *Cycadoidea*.

A due proportion is maintained between the space allotted to the account of internal microscopic structure and of general morphology respectively, although naturally the former, which includes the cytological details, comes in for the greater share. Nevertheless, by no means the least interesting chapters in the book are those dealing with the comparative morphology and phylogeny of the gymnosperms as a whole. The authors would regard them as having a monophyletic origin, traceable to a Filicinean ancestry through the Cycadofilices. They base their opinion mainly on the undoubted descent of the cycads from these forms, and on the difficulty of dissociating the other gymnosperms from the cycads. They do not, however, regard the connection between the different groups as a very close one, and suggest that the Bennettitean stock may have served as the starting-point for the cycads, whilst they would refer Ginkgoales and Coniferales to a Cordaitean ancestry.

They judiciously refrain from dealing very specifically with the Gnetales. The three constituent genera, Gnetum, Tumboa (a name which one regrets to see displacing Welwitschia) and Ephedra differ so widely, both from each other as well as from the rest of the main groups, that they can only be regarded as isolated remnants of some ancient line, the affinities of which it is as yet impossible to do more than guess at.

A short sketch of the geographical distribution of the gymnosperms brings the volume to a close. The authors are to be congratulated on the ability they have displayed in producing a work which is valuable, not only as a text-book, but as a real contribution to science.

Guide Pratique pour les Calculs de Résistance des chaudières a vapeur et l'Essai des matériaux employés. Par G. Huin et E. Maire, avec la collaboration de H. Walther Meunier. "Actualitiés Scientifiques." Pp. vi+67. (Paris: Gauthier-Villars, 1901.) Price fr. 2.75.

THIS book, consisting of a collection of data and tables relating to boiler construction, is a translation of those adopted by l'Union Internationale des Associations de surveillance d'Appareils a Vapeur, which are in common use in Germany.

Part i. is devoted to formulæ, supplemented by extensive tables, for the determination of the dimensions of the principal parts of boilers.

Part ii. gives the rules relating to the selection of the material and specifies the tests to be used in any case.

The whole book covers about the same ground as the Board of Trade or Lloyd's rules for boilers, considered in greater detail and the calculations assisted by tables. The latter include, thickness of flue plates, for various lengths, diameters and pressures, thickness of shell for iron and steel, with various joints, dimensions and pressures, and the thickness of flat plates under various systems of staying.

The formulæ given are in nearly every case of the same form as those used here, but generally speaking the constants are such as to give slightly smaller dimensions.

This is due to the use of an average factor of safety of 4·5 compared with 5 required by the Board of Trade.

For the thickness of flue the formula given is Bach's

$$t=\frac{p.d}{k}\left(1+\sqrt{1+\frac{p}{k'}\frac{l}{l+d}}\right)+k'',$$

which should be applicable for a much wider range than our simple

$$t=\sqrt{\frac{p.l.d.}{k}}.$$

There is very little that is not to be found in an ordinary engineer's pocket book. F. H. H.

Ein Wort über den Sitz der vulkanischen Kräfte in der Gegenwart. (Mittheilung aus dem Museum für Volkerkunde zu Leipzig.) Von Alphons Stübel. Pp. 15; 9 figures in text, 1 coloured plate. (Leipzig: Max Weg, 1901.)

AS such a difficult subject cannot be discussed in a short notice, it must suffice to give the author's conclusions. He regards the globe as originally a liquid mass, which has become incrusted through loss of heat. This crust at first would be thin and incapable of offering an effective resistance to the struggles of the liquid interior. It would be ruptured at countless points, great floods of lava would be outpoured, without, however, the building up of important volcanic hills. At this epoch the earth may have even been surrounded by a photosphere. In the second stage the crust layer thickens to about 10 kilometres—the phenomena are similar in kind, but correspondingly reduced in extent. In the third stage the crust layer is about 25 kilometres, and the places of

discharge from the liquid interior are fewer. Eruptions come from local reservoirs in the generally solid crust, which, however, may have a communication from beneath with the inner mass. In the fourth stage, when the crust layer approaches 50 kilometres, there is a further decline in number, though an increase in violence, of discharges from the liquid interior, but the activity of the reservoirs is maintained, and henceforth these are the main sources of vulcanicity. That is the age of catastrophic eruption, and the photosphere is disappearing. The next stage continues the cutting off of direct communication with the interior, separation takes place in the masses of magma, and local eruptions are still very violent. This phase may correspond with that stereotyped in the moon. The sixth stage begins, the seventh continues, the deposit of sediments, during which metamorphism is active in the lower beds, thus forming an outer skin to the crust layer. Eruptions continue to affect a plateau type in the earlier of these; the volume of the reservoirs is gradually being reduced, as well as the communications with the more distant interior of the earth. The eighth, in which the liquid reservoirs are few and small, and communication from within any part of the thickened crust layer to the interior very rarely exists, is the present period.

Photographic Cameras and Accessories. Edited by Paul N. Hasluck. Pp. 160. (London: Cassell and Co., Ltd., 1901.)

IT is not often that one meets with amateur photographers who possess cameras made with their own hands, because at the present day instruments can be obtained at such prices that the pocket of even the most modest purchaser can be suited. This is, however, no reason why a camera should not be home-made; and, in fact, besides affording the worker a very pleasant occupation, especially anyone who is interested in carpentry, it redounds to his credit if he turns out a good-looking and serviceable camera and produces first-class pictures with it.

The contents of this little book will afford a very ready and serviceable guide to anyone who wishes to try his hand in this direction, and supply the reader with concise information on the details of the subject of which it treats. As we are told in the preface, the matter consists essentially of a digest of material contributed by a professional photographer to a weekly journal, so that the instructions should be, and are, thoroughly practical. The text is accompanied by a great many working drawings, 241 in number, and deals, not only with the construction of the bodies of cameras, but with dark slides, shutters and stands.

Trattato elementare di Fisica. Da Oreste Murani. Vol. iii. Optics and Electricity. Second edition. Pp. xxi+675. (Milan: Ulrico Hoepli, 1901.)

THIS is a descriptive treatise in which the experimental phenomena in optics and electricity are described and the apparatus used for exhibiting or applying them are illustrated by no less than 593 woodcuts. It is essentially non-mathematical in its treatment, the few formulæ included in the text in connection with such laws as the law of refraction of light and Ohm's law involving no calculus and merely the notation of trigonometry. In regard to modern electrical discoveries and notions, Prof. Murani has brought his treatise very much up-to-date, and the experiments of Righi, Lenard, Hittorf and Hertz on electric discharges, the Röntgen and Becquerel rays, Kerr's, Hall's and Zeeman's phenomena, Tesla's experiments, wireless telegraphy, the coherer and the Wehnelt interrupter, afford instances of the many recent innovations which are described at some length. In the concluding sections the author expresses doubts as to the efficacy of lightning conductors of the old style when the effects of electromagnetic induction are taken into account. The book should be useful both as a class-book in technical colleges, for which purpose it is especially written, and as a work of reference for general readers who wish to acquire some notion of modern electricity and optics without entering into abstruse theories or technical minutiæ. G. H. B.

A First Course of Practical Science. By J. H. Leonard, B.Sc. Pp. xii + 138. (London: John Murray, 1901.)

EXCELLENT courses of practical work in the rudiments of mensuration and physics are now available in several text-books, but there is still room for volumes like the present one. The exercises described are suitable for quite young beginners, and they will serve the double purpose of applying the pupils' knowledge of arithmetic and developing a scientific frame of mind. Simple measurements of length, area and volume, and calculations (particularly with decimals) referring to them, form the subjects of the opening chapters. Following these are laboratory exercises on weight and centre of gravity, relative weight, atmospheric pressure, thermal expansion, thermometers, latent heat, filtration, solution and distillation.

The experiments are described concisely and are well arranged, so that a pupil of average capacity could perform them without much assistance, and at the same time would acquire clear ideas on fundamental principles. We do not like such expressions as "Have all liquids got a latent heat? Have all gases got a latent heat?" but that is a detail. As a whole the book is satisfactory, and, with others of the same kind, will assist the movement in favour of introducing scientific measurements in early stages of instruction in schools. Dr. Gladstone contributes a short preface.

Coltivazione delle Miniere. By S. Bertolio. Pp. vii+284, with 96 figures. (Milan: Hoepli, 1902 [*sic*]. Price L. 2·50.)

THIS is one of the numerous manuals published by Hoepli of Milan; it contains a useful little epitome of the art of mining. It is not fair to expect too much from a book costing only 2*s*., and consequently one must not carp too loudly at the absence of detailed descriptions and figures of certain important mining appliances. Steam shovels and dredges, which play so weighty a part nowadays, are merely mentioned by name, and hydraulic mining is dismissed in a couple of lines. This defect should be remedied in a second edition, for it is well even in a small manual to impress upon the student the great importance of all mechanical methods of excavation.

On the other hand, the author deserves credit for his picture of the well-marked projecting outcrops of three parallel lodes at Montevecchio in Sardinia; the student has not always the opportunity of seeing such a fine example in the field. Mistakes in foreign words are too frequent, and when the simple name of the inventor of the safety-lamp is spelt "Dawy," the Englishman feels aggrieved; however, all nations are treated alike, for the author is not absolutely faultless in his own tongue.

The Ballads and Shorter Poems of Frederick V. Schiller. Translated into English Verse by Gilbert Clark, M.A. Pp. xv+408. (London: Williams and Norgate.)

SCHILLER'S philosophical writings have admirers in the world of science, and this translation will contribute to the wider appreciation of his poems among people unable to read them in the original. The series of poetical parables and riddles referring to natural phenomena, and the verses on astronomy, astronomers, nature knowledge and transcendental philosophy are of interest to scientific minds.

LETTERS TO THE EDITOR.

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

Humus as a Preservative against Frost.

I HAVE just read a French translation, by my old friend Prof. Henry of the Nancy Forest School, of Wollny's classic work on the decomposition of organic matter. In it I find the statement that spring and autumn frosts are dangerous on peaty soils only when the surface of the latter is dry. Wollny gives no illustrations of this law, but I recently observed one in my garden at Coopers Hill.

Last September I dug up several rose beds on my lawn and sowed them with grass seed, which has produced a fine crop of young grass. This I carefully watered, and the soil in the beds was well trenched and covered with decomposed leaf mould before the seed was sown. The rest of the lawn has not been trenched, probably for thirty years, and the soil under the grass in it, a stiffish loam, is now singularly dry for the time of the year.

On the morning of December 6 there was a slight frost, 31° F. being registered six inches above the grass. At 8 a.m. the lawn was white with rime, except on the new grass, which remained green.

This must be due to the fact that the moist, well-trenched humus soil under the new grass was able to conduct heat from below and thus kept the air in contact with it above the freezing-point, while the dry, compact loam under the old turf could not supply sufficient heat to the old grass to preserve it from freezing. Dry humus, according to Wollny, has a low specific heat and is a bad conductor, while wet humus has a high specific heat and is a good conductor of heat. On another occasion, when snow fell, it melted much sooner on the new grass than on the rest of the garden.

As a further illustration of Wollny's law I may cite the fact that water is let on to cranberry swamps in Carolina when frost is feared during the blossoming period, and also that in north-west India, on clear evenings when frost is feared, vegetable gardens and sugar-cane plantations are irrigated in order to obviate danger from frost.

It is also well known in Germany that if a sphagnum peat bog is to be reproduced, a thin layer of peat must be left at the base of the bog after the upper peat has been removed, and this layer kept carefully under water, as otherwise the drying up and consequent freezing of the peat will kill the moss.

Slight frosts are very prejudicial to vegetation in sub-tropical forests, and, when frost is imminent, the precaution of trenching the soil, removing weeds and irrigating cultivations is extremely important for young sugar-cane and other crops.

Coopers Hill, December 8. W. R. FISHER.

A possible new Petroleum Field near Naples.

WHEN sailing from Posilipo to Sorrento on August 31 last, at about four or five miles from the nearest land of the Sorrentine Peninsula we encountered a most unmistakable smell of petroleum, just as if a leaking petroleum tank steamer had crossed our bows a few moments previously. Two tracks of the smell were distinctly noticeable, the one at lat. 40° 41′ 30″, long. 14° 19′, and the other at lat. 40° 42′, long. 14° 18′ 30″. A moderate *furano* or southerly wind was blowing at the time, so that in all probability the source of the petroleum was somewhat to the south of the position given.

The only other record of a petroleum source in the immediate vicinity of Naples is that of the Balneum Olii Petrolei, or *bagno del petroleo*, which formerly existed near the Stufe di Nerone, between Pozzuoli and Baia. This petroleum bath has now quite dried up, but formerly was much praised by mediæval writers for its curative powers in cases of leprosy and cholera, and also because its waters caused the limbs of bathers to rejoice in new found vigour. The last mention of this petroleum bath was by Bartolo in 1679. In the southern Italian provinces petroleum has been found in considerable quantity at San Giovanni Incarico and at Pico in the valley of the Liri in the district of Gaeta. Indeed, in 1878, 600 tons, or almost all the Italian petroleum, came from this source alone. In the last two decades the annual output has much diminished and has become insignificant as compared with the increased production of the wells in northern Italy. Petroleum has also been stated to occur at Tramutola, on the Gulf of Taranto, and asphalt is recorded from the east side of the Abruzzi, about twenty miles from Pescara on the Adriatic (Redwood).

The depth of the water (80 fathoms) at that part of the Bay of Naples where the smell was noticed is too great for the collection of the petroleum to be commercially practicable. But the long-continued escape of petroleum in the immediate vicinity of the Apennine Limestones of the Sorrentine Peninsula is an indication that deep borings might be successful and might one day yield as profitable a supply of petroleum as the borings in northern Italy. The petroleum fields of the north of Italy near Bologna and Piacenza extend along anticlinals of the Tertiary Limestone, and therefore are geologically similar in many respects to the country in or near which the newly discovered petroleum spring occurs. R. T. GÜNTHER.

Magdalen College, Oxford, December 13.

Automatic Actions.

As Mr. Dixon points out (p. 102), a mental process frequently repeated becomes automatic.

The impulse passes readily along a path in the brain-cells previously frequently traversed by similar impulses, much as a man who revisits the haunts of his youth may, while in a brown study—that is, while abstracting his mind from conscious direction—find his way unerringly through cross-paths, whereas if he had tried to think out his route he would probably have gone astray.

Mr. Dixon's remarks on the different modes of rising of the horse and cow suggest an explanation. I have hitherto regarded the explanation as due to anatomical differences, but the anatomy of animals has been modified by habit and habit by the necessities of environment.

The horse, which couches on the plain in long grass, rises head first. This method gives him an early view over the surrounding grass and keeps his hind legs (his chief propellers) well under him.

