THURSDAY, SEPTEMBER 27, 1900.

THE MAMMALS OF SOUTH AFRICA.

The Fauna of South Africa; Mammals. Vol. i. *Primates, Carnivora and Ungulata.* By W. L. Sclater. Pp. xxx + 324; illustrated. (London: Porter, 1900.)

IN our review of the "Birds of South Africa" (vol. i.), published earlier in the year, reference was made to the scope of the present series of volumes and the peculiarities of the South African fauna; and it will therefore be unnecessary to recapitulate what has been there written. In the introduction to the volume before us Mr. Sclater remarks that since 1832 no one has attempted to give a complete account of the mammals of South Africa, attention having been concentrated by writers on this subject to the larger forms which constitute the chief attraction to sportsmen and travellers. Accordingly, in the case of the smaller representatives of the class the author has practically a clear field before him, much labour being necessary to collect and collate the numerous papers which have been written of late years on the Rodents and other small mammals of Africa. This portion of his subject is, however, reserved for the second volume; and at present we have only to consider how Mr. Sclater has treated the section dealing with the larger types of mammalian life.

As he himself admits, his task in this respect has been a comparatively easy one; the "Book of Antelopes" clearing the way in regard to that very important group of the Ungulata, while the Zebras have been carefully worked out by Mr. Pocock and other naturalists, and the Carnivora have attracted the attention of numerous writers. On all these valuable sources of information Mr. Sclater has drawn largely; and it is no discredit to him if the work partakes to a very considerable degree of the nature of a compilation, and contains comparatively little that is new and original. Indeed, this is fully acknowledged in the Introduction, where the author takes care to state that in his account of the habits of the different animals he has relied on the observations of others, and endeavoured to compile from published writings and manuscript letters an adequate and readable account of each.

By these observations we by no means intend to imply that Mr. Sclater's work is in any sense a superfluous or unnecessary one; the "Book of Antelopes" and other works of that description are expensive and accessible only to the few; and, as already said, there is no modern and up-to-date work treating of South African mammals as a whole.

Both in respect to his treatment of the aforesaid life-histories and in his description of the species themselves Mr. Sclater may, indeed, be fairly congratulated on the result of his labours; the volume before us being sufficiently popular and interesting to attract the attention of the sportsman, while at the same time it contains a sufficient amount of technical detail to satisfy the needs of the working naturalist. Whether, however, in these days of cheap natural histories and zoological text-books it is necessary that every work on local faunas should contain a hackneyed recapitulation of the characteristics of the orders and other large groups of animals may be a question which many would, we think, be inclined to answer in the negative. As regards the numerous illustrations in this volume, it is much to be regretted that the majority, which were executed in the Colony, are of a very inferior description, and in no wise worthy to stand alongside those borrowed from the "Book of Antelopes" and other well-known works. Probably there is not time to alter the arrangements made for illustrating the second volume; but if there be, it is most desirable that the drawings should be made and photographed in this country.

As regards the local variations presented by species, the author is perhaps a little too conservative; and although he gives full details in regard to the numerous races of Burchell's zebra, we venture to think that more might have been said, for instance, with regard to the local phases of the Kaffir cat and some of the jackals. Among the Carnivora, it is interesting to find that the author recognises the black-footed cat (*Felis nigripes*), which has been so unaccountably overlooked by recent writers, as entitled to rank as a species. And, in another group, we think he is decidedly well advised in adopting the Colonial term "Dassie" (an abbreviation of the Boer *klip-dass* = rock-badger) as the popular name for those animals which used to be scientifically known as Hyrax, until that name was displaced by the earlier Procavia.

Generally speaking, Mr. Sclater is, indeed, well up to date as regards nomenclature, both popular and scientific. He does not, however, in all cases give credit for recent emendations in nomenclature to those to whom it is due. For instance, the reader would be led to imagine that the author was the first in modern times to replace the ordinary scientific title for the eland by *Taurotragus oryx*, whereas the change was initiated last year by Mr. Rowland Ward in his "Records of Big Game." And it cannot be urged in the author's defence that the omission is due to the fact of his quoting only references from works bearing directly on South Africa, since he departs from this rule in the case of *Cephalophus grimmi* (p. 157), as well as in other instances. A change of name for which the author appears to be really responsible occurs in the substitution of *Strepsiceros capensis* for *S. kudu*; but this directly raises the question of the advisability of adopting the alliterative *S. strepsiceros*, which some would now regard as the proper name of the kudu.