The cow, whose natural lair is under low-hanging boughs, rises tail first. This method allows her till the last moment to keep her eyes upon and her horns presented to an approaching foe. W. BENTHALL.

December 7.

VARIATION IN FOWLS.

THE recurrence of the large shows of the different varieties of domestic poultry which occurs at this season of the year gives an admirable opportunity to those interested in the subject of studying the characters of the different breeds, and the almost innumerable varieties produced by crossing them. The study of variation has been a favourite pursuit of mine for more than half a century. When Darwin was preparing his works on the "Origin of Species" and on the "Variation of Animals," he was surprised to find, when I was introduced to him by Yarrell at a poultry show, that I had made a large collection of crania of the different varieties. Of these specimens he availed himself largely in his work on "Variation," in which I had the great pleasure of assisting him. I can, therefore, speak with considerable precision of the great change which has taken place in the breeds of poultry during the last fifty years. The figures in Darwin's large work on the "Variation of Animals" were all drawn from birds selected by myself as the most typical specimens of the various races, but I may state that there is not a single figure shown that would not now be repudiated as utterly unworthy of exhibition by the present fanciers, every variety having had its fancy points so greatly increased. To take the figure of the Spanish fowl (shown in chapter vii.), characterised by its white face and large white ear lobe. This represents a fowl which now hardly exists, for the comb has been increased to at least four times the area of that shown by Darwin; the white skin on the face has been so much enlarged as to cause the birds when aged to become

blind unless the skin is cut away. The ear lobe, enlarged in the portrait to many times its natural size, has been again increased, becoming in some cases more than seven inches in length by four or five in breadth when spread out, and offering an area of some thirty square inches. These characters have been carried to such an excess that the breed has become altered from an abundant layer of large eggs into a practically useless variety, and at many shows where they were formerly the most numerous birds exhibited they are now absent, having been, as it were, improved by the fanciers almost out of existence, their laying qualities and utility having almost entirely disappeared. At the Crystal Palace show recently held, where nearly 4000 fowls were exhibited, less than a dozen Spanish put in an appearance, and at the show just opened at the Alexandra Palace, where there are no less than 281 classes for the different varieties of fowls, Spanish are conspicuous by their absence.

Darwin in his list enumerates thirteen varieties of fowls as known to him, namely Game, Malay, Cochin, Dorking, Spanish, Hamburg, Polish, Bantam, Rumpless, Creepers, Frizzled, Silky and Sooties, with their sub-breeds, which he also mentions. In the last Crystal Palace show we had no less than 240 classes, which included all the varieties shown. The old English Dorking breed was the one which has been least changed or modified during the last fifty years, having been merely increased in size. Cochins, which were imported, not, as the name implies, from Cochin China, but from Shanghai,

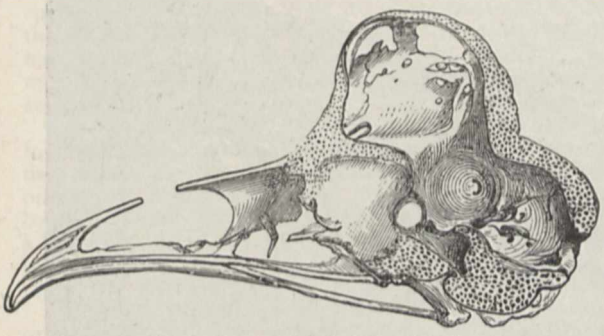

FIG. 1.—Section of skull of crested fowl.

many hundred miles distant, were originally characterised by profuse fluffy plumage, very small wings, which rendered them almost incapable of flight, a small amount of feather on the tarsus or scaly part of the leg and on the foot. This breed, with all the others, was regarded by Darwin as descended from one wild species, the jungle fowl, *Gallus ferrugineus*. This was one of the very few points in which I differed from my honoured master. I believe that the Cochin descended from another species of wild Gallus, which in consequence of its scant power of flight had all passed into a state of domestication and which has long ceased to exist as a wild bird. My opinions are based upon the fact that there is considerable structural difference between the Cochin and the varieties of the *Gallus ferrugineus*. In the Cochin, the axis of the occipital foramen is greatly elongated perpendicularly; in the ordinary fowl its long axis is horizontal. In the Cochin, as originally introduced, a deep median furrow is visible down the frontal bone, which is not present in other fowls. These points could not have been produced by artificial selection. Then again, the voice of the bird was utterly distinct from that of any descendants of *Gallus ferrugineus*. The habits of the birds, as originally introduced, were exceedingly distinct from those of our domesticated species. At the present time the Cochin threatens to become as nearly extinct in England as the Spanish, having been bred for fancy points, and the tendency to produce feather on the lower extremities has been so enormously exaggerated that in prize specimens the feet are as nearly full plumaged as the wings.

In Darwin's time one of the most remarkable breeds raised by fanciers was the crested, or, as they were then called, the Polish breeds, characterised by a very large tuft of feathers on the top of the head. I paid much attention to these breeds from the singular anatomical peculiarity which they offered; the cranium became greatly modified, the crest taking its rise from a very large bony protuberance of the frontal bones. This in well-developed specimens contained more than half the brain, which, instead of retaining its normal form, became of an hour-glass shape. Specimens of these remarkable skulls were shown by me at the Zoological Society in 1856, figured by Darwin in "Variation" and in my "Poultry Book," from which the accompanying engraving is reproduced. These birds have almost gone out of fashion, there being now no classes for them at the Crystal or Alexandra Palace shows.

If we compare the varieties of poultry as shown at present with those that existed in Darwin's time, we find that the offer of prizes, often of great value, at poultry shows, has induced, not only the formation of innumerable new breeds obtained by crossing and selection, but has led to the exaggeration of the salient points of every variety, as far as is actually possible. If I may presume to quote my own book, on "Table and Market Poultry," I would state: "The fancier has not even a standard of beauty which he regards as final. The greater the extent to which he can make the specimens he produces excel others in fancy points is the object at which he aims; consequently hideous monstrosities are not unfrequently produced and exhibited, the only advantage of which, from a scientific or practical point of view, is to prove the extent to which living organisms are variable under the influence of artificial as opposed to natural selection." W. B. TEGETMEIER.

FRESH LIGHT ON THE ANTARCTIC.[1]

THIS is the second narrative of the cruise of the *Southern Cross* and of the first winter spent on Antarctic land. It is written for the same class of the general public as its predecessor by the commander of the expedition. Mr. Bernacchi is, however, a man of scientific training, and although the exuberance of his literary style is sometimes in excess of the strict requirements of science and some of his words do not occur in the dictionary, we are able to gather a few new facts and some corrected impressions from his book. Unfortunately, the book has been written in a hurry, for which there is at least the excuse that the author has set out once more to the South Polar regions; but in one place he acknowledges, and in many places leaves it to be discovered, that he was unable to consult his companions on points that require some explanation.

It is not everyone who can write a book so as to exclude the irrelevant and make the essential attractive to the average reader; yet this, we think, should be the chief justification of a narrative, and especially a second narrative, of an expedition that was in a considerable degree scientific.

The book is divided into two parts, "Narrative" and "Scientific." The narrative need only be referred to in order to remind the reader of the necessary dates which are usually difficult to gather in such works. The *Southern Cross* left London on August 22, 1898, reached Madeira on September 4, left on the 5th, touched at St. Cruz on

[1] "To the South Polar Regions. Expedition of 1898–1900." By Louis Bernacchi, F.R.G.S. Illustrated from photographs taken by the author. Pp. xvi + 348. (London: Hurst and Blackett, Ltd., 1901.) Price 12s. net.

the 7th, stayed a day at St. Vincent (date not given), reached Tasmania on November 27, ninety-seven days out from London, and sailed on December 19 for the Antarctic regions. The ice-pack was entered on December 31, the Balleny and Russel Islands were seen while fast in it, and on February 10, 1899, the ship, having been unable to penetrate the belt of ice, came out again on the northern side. She entered it once more on the 14th, got through in six hours, and reached Cape Adare on the 17th. On March 1 the ship left for Australia after landing the expedition, and on January 28, 1900, she returned; but no particulars are given, either here or in Mr. Borchgrevink's book, of her two voyages through the pack. On February 2 the whole party started southward in the ship; they landed on Possession Island, in Wood Bay, at the foot of Mount Melbourne, on Franklin Island on February 10, at Cape Crozier, close under Mount Terror, and finally upon the ice-barrier itself in 78° 34′ S. on the 17th. The ship remained moored to the ice-barrier all day on the 18th, and on February 19 the return voyage began along nearly the same route as had been taken coming south. The weather was very boisterous, and the remarkable fact is now stated, we believe for the first time, that no ice whatever was met with and there was absolutely no pack to go through. Auckland Island was reached on March 21, 1900, and here the expedition may be said to have completed its labours. It would have been highly important if the log of the *Southern Cross* were published in full, so that there might be no uncertainty as to the exact dates of reaching the various points, and in particular as to the condition of the sea-ice.

Mr. Bernacchi very clearly indicates the character of the Antarctic summer, a period of low temperature and high wind, with very frequent fogs and rare intervals of clear weather. He states definitely that Mount Erebus was never clearly visible, merely a glimpse having been had of it, too short to allow a photograph to be taken. On February 19 the ship as she lay at the ice-barrier was beset with young ice, and broke through with such difficulty that another day's delay would have meant another year.

The specially "scientific" part of the book is an appendix, though not so called, of 50 pages. It treats of the climate of the South Polar regions, terrestrial magnetism, zoology, geology, astronomy, and concludes with miscellaneous notes and a short glossary of ice-terms.

In discussing the climate, Mr. Bernacchi founds his remarks on a preliminary study of the observations taken at Cape Adare, which have been discussed at the Meteorological Office and are to be published by the Royal Society. The winter was not nearly so cold as at continental stations within the polar circle in the northern hemisphere, the absolute minimum recorded being −43°·5 F. and the mean minimum of the coldest month, August, −22°·7 F. On the other hand, the summer is very cold, the absolute maximum being 48°·7 and the mean maximum of January (the warmest month, apparently, although there are no values for February) 37°·0; the mean temperature of this midsummer month was only 33°, and the absolute minimum 25° F., but a short distance further south minima below zero Fahrenheit were observed early in February. The most remarkable feature, however, was the wind. Windroses are given for each month of the year, showing that the south-eastern quadrant of the horizon has an immense preponderance of winds in every month and a monopoly of gales. This is assumed as strong evidence of the existence of a great continental anti-

FIG. 1.—The Slate Formation in Robertson Bay. (From "To the South Polar Regions," by L. Bernacchi.)

cyclone to the south; and no doubt that theory is attractive and has much evidence in its favour. But the gales which burst from the E.S.E. or S.E. were invariably accompanied by a sudden and great rise of temperature, which in eleven cases cited ranged from nearly 14 to more than 44 Fahrenheit degrees. This wind beat against Cape Adare from the level surface of the frozen sea, and does not suggest a Föhn effect or an origin in the icy heart of a South-Polar anticyclone. Does it not rather indicate the passage of a cyclone centre to the north and the sweeping in of air from the warm surface of the sea south of Australia? An anticyclone brooding over the southern land would probably tend to turn wandering cyclones eastward along its margin, and the two explanations are thus to some extent compatible.

The magnetic observations are being worked up by Dr. Chree; from the preliminary figures quoted here we note that the greatest dip observed was 88° 2′ 37″ at the base of the Mount Melbourne, but it is pointed out that the magnetic dip all along the coast of Victoria land was less than at the time of Ross's expedition. The zoological chapter contains no information; it merely quotes a few descriptive remarks of the vertebrates noticed, all of them of known species. The invertebrates are not referred to, but the whole of the zoology of the expedition is being worked up at the British Museum.

There was no geologist on board the *Southern Cross*, but the non-technical descriptions of rocks in the narrative and the reference to the determination of specimens by Mr. J. T. Prior show that the geologist on the *Discovery* will have a splendid field in which to win his spurs, though the alternation of volcanic and metamorphic rocks does not suggest the probability of sensational fossil finds.

The difficulty of making astronomical observations in high southern latitudes is feelingly dealt with. The determination of longitude was particularly difficult, the only really satisfactory attempt to fix Cape Adare being by an occultation of Saturn by the moon. Refraction was a never-ceasing trouble, for the horizon was frequently very far from being a straight line. Thus on one occasion Mr. Bernacchi says (p. 156):—

"Huge icebergs to the north which must have been quite thirty miles away, and which, under ordinary circumstances, were invisible even from the huts, were elevated by refraction to a height on a level with the top of Cape Adare, the height of which is nearly 900 feet. The display, it can almost be called so, was ever changing in appearance; sometimes one part of the horizon was elevated, then this would subside and another part rise up. At this time of the year the coast line in the direction of Yule Bay and Cape North, nearly 100 miles away, was frequently seen on clear days in consequence of the great rarity of the atmosphere."

A comparison of Mr. Borchgrevink's and Mr. Bernacchi's narratives yields several minor points of interest to which it is unnecessary to refer; but we find the resultant of reading both books is an increase of our opinion of the commander's power of overcoming difficulties and of the physicist's scientific zeal and loyal cooperation.

THE SPECTRA OF BRIGHT SOUTHERN STARS.[1]

THE well-known researches on stellar spectra which have been carried on for many years at the Harvard College Observatory under the direction of Prof. E. C. Pickering have now reached another very definite stage. The publication of the Draper Catalogue in 1890 put us in possession of the general characteristics of the spectra of more than 10,000 stars, and this work will long remain a monument to the skill of Prof. Pickering, besides fulfilling its original purpose as a lasting memorial of Dr. Henry Draper (NATURE, vol. xlv. p. 427). Following this, a detailed description and classification of the spectra of 681 of the brighter stars north of −30°, based upon photographs taken with relatively large dispersion, was published in 1897 (NATURE, vol. lvi. p. 206). The establishment of a branch observatory in the southern hemisphere, at Arequipa, Peru, has enabled Prof. Pickering to extend the inquiry to the southern stars, with results described in the volume under notice.

The prismatic camera has been employed throughout the whole investigation, and the accumulation of so much valuable material in so short a time must be attributed in great measure to the many advantages which this instrument possesses over the slit spectroscope when radial velocities are not in question. At Arequipa the 13-inch Boyden telescope has been employed in conjunction with one, two or three prisms, giving spectra of lengths 2·24, 4·86 and 7·43 centimetres respectively from $H\epsilon$ to $H\beta$. The number of photographs taken from November 29, 1891, to December 6, 1899, was no less than 5961, with an average exposure of one hour; but as many of the spectra were photographed several times the number of individual stars investigated is smaller, namely 1122. In these are included all stars south of declination −30° which have a photometric magnitude of 5·0 or brighter, numerous fainter stars in the same region, many stars between the equator and −30°, and a few northern stars.