On the whole, the volume appears to be remarkably free from misprints and slips. On p. 317 the author has, however, given *Elephas planifrons* as the type of Falconer's subgenus *Euelephas*, and *E. hysudricus* as that of *Loxodon*; whereas the two specific names should be transposed. But this unfortunate slip is not all, for in making these two species the respective types of the subgenera the author has totally misrepresented Falconer. Mr. Sclater has, of course, taken them as the types because they occur first in Falconer's table. But *Euelephas* of Falconer is merely the typical subgenus of *Elephas* (*Elephas* proper it would now be called), and therefore the type of the one is the type of the other; this being, of course, the Indian elephant. Again, in the paper to which Mr. Sclater refers, Dr. Falconer, in writing of the Loxodons, says that "the existing type of this group is the African elephant, which Fred. Cuvier, in 1835, proposed to erect into a distinct genus under the name of Loxodonta." A more unfortunate error, complicated by a more unfortunate slip, could scarcely be conceived.

In one other passage where the author ventures into the domain of palæontology he has scarcely been more successful, since (p. 308) he unhesitatingly accepts the alleged Cretaceous age of presumed Hyracoid remains discovered in the Argentine. Possibly, however, his omission to mention that fossil "dassies" occur in the European Pliocene may be due to the time that the volume has taken in passing through the press, although the fact was announced at the Zoological Congress held at Cambridge in 1898.

Much general interest will attach to Mr. Sclater's account of the two large mammals which have undoubtedly become extinct in South Africa in modern times. With regard to the first of these, the author remarks that the last blaauw-bok (*Hippotragus leucophoeus*) was probably killed in 1799; and that, in addition to several pairs of horns, five complete mounted specimens are known to be preserved. The quagga (*Equus quagga*) he believes to have survived in the Orange Colony till at least 1878, although it is difficult to obtain exact information owing to the Boers confounding this species with Burchell's zebra. Of the white rhinoceros it is considered not improbable that a few may still survive in Zululand, although it is sad to learn that no less than six are reported to have been killed so lately as 1894, one of these being exhibited in the museum at Pretoria. The latest information with regard to the white-tailed gnu is that a few herds were, till recently, preserved on some farms in the Orange Colony and the Transvaal; while it is suggested that a few stragglers may survive in the Kalahari, Gordonia and German South-west Africa. Much anxiety will now be felt by naturalists as to what has happened to the gnus, and also to the blesboks, till lately preserved in the Boer Republics; and it is to be hoped that those responsible for the settlement of these districts will do all in their power to protect such remnants as the war may have left.

We hope ere long to have the pleasure of congratulating Mr. Sclater on the completion of his task. R. L.

OUR BOOK SHELF.

Acetylene, a Handbook for the Student and Manufacturer. By Vivian B. Lewes, F.I.C., &c. Pp. xxvi + 978. (Westminster: Archibald Constable and Co., Ltd., 1900.)

IN this handsome volume of nearly 1000 pages, Prof. Lewes has presented the English reader with a handbook on the manufacture and use of acetylene which in completeness of scope and wealth of illustration will compare with its French and German rivals.

In the first part (consisting of four chapters) the scientific history of acetylene and its properties is set forth with considerable detail; useful summaries of many researches are given, and references to the original memoirs are added. The question of the discovery of "commercial calcium carbide" is discussed with discrimination, the chief credit being assigned to the Canadian engineer, Mr. T. L. Willson. The reactions of acetylene, especially with metallic salts, are fully considered.

Part ii., the most important in the book, describes the development of the electric furnace, and its special adaptation to the manufacture of calcium carbide. The generation of acetylene by the action of water on the carbide is next considered, and then the question of impurities and their removal is discussed. Most of the figures illustrating this portion of the book are clear and satisfactory, but a few are indistinct and on too small a scale. The chapter on the combustion of acetylene is illustrated by a number of useful drawings of burners and flames, and full data are given for a comparison between acetylene and other methods of illumination, both as regards prime cost and working expenses. We think Prof. Lewes has shown himself eminently fair in the discussion of this subject.

The method of treatment adopted by the author naturally leads to some repetition, but in a book of reference this will not be felt an inconvenience. It was perhaps hardly necessary to give the author's "acetylene theory of luminosity" twice over. In a new edition we hope that the number of small inaccuracies will be reduced. We did not expect to find a chief gas-examiner saying that "sulphur dioxide, in ill-ventilated apartments, will absorb oxygen and moisture from the air, and will in this way become converted into minute traces of sulphuric acid, which, concentrating themselves upon any cold surface in the room, give rise to corrosion," &c. The Harcourt pentane standard is not approved of, apparently, by Prof. Lewes, who states that it was first described in 1887. It was described ten years earlier. The specific heats of gases given on page 609 are incorrect, and several names are wrongly spelled, *e.g.* Vielle should be Vieille (p. 68), Smithell should be Smithells (563). In spite of small errors, the book is a mine of information, and will be useful, both to chemical students and to others interested in the making and use of acetylene.

Wireless Telegraphy and Hertzian Waves. By S. R. Bottone. Pp. 113. (London: Whittaker and Co., 1900.)

THERE are many whose interest in wireless telegraphy will take the form of a desire to experiment for themselves, and who, whether from inclination or necessity, will prefer to do so with home-made apparatus. To these the little book before us will especially commend itself.

The first half of Mr. Bottone's work is devoted to "preliminary notions," "historical considerations," and to a chapter on electric waves. This earlier half seems to us to leave much to be desired. Thus a clear elementary description of the fundamental experiments of electrical science is followed (p. 12) by a very obscure summary of the properties of electric charges and currents. Again, the confusing of the words "stress" and "strain" will not please the reader accustomed to the modern strict usage of these terms.

The description of apparatus in these earlier chapters is often involved, and many sentences will be found which through faulty punctuation or other small errors are not at once intelligible. A considerable amount of repetition also seems to occur, apart from deliberate recapitulation.

The later part of the book includes a number of really good descriptions in detail of how to make such apparatus as a small induction coil, a Wimshurst machine, a relay, or a coherer; and the author is evidently familiar with the little practical difficulties which arise. Possibly the importance of making a dimensioned drawing before starting work might have been emphasised; but in all other respects these "workshop recipes" seem very complete and well suited to the wants of those about to make such apparatus. D. K. M.

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.*]

Vibrissæ on the Forepaws of Mammals.

It is well enough known that carnivorous and other—especially nocturnal—animals are provided with numerous long hairs, generally called vibrissæ, upon various regions of the face. The "whiskers" of the cat are a familiar example. But it is not so widely known that there exists very commonly in those same creatures a tuft of long hairs upon the wrist, which are connected with a large nerve. There have been incidental references to these structures; thus Mr. Bland Sutton described and figured them in several Lemurs. But it is not, I believe, a matter of common knowledge that they are present in a great variety of mammals. I have examined members of the groups, Lemuroidea, Carnivora, Rodents, and Marsupials, and invariably found these structures in those members of the groups in question which use their forepaws as climbing or grasping organs, or in both ways. They are generally not very conspicuous, as the individual hairs are often not markedly thicker than those of the surrounding fur. But often they contrast by their colour. In a pale, almost albino, example of the squirrel *Sciurus maximus*, the hairs were especially obvious, owing to their being black, and thus contrasting with the pale brown of the surrounding part of the pelage. In a black cat the same vibrissæ were white. It is always, however, easy to assure oneself of their presence by the sense of touch. The bundle of these rather stiff hairs and the thick nerve termination cannot be missed, if the skin be gently squeezed. In a newly born phalanger this structure was particularly obvious; but in a kangaroo of corresponding age there were no signs of an elevation of the skin bearing thick hairs. It will be remembered that the mode of life of these two marsupials is very different. Although I have examined up to the present but few genera of mammals, it appears to me that this structure will be found to be pretty universal. I have of course not detected these arm vibrissæ in Ungulates.