Dr. McClean's magnificent series of photographs of the spectra of southern stars had prepared us to find that the spectra are not less diverse than in the northern hemisphere, and it became a point of much interest to see if the greater number of stars now studied necessitated any revision of the classification proposed for the northern stars alone. This question of classification, it will be understood, is one of the greatest importance, since the ultimate aim is not merely to enable the astronomer to place his photographs in their proper pigeon-holes, but to indicate the various stages of star life. It is an unfortunate circumstance, however, that not one of the classifications hitherto suggested has met with general acceptance, but the reason for this may perhaps be traced to a want of confidence due to the frequent revisions which have been necessary as the more delicate features of the spectra have been brought to light by the use of better instruments. However that may be, it is sufficiently remarkable that the old classification which we owe to Rutherfurd and Secchi is almost the only approach to a universal language of stellar spectra, in spite of the fact that it is hopelessly inadequate to deal with modern data.

For the present discussion Miss Cannon has found it convenient to revert to the nomenclature of the Draper Catalogue, but with modifications to suit the intermediate classes revealed by the use of greater dispersion. It is pointed out that in most cases the symbols can be readily translated into the numbers previously applied to the groups of northern stars, but it would surely have been more convenient to have two such closely associated investigations expressed in the same language. However, the classification is fairly adequate, but as the nomenclature is too cumbersome to be likely to come into common use it is unnecessary to describe it in detail.

The great majority of the 1122 stars discussed in this publication can be arranged in a sequence, agreeing in the main with that arrived at in the case of the northern stars, but permitting its extension towards the beginning of the series. The investigation of the northern stars led Prof. Pickering and Miss Maury to commence the

[1] "Spectra of Bright Southern Stars, Photographed with the 13-inch Boyden Telescope as a Part of the Henry Draper Memorial, and Discussed by Annie J. Cannon under the Direction of Edward C. Pickering." (*Annals* of the Astronomical Observatory of Harvard College, vol. xxviii. part ii.)

series with stars of the "Orion" type, which by transitional stages were succeeded by the Sirian and solar stars, and then by stars with fluted spectra. An important advance has now been made in establishing the place of the bright-line stars of the Wolf-Rayet class as immediately preceding the stars of the Orion type. The spectra themselves do not indicate whether the series begins or ends with the bright-line stars, but that it begins with them is probable from their general spectroscopic resemblance to nebulæ. One piece of evidence on this point does not seem to have been followed up as closely as its importance calls for; on p. 141 it is stated that the green line λ 5007, which has hitherto been regarded as specially characteristic of nebulæ, is sometimes present in the Wolf-Rayet stars. If this be the case there would seem to be no possible doubt that the bright-line stars are the first results of nebular condensation; but we find no further reference to this interesting point in the detailed description of spectra.

A considerable part of the volume is occupied with detailed accounts of typical spectra which are exceedingly valuable, and the descriptions of the various classes of bright-line stars will be especially welcomed by other investigators. The discussion apparently indicates that the forms most closely resembling the planetary nebulæ are those in which there are no dark lines in the spectra, while succeeding stages are represented by stars in which dark lines are gradually introduced, until finally the Orion type of spectra, usually consisting wholly of dark lines, is reached.

Three catalogues are given. One of them brings together the stars belonging to each of the spectroscopic groups; another is a general catalogue with the stars in order of right ascension; and still another is an index to the stars, both northern and southern, which have letters assigned to them. In the last named, the nomenclature previously employed for the spectra of the northern stars has been converted into the new system adopted for the present volume. It will thus be seen that no pains have been spared to provide every convenience for those who may have occasion to use the catalogues for purposes of reference.

Besides the catalogues there are several tables of the wave-lengths and intensities of the lines in the various sub-groups of the bright-line stars and stars of the Orion type, and in some cases the wave-lengths extend into the visible spectrum as far as D_3. It is only in the more obvious cases, however, that an attempt has been made to assign origins to the lines, but the determination of origins is perhaps wisely avoided unless the work of a laboratory goes hand in hand with that of an observatory. Still, one cannot help regretting that the tables of enhanced lines published by Sir Norman Lockyer have not been utilised in this connection, especially as there are distinct indications that some apparent difficulties might thus have been removed. Thus, on p. 186 it is stated that in the spectrum of α Cygni there are two lines of greater wave-length than H_β, which are "well marked and agree in position and intensity with the helium lines 4922·1 and 5015·7 as present in the spectra of the Orion stars. It appears far more probable, however, that these are solar lines." The probability is that these lines, like so many others in α Cygni, according to Sir Norman Lockyer, are enhanced lines of iron, their wave-lengths being 4924·1 and 5018·6, which are curiously near to two prominent lines of helium. It seems very likely also that a reference to enhanced lines would throw much light upon such spectra as that of η Carinæ (Argûs) and possibly upon other "peculiar" spectra.

Again, the descriptions of typical spectra clearly show that among the first additional lines introduced in passing from the Orion to the Sirian stars are 4233·6, 4173·6, 4179·5 and 4385·2, which are doubtless enhanced lines of iron at corresponding wave-lengths; these lines, however, are simply regarded as "characteristic solar lines" (p. 154), although as the true solar stage is approached they cease to be conspicuous.

Among many interesting results, it may be mentioned that a few stars have been found to have spectra resembling that of α Cygni, which hitherto had been practically the only representative of its type. The detailed description of the spectrum of γ Velorum (Argûs), the brightest star of the Wolf-Rayet type, is also worthy of special mention.

The volume is enriched by three fine plates, one of which illustrates six typical spectra; another shows six examples of "peculiar" spectra, including ζ Puppis and γ Argûs; while the third exhibits, by direct enlargements of portions of three spectra, the vast amount of fine detail portrayed by the prismatic camera.

Great praise is due to all who have taken part in this magnificent piece of work. A. FOWLER.

FOREIGN INDUSTRIAL COMPETITION AND TECHNICAL EDUCATION.

ON the occasion of the prize distribution to the students of the Goldsmiths' Institute at New Cross, on December 12, Mr. Balfour made some remarks on technical education and its bearing upon foreign competition which are worthy of comment. With the optimism which characterises this statesman's utterances, he expressed the opinion that although

"unquestionably there was a time when we ignored the great need for a thorough scientific and artistic training in connection with our great industries," yet he was "not sure whether we are not now verging upon the opposite danger to that which we ran a few years ago," for there was a tendency, in some quarters at all events, to "talk as if the only thing which had to be done to restore British manufactures to their pristine condition in the world's industries was a manipulation of our methods of education."

Mr. Balfour then went on to say that he placed no faith whatever in the arguments which he constantly heard indicating the relative decay of British manufactures, and deprecated the tendency, which he characterised as a "dangerous fallacy," of supposing

"that every successful and prosperous manufacture started by any other nation but our own was a kind of robbery committed on British trade," for we ought to be satisfied with the reflection that, "broadly speaking, the prosperity of one nation conduces to the prosperity of all nations, and we are not poorer, but richer, because other nations are rich."

As was to be expected, these self-satisfying sentiments met with full approval; but the distinguished speaker proceeded to introduce a little rift into his lute when he said,

"I look with perfect serenity upon the general increase of the world's wealth as long as I can be assured that in this country we organise our labour in such a manner that the best workman gets the greatest remuneration; . . . . that there is no lack of well-trained and skilled persons in all branches of manufacture; and last, but not least, that those who lead industry in this country, the capitalists, the manufacturers and the managers, show that flexibility, that power of adaptation to the ever-changing needs of the world which is, of course, an absolute necessity if we are to make the best of the great advantages by which we have been enabled to meet the demands of the world in the matter of manufacture."

Mr. Balfour is apparently already assured on these points, but can this attitude be accepted by those who view the future of their country from a higher standpoint than that of an armchair political economy? Are we to stand calmly by and see the supremacy in industry after industry transferred to foreign shores until at last, like the inhabitants of a Gilbertian island, we are re-

duced to living by taking in each other's washing? The economical laws which apply to nations are much the same as those which govern individuals, but we have yet to meet the man who takes pleasure in his competitors' wealth on the ground that it conduces to his own prosperity. What is to be gained by burying our heads in the sand and announcing that no danger is in sight? With nations as with individuals, progress must cease when self-complacency begins.

Considering first Mr. Balfour's last proposition—Do the leaders of industry in this country show that flexibility and power of adaptation to changing needs which is absolutely necessary for meeting the demands of the world in manufactures? If we are to credit the statements of experts in almost every branch of trade, and the facts which are patent to our eyes, we must conclude that they do not. In the chemical industries, where, before all others, adaptation to rapid changes and the immediate utilisation of new scientific discoveries are of paramount importance, we have not only lost the supremacy we once possessed, but we stand at present in great danger, in the organic-chemical manufactures at any rate, of falling out of the running altogether. The chemical trade of Germany, built up almost entirely during the last forty years, now amounts to an annual value of about 50,000,000*l.*, of which about 10,000,000*l.* represents the value of the production of colouring-matters, synthetic medicinal agents, perfumes, and other coal-tar products. If we examine in detail the statistics of this latter branch, we find that the six largest German manufacturers alone employ more than 18,000 workpeople, 500 chemists, 350 engineers and technologists, and 1360 business men, managers, travellers, clerks, &c. In England, the birthplace and cradle of this industry, there are certainly not more than 30 or 40 chemists and 1000 workpeople employed upon it, and whilst our imports of colouring-matters have slowly increased, our exports to the world of these products, which, fifteen years ago, amounted to about one-fourth of those of Germany, do not now amount to a tenth part. Even in the home market we are only able to supply about ten per cent. of the total quantity of dye-stuffs our textile industries require. In the manufacture of synthetic medicinal agents, artificial perfumes, sweetening materials, photographic developers, &c., which are all outgrowths of the coal-tar colour industry, the matter is even worse, for these manufactures are almost non-existent in this country. Even in the "heavy chemical" trade, which has always been regarded as one of our staple industries, we find ourselves seriously assailed, and most of the important developments of recent years have taken place upon the Continent. We further stand in imminent danger of losing nearly three millions annually by the destruction of our Indian indigo industry in competition with the synthetically prepared indigo of Germany, because the study of organic chemistry has been so much neglected in this country that we have neither attempted to improve (until quite recently) the crude and wasteful methods of obtaining the natural indigo, nor devoted ourselves to discovering methods for its artificial production. Is it conceivable that an English firm of chemical manufacturers would be willing to devote, as the Badische Company have done, nearly a million pounds to experimental plant, and scientific investigations extending over twenty years, in an enterprise of this character?

If, again, we turn to the engineering industries, in which a pre-eminence may fairly be considered our birthright, we meet with a somewhat similar state of affairs. In electrical engineering it is universally recognised that we must now concede the palm to America. Also in tool-making machinery, printing machinery, type-writers, &c., the American manufacturers are able to turn out better and cheaper work than our own. In machinery for chemical processes Germany has established a speciality, whilst in the building of motor-cars—a very large and profitable industry directly developed out of the cycle industry—France by her superior workmanship has been able to obtain a monopoly. We are also outstripped by France in all those industries in which the native artistic taste of the workman plays an important part.

Although it could not, of course, be expected that we should excel in every branch of manufacture, can we consider, with such facts as these before us, that our leaders of industry show the requisite adaptability to modern conditions to which Mr. Balfour refers? or, in other words, are they sufficiently alive to the importance of applying science to industry in every branch of manufacture? Further, are we justified in saying "that there is no lack of well-trained and skilled persons in all branches of manufacture"? Are our technical schools, as Mr. Balfour appears to believe, turning out the men who will reinstate our lost or declining industries? Much as we may appreciate the excellent work which these institutions are doing for the general education of the masses, we are forced to the sorrowful conclusion that this is not so, and that so far as higher scientific education is concerned the results are far out of proportion to the enormous sums which have been devoted to their establishment. The fault for this in no way lies with the technical schools themselves, but with the want of system and incompleteness of our national education. In place of putting a coping-stone of technical knowledge upon an already sound and thorough education, these institutions are more often called upon to cram the elements of a science, or, worse, the details of its industrial application, within a minimum of time into the minds of school-boys or lads engaged in rechnical pursuits, who, through absence of a satisfactory educational foundation, are quite unfitted for their reception. The result too often is the entire extinction of any natural originality which the lad might have possessed, and the conversion of his mind into a machine for the unthinking performance of routine operations. How is it possible, for instance, that a chemist who, after a very insufficient general education, has acquired his knowledge of the science by a two or three years' course of study at a technical school, should equal in capacity his German colleague, who, upon the basis of a sound school education, has received a five years' training at a German University or Polytechnicum, where he has not only acquired a thorough grasp of his own and cognate sciences, but by carrying out investigations has been stimulated in originality and encouraged to seek new knowledge for himself? Except in the rare instances where native genius is bound to come to the fore, the former can have no possible chance in competition with the latter. It is even a matter of but little moment whether the education of the German has embraced any technical instruction, as with the sound knowledge he possesses of the principles of his science he will soon learn in actual practice their technical applications, and when learnt can usually carry them much further. That nearly all the best positions of the chemical profession in this country are at present filled by German chemists, or by English chemists educated in Germany, is the best proof of the inferiority of our educational methods.

What we undoubtedly require is what Mr. Balfour satirically calls "a manipulation of our methods of education." We require a "system" in the educational fabric of the country, which, together with a better appreciation of the value of science in every industry, would do much to enable our technical schools to fulfil their proper function and to carry out the work which the country expects of them. That such a reform of our educational methods may be long in coming we may, however, well believe, when we hear a distinguished statesman and leader of philosophical thought fail so entirely to appreciate the needs of the case.

ARTHUR G. GREEN.

NOTES.

MESSAGES from Newfoundland announce that Mr. Marconi has succeeded in signalling from England to America by wireless telegraph. Detailed information is not yet available, but it is said that the signals which were received at St. John's, three on Thursday and one on Friday last, though faint were unmistakable, and that Mr. Marconi intends to come immediately to England to increase the power of his transmitters at Poldhu, Cornwall, in order to establish more satisfactory communication across the Atlantic. According to later information the Anglo-American Telegraph Company have given Mr. Marconi notice to remove his instruments from the Colony, as they possess a fifty years' telegraphic monopoly, of which there are still two years to run. This will involve the removal of his experimental station to Nova Scotia or to some other convenient place on the American coast line, and may, perhaps, somewhat delay further experiments. It is to be hoped, however, that we shall before long see a further development of Mr. Marconi's remarkable achievement, upon which if confirmed by subsequent results he cannot be too warmly congratulated. It is interesting to compare the possible rapid development of wireless telegraphy in Mr. Marconi's hands with that of the ordinary telegraph. The first Atlantic cable was not laid until five-and-twenty years after the invention of the telegraph by Gauss and Weber. The earliest proposal to use Hertz waves for signalling was made in 1891, and Mr. Marconi began his experiments four or five years later; at that time he was able to signal two or three miles, and now, after five years' work, he claims to have succeeded in increasing this distance a thousandfold.