Zoological Society's Gardens. FRANK E. BEDDARD.

The Distance to which the Firing of Heavy Guns is Heard.

In the number of NATURE for August 16, there is an article by Mr. Charles Davison on the distance to which the firing of heavy guns is heard. The writer of the article seems to wish to collect facts bearing upon this question. I can supply one bit of information of the kind desired.

In the summer of 1863, during the siege of Charleston, S.C., by the Federal forces, being at the time an officer in the Confederate Army, I went, under orders, from Macon, Ga., to Charleston by way of Millen, Augusta and Branchville. It was just at the time of the first heavy naval bombardment of Port Sumtra. The train stopping at a water tank a few miles (I do not now remember just how many) on the Macon side of Millen, and therefore somewhat farther than this place from Charleston, I heard distinctly, not only the general, more or less varying, roar of the bombardment, but also the low boom of individual guns. The sound was faint, but unmistakable in the stillness while the engine was taking water, but was lost as soon as the train got into motion again and its noise began. At Augusta, during the stop made there, I could catch the sound of the guns again, though it was interfered with a good deal by the confused noise of a large town. At Branchville, a hamlet of a few houses, the sound was easily recognised by any one, and was accompanied by a general *feeling* of tremor.

Millen is nearly due west from Charleston, and distant about 117 miles in a direct line. Augusta is approximately 25° north of west from Charleston, and about 122 miles distant. Branchville is about 35° north of west from Charleston, and at a distance of about sixty miles.

Mr. Davison says that he has but little information as to the distance at which the discharge of *single guns* has been heard. I may therefore add that the heaviest guns in use in the bombardment I refer to were the 15-inch smooth bore muzzle-loading guns carried by the Federal turreted "Monitors." I do not remember now what was reported to be the charge of powder used, but they were, of course, firing shotted cartridges—some solid shot, but more frequently shell. J. W. MALLET.

The Solidification of Alloys.

In a recent discussion on alloys, which took place at the Bradford Meeting of the British Association in the Section of Chemistry, a curious uncertainty was alluded to, which occurs in the cooling of certain alloys from the liquid state, as to the relative proportions of different varieties of crystals which form, depending on the rate that the cooling is proceeding with.

I would wish to draw the attention of those more particularly interested in the matter to a direction in which to look for what may be one of the causes of this peculiarity, namely, to the effect that different conductivities for heat in the different kinds of crystals may exercise in determining the relative proportions in which they form, where, as in this case, two or more varieties are possible. Where there is a difference in the conductivity of two possible varieties, the more of the better conducting material that is formed the faster in general the cooling can proceed.

The matter might be looked upon as a kind of inorganic evolution. Suppose that in the first instance round the boundaries, through which heat is passing out, of the cooling material, the two varieties form with equal facility, where the better conducting material forms heat escapes fastest and solidification of the molten material proceeds fastest, we may suppose this to follow in composition the lines of the crystals in proximity, namely, of the better conducting kind. Thus, by a kind of survival of the fittest, one of the varieties prevails.

When the cooling is very slow, where in the limit the temperature is at any moment the same throughout, this controlling influence is a vanishing quantity.

A similar principle is probably the cause of the radiating structure seen often in a cooled mass of certain materials, such as bismuth and possibly ice, which have different conductivities in different directions in the crystal. FRED. T. TROUTON.

Physical Laboratory, Trinity College, Dublin.

The Reform of Mathematical Teaching.