GEOLOGISTS and geographers will be glad to learn that they may soon expect the publication of a new map of Iceland on which Mr. Thoroddsen, whose labours in his native island are so well known, has been engaged for twenty years. It is on a scale of 1/600,000, or about twenty English miles to the inch, and thus affords at a glance an excellent picture of the general physical structure and geological characters of the country. But t is also replete with details which are expressed in symbols that take up little space and are readily intelligible. The map, of which we have seen a proof copy, is excellently engraved and printed in colours at Copenhagen, and will be issued under the auspices of the Carlsberg Fund. The title and table of signs and colours are in English.

CONVINCED that increased knowledge of the methods of education on the Continent and in America, with special regard to their bearing on questions of commerce and industry, is required in England, Mr. Alfred Mosely, C.M.G., has offered to defray the whole expense of a commission of inquiry, which would visit parts of the Continent and of America to study the question. At a meeting held on Monday, under the presidency of Lord Reay, Chairman of the London School Board, to confer with Mr. Mosely, it was decided that the inquiry should take place in the autumn of 1902. It is understood that the promoters of the inquiry will endeavour to secure the co-operation of a number of public men representing various types of educational authorities and also the interests of industry and commerce.

THE full text of President Roosevelt's message to the U.S. Senate and House of Representatives has now been received, and we are glad to notice that it contains the following references to the valuable assistance given by the Smithsonian Institution to scientific progress:—"The advancement of the highest interests of national science and learning and the custody of objects of art and of the valuable results of scientific expeditions conducted by the United States have been committed to the Smithsonian Institution. In furtherance of its declared purpose —for the 'increase and diffusion of knowledge among men'—the Congress has from time to time given it other important functions. Such trusts have been executed by the Institution with notable fidelity. There should be no halt in the work of the Institution, in accordance with the plans which its secretary has presented, for the preservation of the vanishing races of great North American animals in the National Zoological Park. The urgent needs of the National Museum are recommended to the favourable consideration of the Congress."

THE Imperial Leopold Caroline Academy of Science at Halle will celebrate the one hundred and fiftieth anniversary of its foundation on January 1, 1902.

THE first meeting of the Royal Geographical Society in the new year wlll be held on the afternoon of January 8, when Dr. Vaughan Cornish will give a lecture on "Waves," adapted to young people. At the ordinary meeting on January 13 Dr. Logan Jack will give an account of his recent expedition from Shanghai to Bhamo, and on January 27 Mr. Stanley Gardiner will lecture on the Maldive Islands.

THE council of the Institution of Mining and Metallurgy announce that a gold medal and premium of the value of fifty guineas, presented by the Consolidated Gold Fields of South Africa, Limited, will be awarded annually to the author of the paper of highest merit contributed to the *Transactions* by any member, associate, or student of the Institution, during the preceding session, upon the mining, treatment, or reduction of gold ores. The first award will be made in June, 1902, and succeeding awards in June in each year.

AN exhibition of burners and appliances connected with the use of gas for illumination and other purposes was opened at the Crystal Palace on Saturday. A development of the Welsbach incandescent light is the inverted burner, on which the cone is fixed in a downward position. It consists of a Bunsen burner fitted with a regulator for the supply of gas and attached to a cone of white china, which acts both as a radiator and as a reflector. Hitherto the difficulty has been to get the Bunsen burner to burn downwards on account of its liability to strike back. This difficulty the manufacturers of the burner claim to have overcome. The construction of the burner, with the globe fixed, closely resembles in appearance the hanging globe of the electric light, and, as there is nothing below the light, no shadow is thrown. A new invention in street lamps is exhibited. This is a high-pressure lamp for burning ordinary gas by the method of a self-intensifying action of combustion, and is said to produce a light of from 300 to 500 candle-power from one burner. There are two stands in the show which exhibit the acetylene light. These are interesting on account of the use which is now being made of that gas, not only for motor-car lights, but also for the illumination of omnibuses in London.

AN exhibition of electrical appliances was opened at the Royal Aquarium on Monday. The exhibits include many ingenious electrical instruments and accessories, such as switch-boards, electrical heating and cooking devices, generators, accumulators, Röntgen-ray outfits, lamps, electric clocks, anemometers and electric meters. Mr. W. Langdon, the president of the Institution of Electrical Engineers, who was to have performed the opening ceremony, was unable to be present, owing to his work in connection with the interruption of the telegraphs by the recent gale, but he sent a statement, in the course of which he said that exhibitions were performing good educational work, because they gave the manufacturer an opportunity of bringing his achievements before the public and those interested in their use, and enabled the visitor to obtain a more complete knowledge of the use of what was to be seen. If

England was to compete with other nations in the markets of the world, it was necessary that we should not only foster all our resources, but should also endeavour to see that our merchants and manufacturers were placed in as favourable a position to do so as were those of other nations. President Roosevelt had shown how fully he appreciated the fact that the supremacy of a nation, or, rather, its position in national life, would in future depend upon its commercial success. It would be a great advantage to the producer if he could be placed in possession of information relating to the progress of other lands. This had been recognised by the President of the United States, and they could not help hoping that our own Government would have no hesitation in following his example and promptly establishing a Ministry of Commerce and Manufacture to watch over those all-important branches of our national life.

THE Göttingen Academy of Sciences has decided to establish and maintain at its own expense, during the period of the special international magnetic work, a magnetic observatory near Apia, in the Samoan Islands. The observatory, says *Science*, will be equipped for observations in terrestrial magnetism, atmospheric electricity, meteorology and seismology. This observatory will be nearly magnetically south of the Honolulu observatory, and about the same distance south of the magnetic equator as the latter is north of it. The two observatories will likewise use practically the same instruments and methods, so that interesting and valuable contributions may be expected from them. Mr. A. Nippoldt, of the Potsdam Observatory, will be in charge of the Samoan Observatory.

MR. H. N. RIDLEY, Director of the Botanic Gardens, Singapore, delivered a lecture at the Imperial Institute on Monday entitled "The Economic Resources of the Straits Settlements and the Malay Peninsula." He remarked that the forests, which originally covered the whole peninsula, contain many valuable products, such as timbers, wood-oil, benzoin, gutta-percha and rattans. Owing to the felling of trees by the Malays, gutta-percha, so indispensable for electric work, has been nearly exterminated. Fortunately, however, the product can now be extracted from the leaves and twigs without injury to the trees, which are being planted by the Government. A very large area of the Federated States is under coffee, but on account of the present glut of the market and the consequent low prices, most of the planters are adding Para-rubber to their estates—a tree which thrives marvellously well and produces a very satisfactory amount of rubber of the first quality. India-rubber from the *Ficus elastica* also promises well, but although it is being planted, its product is less highly valued. Accounts were given of the cultivation and preparation of sago—one acre of the sago palm gives as much nourishment as 163 acres of wheat—tapioca, gambir, mangrove-cutch, pepper, nutmegs, cloves, indigo and pineapples. The greater part of the preserved pines of commerce come from Singapore, where the price of the fruit varies from a farthing to a penny each, and the lecturer remembered a time when they had been as cheap as sixteen a penny. The mineral resources of the colony include gold and tin, the latter being found in great abundance.

DURING the past week this country has been visited by disastrous storms, which have caused more interruption to railway and telegraphic communication than has occurred for many years—although in few cases only has the force of a strong gale been reached; the principal damage appears to have been due to the amount and weight of the snowfall. The daily weather reports published by the Meteorological Office show that on the morning of Wednesday, the 11th inst., the barometer was rising generally and that there were no signs of any material change in the weather beyond the fact tha shallow cyclonic areas of a "secondary" character were apparently moving southwards over the northern districts and were likely to occasion snow showers in most parts of the kingdom. But the chart for the next morning showed that a deep cyclonic disturbance had reached our south-west coasts from the Atlantic and was moving in an easterly direction. By Friday morning (13th) communications with many of the northern and north-western stations were completely interrupted. The progress of the storm was rather slow, and the unusual course taken, to the south instead of the north of our islands, brought cold easterly and northerly winds and very heavy snowfall in the north and rainfall in the south. The fall measured at Yarmouth for the twenty-four hours ending 8 a.m. on Friday amounted to two and a half inches (or about the average amount for the month). The loss at sea has not been great, owing, presumably, to timely notice issued to the eastern districts.

SIR CHRISTOPHER FURNESS, M.P., who has recently returned from a business journey through Canada, appears to have been very considerably impressed with the enormous strides that are being made in the development of water-power for manufacturing purposes in that country. On Lake Superior, which is 400 miles long and 160 miles wide, the Lake Superior Power Company, about five or six years ago, commenced operations by constructing a canal from the lake of sufficient capacity to work turbines of 20,000 h.p. This power is used for making pulp for paper from spruce fir, and an area of 8,000,000 acres of forest has been obtained for supplying the wood by grant from the Dominion Government and by purchase. The Algona Iron and Steel Works have also been established; besides the nickel ore which is being worked, a large find of iron, said to be practically limitless, has been located. Large Bessemer steel works for the manufacture of steel rails, capable of turning out 1000 tons of steel rails a day, are expected to be in operation at the beginning of the new year. In these works electricity has been almost entirely adopted for applying the power to the machinery. Further works for developing 40,000 h.p. are in progress and expected to be completed in about a year and a half.

THE equations of rational dynamics required for the solution of physical problems involve only one independent variable, namely the time. Dr. Leo Königsberger, of Heidelberg, has communicated to the Berlin *Sitzungsberichte* a paper dealing with the extension of the Lagrangian equations to systems involving any number of independent variables, in which the kinetic potential is of the most general possible form. In the present paper Dr. Königsberger treats in detail the case of two independent variables, where the kinetic potential involves only differential coefficients of the first order. The author thus formulates a dynamics of two-dimensional, or n-dimensional, *time*, analogous to the geometry of n-dimensional space. Among the most interesting results are those dealing with the conditions under which the principle of conservation of energy holds for two or more independent variables. In the case of two variables it appears that a certain condition must be satisfied in order that an infinite number of integrals of the Lagrangian equations of motion may exist which satisfy the principle of energy, but it is no longer the case that all integrals satisfy the principle in question. A special case is that in which there is only one *dependent* variable; here the equation of energy is always an integral of the equations of motion.

GEOLOGY and meteorology formed the subject of a brief article in NATURE for November 14. Since then an important essay has been issued on the distribution of vertebrate animals in India, Ceylon, and Burma, by Dr. W. T. Blanford (*Phil. Trans.* 1901), who finds that certain peculiarities in the Indian

fauna may have been due to the Glacial epoch. Ancient terminal moraines occur at an elevation of about 7000 feet in Sikhim, whereas no glacier at the present day is known to descend much below 14,000 feet. The author's observations, moreover, lead him to conclude that the Glacial epoch affected the whole world, and that it was not a partial phenomenon induced by special conditions, such as local elevation.

MR. GEORGE ABBOTT, of Tunbridge Wells, has printed a classified list of the "Cellular" Magnesian Limestone Concretions found in the Permian formation of Sunderland. These concretions are grouped as pseudo-organic or discoid, coralloid, and honeycomb, and are considered by Mr. Abbott to have originated in a different way from the botryoidal masses. He illustrates four stages in each group, remarking that the structures have been produced by the action of a "molecular directive force." As a contribution to the study of "concretionary action" the diagrams should prove useful, but some particulars are desirable with regard to the conditions under which the different groups occur.

IN a letter to the *Centralblatt für Mineralogie* (1901, No. 21, p. 641) Dr. Berwerth, of Vienna, discusses the structure of chondritic meteorites. It will be remembered that according to one view the structure is that of a tuff and the stone is the product of a celestial volcano; according to another view, the structure, though fragmental, is not that of a tuff, but the result of the sudden cooling of a molten mass; according to a third view the chondritic structure is that of a metamorphic rock and may be really of a terrestrial origin, having possibly resulted from the enormous pressure on the stone during its passage through the earth's atmosphere. After a minute petrographical study of the Zavid meteorite, Dr. Berwerth infers that the structure of a chondritic stone is that of a metamorphosed volcanic tuff, and that the metamorphosis has been due, not to great pressure, but to a partial remelting of the material, through exposure of the stone to great heat, followed by quick cooling. The author points out that there may have been a sudden development of heat while the tuff was *in situ*, for instance, through the birth of a new and neighbouring star, or, again, that the stone may have passed through the upper region of a sun's atmosphere during part of its celestial journey.

AMONG a number of papers in the recent issue of the *Proceedings* of the Philadelphia Academy, attention may be directed to one by Mr. H. A. Pilsbry on the Clausilias of the Liu-Kiu (Loo Choo) Islands. A large number of these land-shells are recorded, many of which are new; for one group a new subgeneric term is proposed. A second paper, by A. M. Fielde, describes in detail the life-history of the ant known as *Stenamma fulvum*. The observations were made, for the most part, on colonies kept in portable nests, of which a description is given in No. 2 of the second volume of the *Biological Bulletin*.

THE first annual general report has been published (1900–1901) of the newly formed Department of Agriculture and Technical Instruction for Ireland, wherein the scope and constitution of that body are defined. The Dublin Science and Art Museum now comes under the cognisance of the Department, and the report of the director is included in the volume before us. It is satisfactory to learn that the Museum is making steady progress in all its sections. Among several interesting additions to the zoological collections during the year, "by far the most important was Ussher's collection of Irish birds' eggs, contained among which are many which have now become rare and practically unobtainable. For the purpose of showing the wide range of variation in clutches such as those of the peregrine falcon, the guillemot and others, Mr. Ussher's collection is unequalled and invaluable." The director adds that his permanent staff is not sufficiently large to allow him to make all the improvements in the arrangement of the Museum he thinks desirable.

A NEW illustrated catalogue of apparatus for laboratory experiments and lecture demonstrations in frictional and voltaic electricity has been published by Messrs. C. E. Müller, Orme and Co. It is evident from the catalogue that scientific apparatus can now be obtained at a much lower price than formerly.

A WORK on "British Vegetable Galls, an Introduction to their Study, Collection, Mounting, Classification, &c.," by Mr. Edward T. Connold, will be published immediately by Messrs. Hutchinson and Co. The volume will contain numerous illustrations reproduced from photographs of living specimens of vegetable galls.

THE *Electrical Review* devotes practically the whole of its last week's issue (December 13) to electric traction work. The number contains articles by such well-known traction experts as Messrs. Philip Dauson and F. J. Sprague, and also many excellent descriptions and illustrations of machinery and appliances used in traction work, which make it of great value to those engaged or interested in this branch of engineering.

THE first part of a work on "The Fauna and Geography of the Maldive and Laccadive Archipelagoes," by Mr. J. Stanley Gardiner, was published a few weeks ago by the Cambridge University Press. Mr. Gardiner left England in 1899 as Balfour Student of the University of Cambridge, with a commission to explore and investigate the coral reefs of the Laccadives, Maldives and Ceylon. The results of the expedition will be described in the work now in course of publication. The second part of vol. i. will be published in April next, and when the work has been completed it will be reviewed.

MEMBERS of the British Association are well aware that excellent manuals upon scientific aspects of the places of meeting are prepared under the direction of the Local Committees. In connection with the meeting at Glasgow three volumes of this kind were prepared, and as copies have been sent to us since the conclusion of the meeting we presume they are still available. The subjects are:—"Fauna, Flora and Geology of the Clyde Area," edited by Messrs. G. F. Scott Elliot, Malcolm Laurie and J. Barclay Murdoch; "Local Industries of Glasgow and the West of Scotland," edited by Mr. Angus McClean; and "Handbook of Archæology, Education, Medical and Charitable Institutions," edited by Prof. Magnus Maclean. The volumes are filled with trustworthy information upon matters of scientific and engineering interest, and deserve to be widely known. Though published particularly for the meeting of the British Association, probably copies can still be obtained from Glasgow booksellers, or the acting secretary of the Local Committee, Mr. John S. Samuel, 30 George Square, Glasgow.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mrs. K. Harris; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Captain R. J. Vyner; a Rhesus Monkey (*Macaeus rhesus*) from India, presented by Miss Rodel; a Marica Gazelle (*Gazella marica*) from Arabia, presented by Mr. F. C. Strick; a Common Otter (*Lutra vulgaris*) from Scotland, presented by Mr. W. Radcliffe Saunders; a Plantain Squirrel (*Sciurus plantani*) from Java, presented by Mrs. Beauchant; two South Island Robins (*Miro albifrons*) from New Zealand, deposited; a Nicobar Pigeon (*Calaenas nicobarica*) from the Indian Archipelago, purchased: five Shaw's Gerbilles (*Gerbillus shawi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

AN ASTEROID-ORBIT OF GREAT ECCENTRICITY.—Prof. E. C. Pickering announces that from an examination of a plate taken on August 14, 1901, with the Bruce telescope, Dr. Stewart found an asteroid having the great southern declination, − 62°. Fourteen photographs were taken up to November 13, furnishing approximate positions for the computation of the orbit. A circular orbit was first calculated, which gave the surprising result that the heliocentric diurnal motion exceeded 2200″, indicating a distance from the sun less than that of any known asteroid. Prof. Newcomb furnishes the following elements :—

Epoch 1901, October 2·627 G.M.T.

M = 358° 30′		φ = 22° 8′
ω = 301 19	1900.0	μ = 860″
Ω = 35 48		log a = 0·4103
i = 18 38		Period = 4·13 years.

The uncertainty of the elements ω and Ω may be about ±1°. It would thus appear that the ellipticity of this new planet is in considerable excess over that of any previously known asteroid. The only others for which φ exceeds 20° are :—

	° ′
Eva (164)	20 19
Istria (183)	20 27

The new asteroid was near perihelion at the time of its discovery, moving rapidly round the sun at a distance of about 1·6. It is rapidly moving north, and will soon be available for observation from northern observatories, as shown by the following approximate ephemeris for Greenwich midnight :—

1901.	R.A.	Decl.
	h. m.	° ′
Dec. 21·5 ...	23 11·3 ...	− 11 42
Jan. 10·5 ...	23 51·8 ...	− 3 47
,, 30·5 ...	0 31·9 ...	+ 3 26

BRIGHT METEOR OF DECEMBER 16.—An exceedingly brilliant meteor was observed at South Kensington on the evening of Monday, December 16, about 6·45 p.m. Starting from near α Persei, about 60° elevation, it travelled in a northerly direction inclining downwards until, after a path of about 30°, it disappeared beneath the Pole star. The meteor was two or three times brighter than Capella, and appeared of a similar tawny yellow colour, although this might have been mainly due to the slight fog prevailing at the time. The trajectory was practically rectilinear and the movement very slow.

THE INERT CONSTITUENTS OF THE ATMOSPHERE.[1]

THE discovery of an element always awakens interest; for the total number of the known elements does not exceed seventy-five, and all the various forms of matter which exist on this globe are necessarily composed of these elements.

Elements must not be regarded as isolated entities, each self-dependent, having no relations with its compeers; on the contrary, all the elements exhibit certain connections with their neighbours; and there is to be traced an orderly progression from one class of elements, strongly electro-positive in character, metallic in appearance, very inflammable when heated in the air, and at once attacked by water, to another class, highly electro-negative, transparent, unattackable by oxygen, and without perceptible action on water, through a number of connecting links, each of which serves to soften the transition.

These elements have been arranged in series, and it is by considering the method of arrangement that our interest is awakened.

The revival of the hypothesis of the atomic constitution of matter by Dalton and of his attempt to determine the atomic weights of the elements was not long in provoking the guess that perhaps there could be found some connection between the numbers representing the relative atomic weights of kindred elements. But, as is well known, the state of knowledge in Dalton's day was not sufficiently advanced to enable him to attribute to elements their correct relative atomic weights; and it was not until the eminent professor of chemistry in Rome, Cannizzaro, whose jubilee has recently been celebrated, pointed out the bearing on Dalton's numbers of all the facts accumulated up to the year 1856 that the close relationship between the atomic weights and the properties of the elements was suggested by John Newlands. Some years later Lothar Meyer and Dmitri Mendeléef amplified and elaborated the ideas which had first been propounded by Newlands; and the periodicity of the atomic weights and the gradual variation of the properties of the elements and their compounds were established on a firm basis.

The division of the elements into metals and non-metals corresponds broadly with another well-marked division—that into basic and acidic. Generally speaking, it is the oxides of the metallic elements which react with water to form bases, and those of the non-metals which form acids with water. According to modern ideas, bases, by the mere act of solution in water, are supposed to be split up into portions, for which the term ion, invented by Faraday, has been retained; one ion is charged by the process of solution with a positive charge, and that portion is usually a metal; the other portion, which consists of one or more groups of hydrogen and oxygen in combination, termed "hydroxyl"—OH—has a negative charge. A base, indeed, is a compound which splits in this manner. On the other hand, an acid, when dissolved in water, undergoes an analogous split; but in this case the electro-positive ion is always hydrogen, while the electro-negative ion may either be an element such as chlorine, or a group of elements such as exist in nitric acid (NO_3).

The order of the various elements in the electric series has been determined; and not merely determined, but to each has been attached a numerical value. This value is identical with what is termed "chemical affinity"; and it represents the electric potential of the element with reference to an arbitrary starting-point, which does not differ much from that of nickel, an element closely related to iron. Only a few such values have as yet been determined numerically; instances may be chosen from the magnesium group, where the numbers run: Magnesium = + 1·2; Zinc = + 0·5; Cadmium = + 0·19; or from the fluorine column, where the numbers are: Fluorine = − 2·0; Chlorine = − 1·6; Iodine = − 0·4. In each case the potential, positive or negative, is the highest for the element with smallest atomic weight, and decreases with increase of atomic weight, for elements in the same column. The order of some of the elements is: Cs Rb K Na Li Ba Sr Ca Mg Al Mn Zn Cd Fe″ Co Ni Pb H Cu Ag Hg′ Pt‴′ Au′″; and for electro-negative ions, S″ O″ I Br Cl F; the first element, cæsium, being the most electro-positive, and the last, fluorine, the most electro-negative.

The order given above corresponds fairly well with the order in the periodic table, passing from left to right. But, as in the table, the atomic weights follow each other continuously round the cylinder or round the spiral, the abrupt change from elements of an extreme electro-negative character, like fluorine to sodium, an element of highly electro-positive character, or from chlorine to potassium, has always appeared remarkable. The old dictum, *Natura nihil fit per saltum*, if not always true (else we should have no elements at all, but a gradual and continuous transition from one kind of matter to another—a condition of affairs hardly possible to realise), has generally some spice of truth in it; and it might have been predicted (and the forecast seems to have been made obscurely by several speculators) that a series of elements should exist which should exhibit no electric polarity whatever. Such elements, too, should form no compounds, and, of course, should display no valency; they should be indifferent, inactive bodies, with no chemical properties.

The discovery of argon in 1894, followed by that of terrestrial helium in 1895, and of neon, krypton and xenon in 1898, has shown the justice of the foregoing remarks. Inasmuch as the methods employed for the isolation of these elements illustrate their properties and confirm the views as to their inertness and lack of electric polarity, I propose to sketch shortly the history of their discovery.

An accurate investigation of the density of atmospheric nitrogen and of nitrogen prepared from its compounds led Lord Rayleigh to inquire into the cause of the density of the nitrogen of the atmosphere exceeding that of "chemical nitrogen" by about one part in two hundred, whereas the accuracy of his experiments was such that it would have excluded an error of one part in five thousand. I need not here allude to the reasons which were at first put forward to account for this anomaly; suffice it to say that they offered no

[1] Abstract of an evening lecture delivered at the meeting of the British Association at Glasgow, September 13, by Prof. W. Ramsay, F.R.S.

explanation; and that we ultimately traced the discrepancy to the presence in "atmospheric nitrogen" of a gas nearly half as dense again as nitrogen.

A convenient form of apparatus for isolating this gas is shown in Fig. 1. The gas, air mixed with oxygen, is confined over mercury in an inverted test-tube, in contact with a few drops of a solution of caustic potash; and by connecting the rings with wires from the secondary coil of an induction apparatus, sparks pass between the platinum terminals in the interior of the test-tube. The volume of the gas rapidly diminishes; and in a few hours the gas is removed to a clean tube, and the excess of oxygen absorbed by burning phosphorus; the inert gases remain behind.

On a larger scale, the apparatus used by Lord Rayleigh, consisting of a balloon of six litres capacity, in the interior of which an electric flame is kept alight by means of a transformer, while a jet of caustic alkali forms a fountain in the interior, gives good results. By its help seven or eight litres of mixed gases can be made to combine per hour.

Such experiments show the inactive nature of the argon group of gases towards an electro-negative element, oxygen.

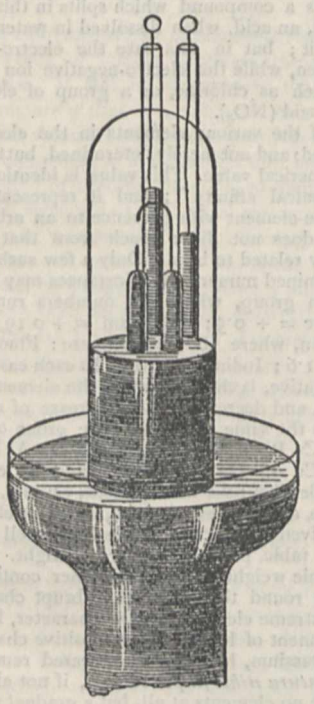

FIG. 1.

The gases are absolutely incombustible. No other elements can withstand such treatment, save platinum and its congeners and gold. But even these metals combine with fluorine or chlorine when heated in a current of one or other gas. Argon, however, is wholly unaffected when electric sparks are passed through its mixture with chlorine or fluorine, the two other most electro-negative elements. To them, too, it shows itself completely indifferent.

A more convenient method of separating the nitrogen from its admixture with argon in atmospheric air is by means of red-hot magnesium. The metal magnesium, which is now made on a considerable scale for photographic and signalling purposes, is a white, silvery metal, which can be planed or turned into shavings. In the early experiments a measured quantity of atmospheric nitrogen dried by passing over suitable drying agents was brought into contact with magnesium turnings, heated to redness in a tube of hard glass. It has been found, however, by M. Maquenne that the metal calcium, which, for this purpose is most easily produced by heating together a mixture of magnesium filings and pure dry lime, is a more efficient absorbing agent for nitrogen, for it does not require such a high temperature and can be effected without danger of melting the glass tube. Indeed, the operation is a very easy one and can be carried out with the very simple apparatus shown in Fig. 2. M. Guntz has also found that lithium, an element belonging to the same column in the periodic table as sodium and potassium, is an exceedingly good absorbent for nitrogen, for it tarnishes in nitrogen even at atmospheric temperature owing to the formation of a nitride.

On a large scale the magnesium turnings are contained in iron tubes and the gas-holders are made of copper or of galvanised iron. By this means fifteen litres of argon were separated from about two cubic yards of air.

The inactivity of argon in contact with such highly electro-positive elements as lithium, magnesium and calcium again demonstrates its want of electric polarity. No other elements would have resisted such treatment except those of the argon group. But these are not the only data from which such a conclusion can be drawn, for it was found that no action takes place between argon and hydrogen, phosphorus, sulphur, tellurium, caustic soda, potassium nitrate, sodium peroxide, sodium persulphide, nitro-hydrochloric acid, bromine-water and many other reagents which it would be tedious to mention, all of which are remarkable for their chemical activity. We may therefore take it that the name "argon," which means "inactive," has been happily chosen.

In attempting to form compounds of argon, however, another consideration was not lost sight of; if compounds of argon were capable of existence they ought to exist in nature, and, as in all probability they would be easily decomposed by heat, it ought to be possible to decompose them with evolution of argon, which could be collected and tested. Prof. Miers, in a letter which he wrote me the day after an account of the fruitless attempts to cause argon to combine had been given to the

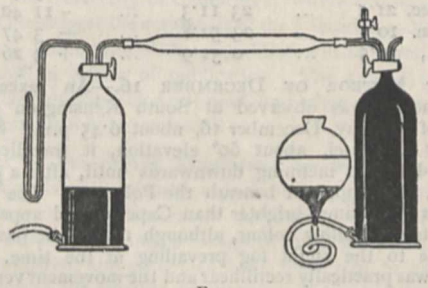

FIG. 2.