As I am in full sympathy with Prof. Perry's views, my own training, somewhat on the lines suggested by him, may be of interest. I was once taught Euclid and thoroughly hated the subject. At thirteen I was sent to school in Germany, where I was taught geometry; it had so little resemblance to Euclid that I looked on it as a new subject and was delighted with it. After eighteen months I returned to England to serve my apprenticeship, but not before I had advanced as far as solid geometry, quadratic equations and trigonometry, and I believe that this early and rapid mathematical training was of inestimable advantage to me in the works. It seems unconsciously to have led me to look on practical subjects with so much of a mathematical feeling that even now my fellow engineers consider me very mathematical, yet all the subsequent mathematical training at college (Germany) only extended over another eighteen months, and I admit that I would have liked to have had more.

I now come in contact with many engineers, both old and young, and almost invariably find that they are unmathematical, *i.e.*, they cannot look at an engineering problem with an analytical eye; and no wonder, if they have been brought up on Euclid. To me these volumes seem to be a collection of mathematical puzzles, which the ancient Greeks sent each other for solution, and which are most excellently edited by Euclid. A similar collection might nowadays be made of the trying problems in the chess columns of our daily literature, and these might be so pieced together as to afford most excellent mental training, but such a work would never teach good chess playing. It would be an excellent reference book for past masters, and that is what Euclid would still be if higher mathematics had not been invented. C. E. STROMEYER.

Lancefield, West Didsbury.

Leaf Decay and Autumn Tints.

"Observation shows," says Emile Mer, "that in most cases where wood dies in contact with living wood there is produced from the second towards the first a migration of starch and tannin, and (in a conifer) of resin; there is thus produced from the portions remaining living towards the dying or dead portions a drainage of substances, &c." These remarks refer to the formation of secondary periderm and of the duramen, but their scope and tenour may perhaps, I think, be extended to the case of forest leaves approaching the end of their existence as living organs. How does it come to pass that in autumn the leaves of some of our forest trees exhibit a brilliant livery of crimson, while others exhibit only a yellow or golden glory? Take, for instance, the case of the ash constituents in the dry substance of the leaf. It is known by analysis that the percentage of ash increases through nearly the whole life of the leaf in beech, sycamore, elm, but not in oak, larch, cherry, &c.; it depends a good deal on whether some one ash constituent (generally lime or silica) is being steadily stored up. For example, the dry leaf of *Acer campestre* on May 1 has 6 per cent. ash, and in October 16·2 per cent. ash; the dry leaf of *Prunus avium* has on April 28, 7·8 per cent., and on October 2, 7·2 per cent. ash. Now the leaf of the former tree is only yellow in autumn and never red, while that of the latter is very often beautifully crimson. In the former case there is a kind of gradual decay or death of some of the cells (mostly of the upper epidermis) which occasions a drainage of mineral and organic substances to these parts from the still living tissues. This drainage and accumulation attest, in fact, such a decay; and what is more, they seem to have a distinct influence over the ultimate autumnal coloration of the leaf itself. It is easy to understand, in fact, that the leaves which exhibit such a decay and approach to dissolution are just these wherein the chromogen precursive of the brilliant red coloration would likewise suffer an analogous kind of change, *i.e.* it would tend to become brown, to produce phlobaphene, just as it does in the outer bark which is the practically dead portion of the rind. Where this accumulation of mineral matter and all which it implies does not take place, as in cherries, currants, American oaks, pears, wild vine, barberry, &c., then the chromogen does not deteriorate; it evolves its proper pigment, and assumes the flush and glow of active living colour. On the other hand, in elms, chestnut, linden, birch, poplars, &c., which are never red but only yellow, it is only the vivid carotin attached to the last faded and now exhausted chlorophyll which gleams forth, but only for a time, and if not too much obstructed by the dull browns of decomposed carbohydrates and superoxidised tannic chromogens. P. Q. KEEGAN.

Patterdale, Westmorland.

Homochronous Heredity and Changes of Pronunciation.

SEEING that in ancient German, or rather Gothic, Swedish, Danish, probably in French, and possibly in Sardinian, the *th* sound surviving in English (though much less frequent than it used to be) was once largely used, but nowadays Frenchmen and Germans find a difficulty with it, I should like to know whether systematic experiments have been made as to whether children of various ages of these two nationalities can pronounce it more exactly and spontaneously than their compatriots of a maturer age? I should like to make the same inquiry concerning English children and their pronunciation of the gutturals discarded or altered in such words as *night*, *bough* or *laugh*?

CHARLES G. STUART-MENTEATH.

23 Upper Bedford Place, W.C.

Authorities:—Helfenstein, "Comparative Grammar of the Teutonic Languages," 1870, pp. 156–9; G. Koerting, "Neugriechisch und Romanisch," 1896, p. 23; W. Meyer-Luebke, "Grammatik der Romanischen Sprachen," 1890, p. 428.

The Daylight Meteor of Sunday, September 2.

As Mr. Denning expresses a wish in your issue of September 13 for further information concerning this meteor, I write to inform you of what I saw myself.

I observed the time at which the meteor fell, and made it 6.50, but my watch is no chronometer. I saw the meteor from the road, between Deganwy and Llandudno, and it appeared to fall over the Little Orme's head. If you join this point to Leyburn in Yorkshire, you have the line as near as I can give it, and I do not think it is very far out. I did not note any column of smoke or cloud after the meteor fell. Its path was vertical. Some one says its angle of appearance was 35°, and disappearance 25°, which I should say is about correct. The sun was shining brightly, though low down in the west. The brilliance was greatest just before disappearance. I have never before seen any meteor to compare with it in brightness.

38 Hillfield Road, Hampstead. T. ROOKE.

THE meteor of September 2, described in your issue of September 13, was seen in Ireland also, in even brighter daylight.

I noted the time, 6.27 p.m. (Irish), and the direction, E.N.E., from a point near Enniskerry, co. Wicklow. There was a possible error of a couple of minutes in my watch, and a considerable error possible in the estimated direction, which was a rough approximation made without a compass.

B. ST. G. LEFROY.

THE THEORY OF IONS.

EVER since Faraday enunciated the law of electrolysis, that the same quantity of electricity passed when chemically equivalent masses of different substances were produced, it has been a matter of speculation whether this may not be due to atomic charges of electricity. Every one, in describing electrolysis and explaining how the substances evolved appeared at the electrodes without any apparent action in between them, based his description and explanation upon the supposition of electric charges on the atoms. Some substances, such as hydrogen, were given positive, and some, such as chlorine, were given negative charges, and the electric current through the liquid was explained as due to the convection of these charges by the moving atoms or groups of atoms, and the movements of these were ascribed to the electric force acting on these charges. The amount of the charge on each atom or group of atoms was proportional to its valency, and as this has with good reason always been taken as a whole number, the charges ascribed to the moving elements were all simple multiples of the charge ascribed to a monovalent atom, such as hydrogen or chlorine. All this has naturally led to the hypothesis that electricity itself is atomic. In electrolysis, at least, there is a certain minimum quantity that corresponds to a single atomic bond, and quantities of electricity transferred by electrolysis are always multiples of this unit. It was surely natural, then, to give a name to this important physical unit quantity of electricity, and it has consequently been called an "electron."

Further, in electrolysis, the electrons always appear connected with, and travelling with, certain atoms or groups of atoms. For example, in copper sulphate solutions, the positive electrons travel in pairs with the divalent copper atoms, and the negative electrons with the divalent atomic group SO_4. These charged atoms, or groups of atoms, playing such an important part in electrolysis, have been called "ions."

Now there is a very important difference between different liquids in their behaviour when we try to pass an electric current through them. Some are quite easily decomposed, others offer a very great resistance, and it has been a matter of most interesting speculation as to the cause of this. In the first place, most of the easily decomposed liquids are solutions in water, of acids, alkalis or salts, and this has naturally attracted attention. In the second place, these solutions are all ones in which double decompositions, and such-like chemical actions take place with facility. Can a common explanation be given of this remarkable coincidence of electric conductivity and chemical activity? Electric conductivity is due to two causes—first, the electric charges on the ions; and second, the independent mobility of these oppositely charged ions under electric force. Without entering upon the very interesting questions involved in innumerable speculations as to the causes of these charges and of the mobility of the ions, all modern theories acknowledge that, in some way or another, water, and some other liquids in a less degree, have the very remarkable property of conferring upon certain substances dissolved in them the wonderful independent mobility of the ions which we see in electrolysis.