Royal Society, drew my attention to experiments by Dr. Hillebrand of the United States Geological Survey, in course of which he obtained a gas, which he believed to be nitrogen, by treating the rare mineral clevite, a substance found in felspathic rocks in the south of Norway, with sulphuric acid. The chief constituents of clevite are oxides of the rare elements uranium and thorium, and of lead. The gas obtained thus, after purification from nitrogen, was examined in a Plücker tube with the spectroscope and exhibited a number of brilliant lines, of which the most remarkable was one in the yellow part of the spectrum, similar in colour to the light given out by the glowing tube. The position of this line, and of others which accompany it, established the identity of this gas, not with argon, as was hoped, but with a supposed constituent of the sun's chromosphere, first observed by M. Janssen of Paris, during an eclipse which was visible in India in 1868. The late Sir Edward Frankland and Sir Norman Lockyer, who studied the spectrum of the chromosphere, gave to the supposititious element, which they regarded as the cause of these lines, the name "helium," a word derived from "ἥλιος," Greek for "the sun." Having been placed on the track, I examined, with the assistance of Dr. Collie and Dr. Travers, no fewer than 51 minerals, while Sir Norman Lockyer examined 46 additional ones, which we had not examined, and in 19 minerals, almost all of them containing uranium, helium was found. Only one gave an argon spectrum, namely malacone. We also sought for argon and helium in meteorites, which all give off gas on heating; but in only one specimen, a meteorite from Augusta County, Virginia, was helium found, in this case accompanied by argon. All natural waters contain argon, for that gas is somewhat soluble in water (4·1 volumes per 100 of water at 15° C.); but some also contain helium, as for instance

the gas from the Bath springs, which Lord Rayleigh found to contain argon mixed with about 8 per cent. of its volume of helium; and helium has also been found in mineral springs at Wildbad, and at Cauterets, in the Pyrenees. It would appear, then, that helium is not such a very rare constituent of our globe; and, indeed, it is probable that it is continually escaping from the earth in small quantities in certain regions.

In 1897, as president of the Chemical Section of the British Association, I chose the title "An Undiscovered Gas" for the address to the Section. The arguments in favour of the existence of such a gas were briefly these: The differences between the atomic weights of consecutive elements in the columns of the periodic table are approximately 16 to 20; thus 16·5 is the difference between the atomic weights of fluorine and chlorine; 16 between those of oxygen and sulphur, and so on. Again, stepping one pace down the scale, we have 19·5 as the difference between chlorine and manganese; 20·3 between sulphur and chromium; 19·8 between silicon and titanium, &c. The total difference between manganese and fluorine is 36; between chromium and oxygen, 36·3; between vanadium and nitrogen, 37·4; and between titanium and carbon, 36·1. This is approximately the difference between the atomic weights of helium and argon, 36. I quote now from that address: "There should, therefore, be an undiscovered element between helium and argon, with an atomic weight 16 units higher than that of helium, and 20 units lower than that of argon, namely 20. And if this unknown element, like helium and argon, should prove to consist of monatomic molecules, then its density should be half its atomic weight, 10. And pushing the analogy still further, it is to be expected that this element should be as indifferent to union with other elements as the two allied elements."

Those who care to read the story of the search for this undiscovered element may find it in the address. Minerals from all parts of the globe, mineral waters from Britain, France and Iceland, meteorites from interstellar space; all these were investigated without result. Helium from various minerals was separated by long and tedious processes of diffusion into a possibly lighter portion, diffusing more rapidly, and a possibly heavier portion diffusing more slowly, but with no positive result. The systematic diffusion of argon, however, gave a faint indication of where to seek for the missing element, for the density of the more rapidly diffusing portion was 19·93, while that of the portion which diffused more slowly was 20·01.

The invention by Dr. Hampson of an apparatus by means of which it is possible to obtain liquid air at small expense and with little trouble placed a new instrument in our hands; and Dr. Travers and I prepared 15 litres of argon from the atmosphere, with the purpose of distilling it fractionally, after liquefaction; for we knew, from the researches of Prof. Olszewski of Cracow, who has done so much to determine the properties of liquefied gases, that argon could be liquefied easily by compressing it into a vessel cooled by help of liquid air. And, moreover, we were in hope that by fractionating the air itself gases of even higher atomic weight than argon might possibly be obtained. Both expectations were realised; on distilling liquid argon the first portions of gas to boil off were found to be lighter than argon, and on allowing liquid air to boil slowly away heavier gases came off at the last. It was easy to recognise these gases by help of the spectroscope, for the light gas, to which we gave the name *neon*, or "the new one," when electrically excited emits a brilliant flame-coloured light; and one of the heavy gases, which we called *krypton*, or "the hidden one," is characterised by two brilliant lines, one in the yellow and one in the green part of the spectrum. The third gas, named *xenon*, or "the stranger," gives out a greenish-blue light and is remarkable for a very complex spectrum, in which blue lines are conspicuous.

Although neon was first obtained by the fractional distillation of argon, it was afterwards found convenient to prepare it direct from air. The torpedo-compressor, which is used for compressing the air before it enters Dr. Hampson's liquefier, was made to take in the air which had escaped liquefaction in the liquefier; the denser portions were thus liquefied, and the lighter portions were liquefied by compressing them into a vessel cooled by the denser fractions, boiling under reduced pressure, and consequently at a specially low temperature. This liquefied portion was again fractionated, and yielded neon; and it was not long before we discovered that helium was also present in the mixture. The presence of helium in atmospheric air had previously been noted by Prof. Kayser of Bonn, and by Prof. Friedländer of Berlin, on submitting the spectrum of argon to a searching examination.

The purification of this mixture of neon and helium from argon, although a lengthy process, was not attended by any special difficulty. It was accomplished by repeated distillation, the lighter portions being always collected separately from the heavier portions, and again distilled by themselves. But after this separation had been accomplished, we found that we were unable by means of liquid air to liquefy the mixture, or indeed any portion of it. We effected a partial separation by diffusion; but it is not possible to separate by this method two gases of which the quantity is limited. Another attempt was made by dissolving the gases in liquid oxygen, on the supposition that neon might prove more soluble than helium; but without satisfactory results. It was evident that a lower temperature than that possible by help of liquid air was necessary.

Prof. Dewar had by that time succeeded in producing liquid hydrogen in quantity, and had indicated the principle, which is identical with that of Dr. Hampson's air-liquefier, although he has not published any detailed account of his apparatus. Dr. Travers undertook to investigate the subject; and after four unsuccessful trials he made a liquefier, with the help of Mr. Holding, the laboratory mechanician, by means of which a hundred cubic centimetres of liquid hydrogen could be easily and cheaply produced. There was then no difficulty in effecting the separation of neon from helium; for, while neon is practically non-volatile, when cooled by liquid hydrogen, remaining in the state of solid or liquid, even that enormously low temperature is not sufficient to convert helium into a liquid. Hence the gaseous helium could be pumped away from the non-gaseous neon, and the latter was obtained in a pure state.

The residues obtained from the evaporation of about thirty litres of liquid air, after being freed from oxygen and nitrogen, were liquefied by help of liquid air, and fractionated from each other. The separation offered no special difficulty, but was long and tedious. It soon appeared that when most of the argon had been removed the residue solidified when cooled; but while it was possible to remove the krypton by pumping, for it goes into gas slowly even at the low temperature of liquid air, very little xenon accompanied it; for at that temperature xenon is hardly at all volatile.

Having finally separated the gases, their densities and other properties were carefully determined; and it was also proved that they are like argon and helium, inasmuch as their molecules consist of single atoms. Neon, as was expected, turned out to be the missing link between helium and argon; the atomic weight of krypton was found to be 81·6, and that of xenon 128. The volumes occupied by equal numbers of molecules of the liquefied gases were determined; and also the boiling-points and melting-points of argon, krypton and xenon. These figures are shown in the following table:—

	Helium.	Neon.	Argon.	Krypton.	Xenon.
Density of gas.....	1·98	9·96	19·96	40·78	64·0
Atomic weight.....	3·96	19·92	39·92	81·56	128·0
Density of liquid ...	0·3 (?)	1·0 (?)	1·212	2·155	3·52
Boiling-points	—	—	−186·1°C.	−151·7°C.	−109·1°C.
Melting-points	—	—	−187·9°C.	−169°C.	−140°C.
Critical temperatures	—	—	−117·4°C.	−62·5°C.	+14·75°C.
Critical pressures ...	—	— (Metres.)	40·20	41·24	43·50
Refractivity of gas...	0·124	0·235	0·968	1·450	2·368

In every case there is seen what is termed periodicity; that is, a gradual alteration with rise of atomic weight, of the densities of the liquids, of the melting-points, of the boiling-points, and of the retardation of light when passed through the gas.

Let us consider, in conclusion, the position of these elements in the periodic table; and it will be sufficient to confine our attention to he groups of elements which form the neighbouring columns. The atomic weights are given in round numbers.

Hydrogen.	Helium.	Lithium.	Beryllium.
1	4	7	9
Fluorine.	Neon.	Sodium.	Magnesium.
19	20	23	24
Chlorine.	Argon.	Potassium.	Calcium.
35·5	40	39	40
Bromine.	Krypton.	Rubidium.	Strontium.
80	82	85	87
Iodine.	Xenon.	Cæsium.	Barium.
127	128	133	137

It is evident that these new elements fall into their natural places between the strongly electro-negative elements of the fluorine group, and the very electro-positive elements of the

lithium group, and that, in consequence of their lack of electric polarity and their inactivity they form, in a certain sense, a connecting-link between the two. It is curious, too, to notice that iodine, xenon, cæsium and barium form the ends of their respective columns. It is, of course, not impossible that other elements may be discovered, possessing similar properties, and yet higher atomic weights than these; but as yet there is no clue to guide us where to search for them.

It is difficult, owing to the impossibility of effecting a complete separation of the inactive elements from each other, to do more than hazard a guess as to their relative amount in air. As they are easily separated from the other constituents of air, there is no doubt as to their total amount; air contains 0·937 parts of argon and its companions by volume in 100 parts. Perhaps the table below may be taken as affording some indication of their relative amounts. Air contains by volume:—

0·937 part of argon per hundred.
One or two parts of neon per hundred thousand.
One or two parts of helium per million.
About one part of krypton per million.
About one part of xenon per twenty million.

It is of course not impossible that xenon may contain an even smaller proportion of a still heavier gas; but it is unlikely. Sea-water sometimes contains a grain of gold per ton; that is one part in 15,180,000; a grain of xenon is contained in about four hundredweights of air.

The problems suggested by the periodic table are by no means solved by the discovery of these aërial gases; but something has been done to throw light upon one obscure corner of the field. The gap between the electro-positive and the electro-negative elements has been bridged.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PRESIDENT ROOSEVELT has definitely decided not to accept Mr. Carnegie's offer of ten million dollars in Steel Trust bonds for public educational purposes. The provision attached to the offer to the effect that the Government should hold the bonds for a term of years is regarded as being especially objectionable.

THE scheme for the establishment of a University of Liverpool is beginning to take definite shape. A report upon the subject, submitted to the Liverpool University Committee on Monday, stated that the capital invested in land, buildings, equipments and endowments at University College, Liverpool, is not much less than 500,000*l*. To realise the ideal of a modern University, efforts will be made to raise a further capital sum of 330,000*l*. and an additional annual income of 9000*l*. Of the capital sum, 130,000*l*. would be required for additional college land and buildings. The remaining 200,000*l*. would supply an endowment for the professorial chairs and lectureships most urgently needed, especially in modern languages, chemistry and applied science, including electrotechnics. The additional yearly income of 9000*l*. would be needed for maintenance of the various departments, scholarships, equipment of the library, &c. The committee hope that the 330,000*l*. will be provided by gifts of Liverpool citizens and others interested in the highest education; and the additional income will be provided by increased grants from the Treasury, an annual grant from the Liverpool City Council, which, as it helped to create the college, will, it is hoped, give its aid in the establishment and maintenance of a Liverpool University.

THE annual conferences of science teachers arranged by the London Technical Education Board will be held on Thursday, January 9, and Friday, January 10, 1902, at the South-Western Polytechnic, Manresa Road, Chelsea, S.W. There will be four meetings, successively presided over by Mr. T. A. Organ, Sir Henry Roscoe, F.R.S., Principal Rücker, F.R.S., and the Countess of Warwick. The addresses to be delivered are as follows:—"Teaching of Hygiene," Miss Alice Ravenhill; "Mental School Hygiene," Dr. Francis Warner; "Teaching of Natural History," Mr. Frank E. Beddard, F.R.S.; "Value of Natural History Collections for Teaching Purposes," Prof. W. R. Bottomley; "American Systems of Nature Study," Mr. R. Hedger-Wallace; "Nature Study in Schools," Mr. D. Houston; "Technical Education in Rural Secondary Schools," Mr. E. E. Hennesey; "Pioneer Work in Secondary and Technical Education in Rural Districts," Prof. R. Meldola, F.R.S. A collection of home-made apparatus for science teaching in schools will be on view during the days of the conference. Applications for tickets of admission should be made to Dr. Kimmins, Park Lodge, Harrow-on-the-Hill, or to Mr. C. A. Buckmaster, 16, Heathfield Road, Mill Hill Park, W.

THE following resolutions passed by the committee of the Agricultural Education Association were confirmed at a general meeting of members held on Thursday last:—(1) That, if the Board of Agriculture retain their present educational work, it is essential that there shall be complete cooperation between that Board and the Board of Education on all educational matters specially affecting the agricultural classes. (2) That for purposes of agricultural education the country should be divided into districts, and such inspectors appointed as may be necessary. (3) That groups of counties, not yet affiliated to any collegiate centre, should be formed, each group being affiliated to some centre. (4) That, after due inquiry, reports should be issued dealing with the most appropriate forms of agricultural education for each county. (5) That permanent demonstration stations should be organised in each county or group of counties. (6) That official information bearing upon all matters of agricultural interest, whether educational or otherwise, should be distributed to the public free of cost. (7) That to carry out the above objects it is essential that larger funds be placed at the disposal of the Board of Agriculture for educational purposes. (8) That the work of the Board of Agriculture might be facilitated by the appointment of a consultative committee on the analogy of those of the Board of Education and of the Department of Agriculture in Ireland. (9) That copies of the above resolutions be sent to the Presidents of the Boards of Education and of Agriculture.

SIR WILLIAM ABNEY, K.C.B., opened the new science buildings in connection with Watford endowed schools on Thursday last. The new rooms comprise a lecture room, a physics laboratory, museum and balance room, a preparation room and a dark room, which, with the chemical laboratory (28 ft. by 24 ft.), erected in 1892, form a serviceable set of rooms, specially designed for science teaching. The cost of the additions has been about 2000*l*., and the sum previously expended on science buildings about 1000*l*. In the course of his remarks at the opening ceremony, Sir William Abney said he did not wish any of them to think that whilst they in the secondary branch of the Board of Education encouraged science in every possible way they discouraged the other branches of education which were given at the same time. One of the reasons for starting the schools of science on their present basis was to insure that any boy or girl going through a course of science should at the same time be educated in literary work, which was so necessary in education. Of course there was a great deal of difference between mere instruction and education. The utilitarianism of education was of minor importance; the great thing was education itself. If they could make the instruction that was given useful so much the better. In the old days the only possible means of education was by literary work, classics and so on. There was no science, and therefore they could not say that a boy or girl was to be educated in scientific methods; but he was certain those who founded schools like those at Watford were so alive to the necessity of education that they would be equally alive to the necessity of education in modern methods.

WE are glad to see that the subject of the coordination of the work of the Polytechnic Institutions of London with that of the Colleges was touched upon by Principal Rücker in the course of an address delivered at the South-Western Polytechnic, Chelsea, on Friday last. A place has been found for the Polytechnics in the reconstituted University of London, but their position is not clearly understood, and the direction in which their work may be usefully developed has not been sufficiently described. The Institutions provide opportunities for study and research, and the buildings, with those of other Colleges, help to make the University of London something more than a name. The standard of Polytechnic instruction is perhaps not so high in some cases as might be desired, but it can be raised in the course of time, and the efforts of friends of the University should be directed to this end. It is far better to make the best use of existing educational material than to neglect it. As Principal Rücker remarked, the endeavours that are being made are scattered, and the object of the University is to focus them into one strong effort in order that they may advance as a well-ordered army towards one common end. If that can be

achieved—if the Colleges and Polytechnics can be connected into one great educational machine—something worthy of the metropolis and of the Empire might be accomplished. The aims of the University of London will be, above all, practical. There should be great technical institutions which would prepare men for their work in life, and all who came within the range of the University should acquire something beyond the mere knowledge which enables them to take their parts in life.

THE connection between scientific knowledge and industrial progress was referred to by Mr. Balfour on Thursday last, in distributing the prizes aud certificates to students at the Goldsmiths' Institute (see p. 136). He remarked, in the course of his address:—"I am but little qualified to speak by personal investigation or experience of the work of institutions like this; but there is one part of their labours in which I have always felt the deepest sympathy, from a strong sense of its transcendent importance—I mean the teaching which gives a sound and thorough scientific training to those who are engaged in any one of the many pursuits which have a genuine scientific knowledge at their base. I am quite sure that, if we were to gauge the deficiencies of British education as compared, let us say, with German education, they would be found more striking in this branch of education than almost in any other. I am strongly convinced that not only is the necessity of a thorough scientific training great at the present moment, but that the necessity is one which grows with every new discovery. There was a time when in reality theoretical scientific knowledge was wholly divorced from manufactures or any form of practical industry. That state of things has long passed away; and now the alliance between the most abstruse scientific investigations and the general manufacturing output of the country is becoming closer and closer. What was yesterday the curiosity of the laboratory will to-morrow be manufactured in the gross and exported from this country, or from other countries, to every quarter of the globe. And no mere surface knowledge, no mere acquaintance with the methods in fashion at a particular moment, can possibly replace that knowledge of principle which lies at the very root of all these discoveries, and which must be possessed by those who are to attain the greatest success, either as the guides and leaders of manufacturing industry or as the inventors who are to increase the sum of human happiness and health by the work of their brains." The Lord Chief Justice gave expression to similar views in an address delivered at the Rutlish Science School, Merton, on Monday. He remarked that there was not the smallest doubt that what was required in these days—not only in Great Britain, but throughout the British dominions—was a more accurate scientific teaching, a more practical scientific teaching. We were, at the present time, suffering from the fact that those in charge, not only of our commercial supremacy, but of our education, up to some ten or fifteen years ago, had not realised that other countries had discovered that the root of all successful commercial enterprise must be scientific knowledge and investigation.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 21.—"Observations on the Physiology of the Cerebral Cortex of some of the Higher Apes." (Preliminary communication.) By A. S. F. Grünbaum, M.A., M.D. Cantab., M.R.C.P., and Prof. C. S. Sherrington, M.A., M.D., F.R.S.

Our experiments have been carried out on individuals representing the four species *Pithecus satyrus* (Orang), *Troglodytes gorilla* (Gorilla), *Troglodytes niger* (Chimpanzee), and *Troglodytes calvus* (Chimpanzee). The specimens so far have included ten adult individuals.

I. *Method employed.*

The method of excitation employed for the cortex has been unipolar faradisation, in the manner previously adopted by one of us (Sherrington, Roy. Soc. *Proc.*, vol. lii., 1893) in examining the cortex cerebri for ocular reactions. This method allows of finer localisation than that possible with the double-point electrodes ordinarily used.

II. "*Motor*" (*so-called*) *Area.*

This area we find to include continuously the whole length of the precentral convolution. It also enters into the whole length of the *sulcus centralis*, with the usual exception of its extreme lower tip and its extreme upper tip.

In all the animals examined, we have found the "motor" area not to at any point extend behind *sulcus centralis*.

On the mesial surface of the hemisphere the "motor" area has extended less far down than was expected. It has not extended to the calloso-marginal fissure. Certain areas near that fissure have yielded us movements, *e.g.* of shoulder, body, wrist and fingers; but we hesitate, for reasons to be given in a fuller communication, to class those with those of the "motor" area proper.

We have found the precentral convolution excitable over its free width, and continuously round, into and to the bottom of the *sulcus centralis*. The "motor" area extends also into the depth of other fissures besides the Rolandic, as can be described in a fuller communication than the present. The hidden part of the excitable area probably equals, perhaps exceeds in extent, that contributing to the free surface of the hemisphere. We have in some individuals found the deeper part of the posterior wall of the *sulcus centralis* to contribute to the "motor" area.

In the "motor" area we have found localised, besides very numerous other actions, certain movements of the ear, nostril, palate, movements of sucking, of mastication, of the vocal cords, of the chest wall, of the abdominal wall, of the pelvic floor, of the anal orifice and of the vaginal orifice.

We find the arrangement of the representation of various regions of the musculature follow the segmental sequence of the

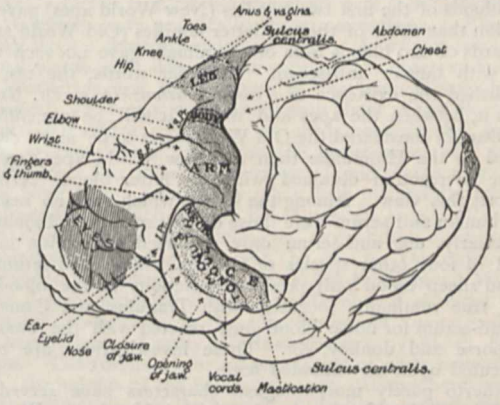

FIG. 1.—Brain of a Chimpanzee (*Troglodytes niger*). The extent of the "motor" area on the free surface of the hemisphere is indicated by the black stippling, which extends back to the *sulcus centralis*. There exists much overlapping of the areas and of their subdivisions which the diagram does not attempt to indicate. S.F. = superior frontal sulcus. S.Pr. = superior precentral sulcus. I.Pr. = inferior precentral sulcus.

cranio-spinal nerve-series to a very remarkable extent. The accompanying figure indicates better than can a verbal description the degree of adherence to this sequence.

We do not find that for the anthropoid brain the exciting current for the "motor" cortex requires to be extremely strong. "Epilepsy" is easily evoked from the cortex of the anthropoids.

Our experiments show that the *sulci* in the region of cortex dealt with can in no sense be considered to signify physiological boundaries. Further, the variation of the *sulci* in these higher brains is so great from individual to individual that, as our observations show, they prove but precarious, even fallacious, landmarks to the details of the true topography of the cortex.

Extirpation of the hand area by itself has been followed by severe paresis of the hand, the hand being for a few days practically useless and seemingly "powerless." In a few weeks use and "power" were remarkably regained in the hand, so that it was once more used for climbing, &c. The animal ultimately not unfrequently fed itself with fruit, making use of that hand alone. Even small ablations in the precentral gyrus have led to severe though quickly diminishing pareses. On the other hand, ablations of even large portions of postcentral gyrus have not given any even transient paresis.

III. *Other Regions of Cortex.*

Our observations indicate that the frontal region, yielding conjugate deviation of the eyeballs, presents such marked

differences of reaction from the "motor" area of the Rolandic region that we hesitate to include it with the so-called "motor" cortex. Spatially it is wholly separate from the Rolandic "motor" area by a field of "inexcitable" cortex. As to the occipital lobe, only from the extreme posterior apex of the lobe and from its actual calcarine region has faradisation yielded any movement (eyes), and then not easily.

The spinal degeneration resulting from ablation in the precentral gyrus of the above-mentioned "hand" area, discovers in the anthropoid cord the human feature of a perfectly large direct ventral (Türcksbündel) as well as crossed pyramidal tract. The relative sizes of these tracts seem about the same as in man.

"The New Biological Test for Blood in Relation to Zoological Classification," by George H. F. Nuttall, M.A., M.D., Ph.D. (Cambridge).

Attention is directed to experiments which prove the value of the biological test for blood in relation to zoological classification. The test is made by means of antisera, which are produced by injections of blood into various animals. If human blood, for example, is injected intraperitoneally into rabbits, the serum of the latter animals, after a course of such treatment, acquires the property of producing a precipitation when it is added to dilutions of human blood. By means of such anti-serum a positive reaction may be obtained with solutions of dried human blood. The anti-serum for human blood also acts on the blood of monkeys. The bloods of eighteen species of monkeys, representing the four families Hapalidæ, Cebidæ, Cercopithecidæ and Simiidæ, all reacted to human anti-serum. The bloods of the first two families (New World apes) gave less reaction than those of the two latter families (Old World apes). Upwards of 200 bloods from other animals gave no such reaction with human anti-serum. In other words, the test has established the existence of a *blood relationship*, as Dr. Nuttall terms it, between the apes and man. It will be remembered that Darwin considered the Old World apes to be more closely related to the Hominidæ than the New World apes, and the degree of reaction obtained with the latter bloods certainly supports this view. Among the bloods which gave no reaction with human anti-serum were those of two species of Lemur.

Similarly, dog anti-serum only produced a reaction in the blood of four other species of Canidæ. The anti-serum for ox and sheep blood only produced reactions in the bloods of other true ruminants (negative with Tragulus and Camelus), the anti-serum for horse blood only reacted with the blood of the horse and donkey, &c. These investigations are being prosecuted upon an extended scale.

Hitherto purely morphological characters have served for purposes of classification in the animal kingdom. We now possess a test whereby chemical differences may be determined between the bloods of different animals, as also, to a certain extent, between the bloods of related species, the differences in the latter case being quantitative. Dr. Nuttall believes that it will be possible by means of this test to determine certain relationships which have hitherto been considered obscure. It is certainly a remarkable fact that a fundamental chemical character has persisted in the bloods of all the Anthropoidea, in spite of the widely divergent modes of life and the different character of the food. Limited space prevents a consideration of the chemical nature of the reaction, but we might add that it is at present but imperfectly understood.

Physical Society, December 13.—Prof. S. P. Thompson, president, in the chair.—The following papers were read by the secretary:—On circular filaments or circular magnetic shells equivalent to circular coils, and on the equivalent radius of a coil, by Prof. T. R. Lyle. It is shown that we can represent the magnetic action of any coil by replacing it by one or more filamentary circuits in which currents circulate bearing a simple relation to the actual current in the coil. If the axial and radial dimensions of the coil in question are the same, then the external magnetic action can be represented by that of one filamentary circuit. If the axial breadth is greater than the radial depth we must employ two filaments (of equal radii separated by an axial distance, and if the opposite condition holds, two circular filaments of different radii lying in the same plane perpendicular to the axis of figure of the coil. In the case of coils in which the axial and radial dimensions are equal, a modification of Bosscha's method is described which yields the equivalent radii directly as the result of length measurements. If the axial and radial dimensions are not equal, it is shown that the method is still applicable, provided that the ratio of the resistances of the Bosscha comparison be altered in a ratio depending on these dimensions. Apparatus for carrying out the experiment is described and applications to some classical cases are given. It is also pointed out that the correction for finite length of magnet in Bosscha's (or the present) method of comparison is in general far from negligible. The formulæ used are based on the expansion of the potential of a coil for points on its axis, and terms up to the fourth have been included, but the effect of neglecting higher terms is not investigated.—The secretary read a letter from Lord Rayleigh, in which he stated that the length of the magnet used in determining the constant of the current balance used in the determination of the electro-chemical equivalent of silver was one-tenth of an inch, and the error due to neglecting this was less than one part in ten thousand.—On air-pressures used in playing brass instruments, by Dr. E. H. Barton and Mr. S. C. Laws. It is well known that in playing upon the "brass" or "wood-wind" instruments of the orchestra the particular note, at any instant desired, is produced by the simultaneous use of the mechanism of the instrument and the corresponding "embouchure" through which air at a suitable pressure is driven by the performer. The object of the paper is to find how the air-pressure required to sound the different notes varies with (1) the pitch of the note, (2) its loudness, (3) the fingering or other manipulation of the instrument, (4) on the instrument itself. Experiments were made with the tenor trombone, the trumpet and the cornet, and the pressures were taken by a water-manometer connected to the performer's mouth by an india-rubber tube terminating in a glass nozzle, which could be held by the side teeth. The following inferences are drawn from the experiments: (1) Other things being equal, the louder the note the greater the pressure. (2) The higher the pitch of the note played on a given instrument the greater the air-pressure used. (3) The curves formed by plotting the logarithms of the frequencies of the notes as abscissæ and the pressures as ordinates are straight lines. (4) The air-pressure required to sound any note with given intensity is approximately proportional to its pitch defined logarithmically. (5) Where alternative positions or fingerings are used for the same note the pressures are practically the same. (6) The pressures for identical notes on trumpet and cornet are almost the same for any given intensity, but very much less than those for the same notes on the trombone. (7) The pressures used for loud low notes may exceed those for soft high notes.—On a new hygrometric method, by Mr. E. B. H. Wade. In this method a thermometer is wetted, not with water, but with sulphuric acid of such a strength that the temperature of the acid bulb is close to that of the dry bulb. The maximum tension of the acid at any temperature is known from Regnault's work, and two or more determinations with this instrument and with a wet and dry bulb hygrometer at the same time enable the constants of both instruments to be determined. If the difference between the acid bulb and the dry bulb is less than 2°, the constant remains fixed over a large range. Experiments show that the readings of the instrument are not affected by ventilation, and since the difference between the temperatures of the bulbs is small, errors in the determination of the constant are unimportant.

Zoological Society, December 3.—Dr. W. T. Blanford, F.R.S., vice-president, in the chair.—Mr. W. E. de Winton exhibited a remarkably large specimen of the grey mullet (*Mugil chelo*), said to have been taken in the North Sea.—A series of papers on the collections made during the "Skeat Expedition" to the Malay Peninsula in 1899-1900 was read. Mr. F. G. Sinclair reported on the Myriapoda, and enumerated the forty species of which specimens had been obtained. Of these, nine were described as new to science. Mr. W. F. Lanchester contributed an account of a part of the Crustacea, viz. the Brachyura, Stomatopoda and Macrura, collected during the expedition, and described six new forms. Mr. F. F. Laidlaw enumerated the snakes, crocodiles and chelonians which had been obtained, and described two new species based on specimens in the collection. An appendix to these papers, drawn up by Mr. W. W. Skeat, contained a list of names of the places visited by the members of the "Skeat Expedition."—Mr. F. E. Beddard, F.R.S., read a paper on the anatomy and systematic position of the painted snipe (*Rhynchaea*), based on an examination of specimens of this bird which had lately died in the Society's menagerie. The author was of opinion that *Rhynchaea* was more nearly allied to the Parridæ than to the

Scolopacinæ. In a second paper Mr. Beddard pointed out the structural differences between the common snipe (*Gallinago coelestis*) and the jack snipe (*G. gallinula*).—A communication from Dr. R. Bowdler Sharpe contained an account of the birds collected by Dr. A. Donaldson Smith during his last expedition to Lake Rudolf and the Nile.—Mr. G. A. Boulenger, F.R.S., described two new fishes under the names *Phractura ansorgii* and *Fundulus gularis*, recently discovered by Dr. W. J. Ansorge in southern Nigeria.

Aëronautical Society, December 3.—Mr. E. P. Frost in the chair.—Papers were read by Sir Hiram Maxim on aërial navigation by bodies heavier than air, by Mr. William Marriott on atmospheric currents, and by Mr. Eric Stuart Bruce on navigable balloons and the scientific aspects of M. Santos Dumont's experiments. Sir Hiram Maxim discussed the work done in navigable balloons by MM. Giffard and Renard. Renard made return journeys, but he never tried a petroleum motor. M. Santos Dumont had done so, had driven his balloon at the greatest pace yet attained, and returned to his starting-point in face of an adverse wind. His motor and balloon had strength and lightness as great as possible, and it did not seem probable they could be improved upon, so that his results seemed carried to the line beyond which no one could go. Turning to the consideration of flying by means of bodies heavier than air, in which, as yet, only a beginning has been made, Sir H. Maxim recapitulated the details of his own machine, relating his preparatory and subsequent experiments, which latter proved that a machine on a large scale could be made to develop a lifting effect greater than its own weight. The petroleum motor would now probably yield the best results. Now, too, there were aluminium alloys strong as wrought iron and light as aluminium, and at the time that he carried out his experiments engineers had nothing so good in their hands. He considered that a flying machine was not only now possible, but practicable.—Mr. W. Marriott, in his paper on atmospheric currents, explained climate and weather as meteorological terms, mentioned the instruments used for meteorological observations, dwelt on pressure records taken on the earth, alluded to the connection between heat and pressure, and by means of a series of charts explained the direction of currents in cyclones and anticyclones. A knowledge of the velocity and direction of winds in the upper air is needed, and he called upon the Aëronautical Society to here help meteorology. Speaking of the valuable kite-observation work of Mr. L. Rotch, up to a height of 8000 feet, Mr. Marriott said that at present a free balloon drifting with the wind can obtain no record of wind pressure or wind velocity; it can only ascertain the direction of the upper currents.—Mr. Eric Stuart Bruce pointed out that for the first time in history M. Santos Dumont had succeeded in steering a balloon from a given point to a given point in a given time. His ingenuity and originality had enabled him to make a real, though small, advance in practice in overcoming the force of the wind; the observations on the Eiffel Tower showed that on the day he won the Deutsch prize the velocity of the wind during his balloon journey was from four to five metres per second. In future navigable balloon competitions, Mr. Bruce thought it should be made a condition that the trials took place when the wind-force was not below a certain value.

Linnean Society, December 5.—Dr. D. H. Scott, F.R.S., vice-president, in the chair.—Dr. W. G. Ridewood exhibited nine specimens of abnormal sacra in the edible frog (*Rana esculenta*) and one in the common frog (*Rana temporaria*).—Dr. J. H. Salter read a paper on protoplasmic connections in the lichens. The author stated, in conclusion, that the observations tended to show that a complete anatomical union exists between the several tissues of the lichen thallus, due to the innumerable connections which may be traced between the ultimate histological units, the segments of the hyphæ. Many physiological problems are simplified, and a new conception is obtained, by our ability to recognise the essential unity of the living matter throughout the organism.—Mr. F. Chapman read a paper on the foraminifera collected round the Funafuti Atoll from shallow and moderately deep water; with notes on new species from the sands of the reef slope. The descriptions were based on material collected by Profs. Sollas and Edgeworth David, and included samples from the beaches down to 200 fathoms and also from the reef slope. They serve as an index to the forms found in the reef-boring. Some idea of the richness of the dredgings may be gathered from the fact that no less than 273 distinct forms are recorded from the dredgings taken between 16 and 200 fathoms. From these samples fourteen new species and varieties have been described.

PARIS.

Academy of Sciences, December 9.—M. Fouqué in the chair.—On the connection of algebraic surfaces, by M. H. Poincaré.—Studies on radium, by M. Berthelot. A detailed study of the action of radium salts upon iodic anhydride. The experiments were carried out at two temperatures, 10° and 100°; blank experiments were carried out, always in the dark, in such a manner as to distinguish between the effects of the phosphorescence produced by the radium and the effects produced by the radium rays in the absence of this phosphorescence. In the case of the iodic acid submitted to the action of the radium tube wrapped round with black paper, that is, protected from the phosphorescence, no reduction took place, whilst in the tube not thus protected iodine was formed. The amounts produced were of the same order of magnitude as the effects observed previously by M. Curie and M. Becquerel.—On the radio-activity of uranium, by M. Henri Becquerel. The observations published by Crookes and by Giesel would tend to show that the activity of uranium may be due to the presence of a small quantity of a very active compound, and that uranium itself is really inactive. This, however, is hardly consistent with the fact that the radio-activity of a commercial uranium salt, whatever may have been its origin, is practically constant. In some earlier work, some uranium salt was fractionated and the radio-active effects concentrated in certain fractions; after the lapse of about eighteen months these fractions were re-examined and were found to have practically the same activity. The lost activity is thus regained spontaneously. A hypothesis is developed which is in accord with most of the observed facts.—The production and maintenance of low temperatures, by M. d'Arsonval. For temperatures down to about −110° the use of solid carbonic acid or acetylene in acetone is recommended, and the necessary precautions given for the maintenance of a steady temperature. For lower temperatures liquid air must be used; it has been found possible to use a bath of carefully rectified petroleum spirit, which remains liquid even at −194°.—Remarks by M. Dehérain on his treatise on agricultural chemistry.—On persistent conjugated systems, by M. A. Demoulin.—On transcendental equations and numbers, by M. Edmond Maillet.—The determination of the observed heights of shooting stars in August, 1901, between the Observatory of Juvisy and the auxiliary station of Antony (Croix-de-Berny), by M. C. Flammarion. The results of the measurements of eight meteors are given, the heights of the first appearance varying between 119 and 15 kilometres, and the heights of the disappearance varying between 68 and 14 kilometres.—A method allowing of the determination of the true velocity of navigable aërostats, by M. H. Deslandres.—A note completing that of November 25 and giving the trace of the trajectory on the ground, with an approximation of about 1/25, of the course of M. Santos Dumont's aërostat on the trial of October 19, by M. J. Armengaud, jun.—The influence of stray currents upon the terrestrial magnetic field, by M. Th. Moureaux. It has been found that in spite of the employment of deadening apparatus the establishment of electric tramways affects, not only the diurnal variation, but also the absolute magnetic elements.—On the auscultation of storms and on the study of the diurnal variation of atmospheric electricity, by M. Th. Tommasina.—On the alloys of aluminium and magnesium, by M. O. Boudouard. The compound Al_4Mg was isolated, and its properties are given. Particulars are also given of the preparation and properties of $AlMg_3$ and AlMg.—On the alloys of strontium with zinc and cadmium, by M. Henri Gautier.—On the state of silicon in cast iron and in ferrosilicons containing a small amount of silicon, by M. P. Lebeau. The compound SiFe cannot exist in the presence of an excess of iron and consequently cannot form a constituent of siliceous cast irons. All the silicon in cast iron would appear to be in the state of the silicide $SiFe_2$.—On a practical means of obtaining trichlorbutyl alcohol, by M. Marcel Guédras. Trichlorbutyl alcohol is prepared by the action of caustic potash upon a mixture of acetone with chloroform. This alcohol is a local anæsthetic, and also possesses antiseptic properties.—On the nutrition of the embryo at the expense of the cotyledons, by M. G. André.—The structure of the lymphatic ganglions of the goose, by MM. L. Vialleton and G. Fleury.—The inoculation of cancer from man to the white rat, by M. Mayet.

—On the existence in cold-blooded animals of a regulating apparatus for heat, by M. J. P. Langlois. Reptiles with impermeable skin have the power of regulating their temperature when it reaches 39° and when the calorific rays strike the head directly.—On the salutary effects of potatoes substituted for bread in diabetics in high doses sufficient to maintain the equivalence of the food ration, by M. A. Mossé. The carbohydrates which may be given to diabetics can be divided into three classes—harmful, indifferent and doubtful—and the potato has been generally placed in this last group. From the experiments here described, the author concludes that the potato is not only permissible, but useful, and may be advantageously substituted for bread.—Organic variations in the hen with respect to its food, by M. F. Houssay.—On the transformations of the germinative vesicle in lizards, by Mlle. Marie Loyez.—Properties of the liberoligneous chains in ferns, by MM. C. E. Bertrand and F. Cornaille.—A contribution to the study of a new disease of the potato produced by the *Bacillus solancola*, by M. G. Delacroix.—The influence of nutritive mineral salts on the production of nodosities in peas, by M. E. Marchal.—Conclusions to be drawn from the study of the series of homogeneous enclosures in a volcanic rock; the series of homogeneous enclosures in the andesites from Mont-Dore, by M. A. Lacroix.—The gases of the blood at different altitudes during a balloon ascent, by MM. J. Tissot and Hallion. The decrease of atmospheric pressure caused by a balloon ascent causes a sensible increase in the power of absorbing oxygen possessed by the hæmoglobin; up to 3500 metres the carbonic acid contained in the blood does not follow the law of solution of gases, on the contrary it varies in the inverse sense. The nitrogen in the blood follows the ordinary laws, the amount diminishing as the pressure is reduced.—Reproductions of the Palæolithic drawings engraved on the walls of the cave of Combarelles, by MM. Capitan and Breuil. The paper is accompanied with reproductions of drawings of a horse, reindeer, mammoth and bison.

NEW SOUTH WALES.

Linnean Society, October 30.—Mr. J. H. Maiden, president, in the chair.—On *Eucalyptus pulverulenta*, Sims, by Mr. J. H. Maiden. The author shows that *E. pulverulenta*, Sims, is conspecific with the "apple or peppermint" of Victoria (one of the trees known as *E. Stuartiana*, F.v.M.) and the "red or black peppermint" of New England (*E. nova-anglica*, Deane and Maiden), both of which he considers to be lanceolar-leaved forms of the species.—On *Eucalyptus Stuartiana*, F.v.M., by J. H. Maiden. The author shows that at least three species of trees have passed under this name, and expresses regret that it is not possible to obliterate the name from the list of species. As this is out of the question, he reiterates the former recommendation of Mr. Deane and himself that its use be confined to the "apple or but but" of Victoria and to the "apple or white peppermint" of New South Wales, the species that probably extends over a greater area than that of any of the other plants included under the name, and the one which was perhaps most frequently named *E. Stuartiana* by Mueller himself.—On *Eucalyptus Gunnii*, Hook. f., by Mr. J. H. Maiden. The author divides the species into the type-form and four varieties, viz., vars. *acervula*, *ovata*, *rubida* and *maculosa*.—The gum-fermentation of sugar-cane juice, by Mr. R. Greig Smith. The viscosity that occasionally develops in cane juice during the manufacture of sugar has been traced to *Bacillus levaniformans*, n.sp., which ferments saccharose producing gum, a mixture of reducing sugars, carbon dioxide and a mixture of acids. Neither mannite nor alcohol is formed. In a culture medium containing 100 grms. saccharose, 1 grm. peptone and salts dissolved in a litre of water, 31 grms. gum and 60 grms. mixed reducing sugars were produced in seven days at 37° C. The gum is formed from saccharose, but not from lactose, dextrose, levulose, maltose, starch or vegetable infusions without saccharose. Peptone increases the gum and acids relatively, and decreases the mixed reducing sugars. The fermentation goes on, though slowly, in weak peptone (·001 per cent.) solutions. The chemical and optical properties of the gum, which is probably the diffluent capsule of the bacillus, show it to be different from inulin, levulan and other previously described gums; it has, therefore, been named levan. Carbon dioxide is produced in good amount, 1·28 grms. being formed from 100 grms. saccharose in five days. The acids are comparatively small in amount, and consist of active and inactive lactic, butyric, acetic, formic and capric acids. These occur in the ratio of about 60 of lactic acid to 1 of the rest. Many races of *Bac. levaniformans* were separated from other sources, and these showed that the organism is related to the potato group of bacilli as a whole and not to any one so-called species.—The chemical properties of bacterial gum levan, by Mr. Thos. Steel. The chemical properties of levan, the new gum produced by the action on sugar of the bacillus described by Mr. R. Greig Smith in the preceding paper, are described. The relationship of levan to other similar known substances is detailed, and it is shown to differ in important respects from inulin, the body which it most nearly resembles generally. The gum found in sugar-cane suffering from the well-known "gumming" disease is quite distinct from levan.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 19.

LINNEAN SOCIETY, at 8.—On the Brain of Recent and Fossil Lemurs: Dr. G. Elliot Smith.—On the Ostracoda collected round the Funafuti: F. Chapman.—Exhibitions: A Gigantic Argulus from Japan and a Specimen dredged at the Cape: Prof. G. B. Howes, F.R.S.—A New Polyzoon from Tanganyika: J. E. S. Moore.—An Example of White's Thrush (*Turdus varius*), shot near Clavering, Essex: Miller Christy.

CHEMICAL SOCIETY, at 8.—(1) Corydaline. Part VII. The Constitution of Corydaline; (2) The Relation of Corydaline to Berberine. The Oxidation of Berberine with Nitric Acid: J. J. Dobbie and A. Lauder.—The Magnetic Rotation of some Polyhydric Alcohols, Hexoses, and Disaccharoses: W. H. Perkin, F.R.S.—Stereoisomeric Halogen Derivatives of α-benzoylcamphor: H. O. Forster and F. M. G. Micklethwait.—Is Argon an Elementary Substance? G. Martin.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some Principles underlying the Profitable Sale of Electricity: Arthur Wright.

INSTITUTION OF MINING AND METALLURGY, at 5.—The Titration, Use and Precipitation of Cyanide Solutions containing Copper: Walter H. Virgoe.—Ore in Sight: J. D. Kendall.—Continuous Section System Mine Sampling: M. H. Burnham.

FRIDAY, DECEMBER 20.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Transmission Dynamometers: A. M. Morgan.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Microscopical Examination of the Alloys of Copper and Tin: W. Campbell.

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