In consequence of this mobility of these differently electrified ions, it is easy to understand their chemical activity in these conducting solutions, and thus these two important properties of these solutions receive a common explanation. No really satisfactory explanation of how the solvent water confers on substances dissolved in it this wonderful independent mobility of the ions has yet been proposed. Some writers have described the phenomena as if all that was needed was to assert that the ions move about independently, that the material, $CuSO_4$ for example, is simply dissociated into Cu and SO_4, and that these ions gad about freely and independently in the liquid. Such writers consequently speak of the substance as being dissociated in solution. In what is recognised as ordinary chemical dissociation there is no different electrification of the constituents into which the substance is dissociated, and there is thus an essential distinction between the independent mobility of electrified ions in solution and what is recognised as chemical dissociation. Whatever be the true account of the matter, it is almost certainly very much more complicated than ordinary chemical dissociation, and the action of the water is evidently of the first importance. There is great difficulty in explaining this independent mobility, on account of two things which have not been satisfactorily explained as yet. In the first place, it is very hard to understand why these oppositely electrified ions do not combine together in pairs as they would do if they were merely under the action of the electric forces due to their opposite electrification. In the second place, it is very hard to understand where the energy comes from that is required to separate these independent ions and keep them free from one another. When copper sulphate is dissolved in water there is very little change of temperature; if it be the anhydrous salt, there is a rise of temperature; while we would naturally expect an enormous absorption of heat to account for all the energy that would be required to separate the Cu and SO_4 from one another. This all shows how very different this phenomenon is from ordinary dissociation, and in consequence this peculiar action of water, and in a less degree of some other solvents, has been called "ionisation." The two most important properties of an ionised fluid are conductivity for electricity, and a remarkably chemical activity which has been shown to be directly proportional to the conductivity.

Besides liquids there are gaseous conductors of electricity. Gases do not usually conduct electricity at all. Even under circumstances when one would naturally expect them to carry electric charges on their molecules, they seem quite incapable of doing so. When the surface of a liquid is electrified and it evaporates, one would naturally expect the escaping molecules of gas to carry away with them some of the electric charge from the surface of the liquid. It is not known whether an electrified metal volatilising would or would not carry away with it some of the superficial electric charge, but ordinary liquids volatilising certainly do so to a very small extent, if at all. This may be, of course, because the charge is carried by superficial *ions*, and it is not the ions that escape, but the *molecules* of the liquid itself. But why these extremely movable ions cannot escape as a gas from the surface of the liquid is a matter still requiring explanation.

Under a great variety of circumstances, however, gases are able to conduct electricity. Leaving aside the spark, glow and arc discharges in gases at high pressures, and the well-known discharges in gases at low pressures, in all which cases there is evidently something like a breaking up of the gas itself under intense electric force, there are a number of cases in which a gas can conduct electricity under quite feeble electric forces. Within any space at all close to a spark discharge of any kind, in flames and in the gases escaping from them, in the neighbourhood of surfaces of solids illuminated by ultra-violet light, in the neighbourhood of surfaces of solids being acted on chemically by the gas, in a gas traversed by kathode rays, and in a gas traversed by X-radiations and by those various, most curious and remarkable radiations that have been classed under the name of Becquerel rays—in all these cases gases conduct electricity, apparently quite freely.

Under these circumstances it has been usual to describe a gas in this condition as "ionised," and to seek for a separate and independent mobility of its ions. Great success has attended these investigations. The difficulties that surround ionisation in liquids are mostly absent here. The ions, if left for a time to themselves, do combine together in pairs, and it requires a continuous and considerable expenditure of energy to keep them apart. The diffusion of the independent electricities has been studied, and many quantitative results that were to be expected from the theory have been proved to exist.

There is, however, an important difference between the conductivity of a gas and of a liquid. In the case of a liquid, the electricity always travels along with matter in the form of an atom or a group of atoms; in a gas there is every reason to believe that we are often dealing with electric charges which, if connected with matter at all, are connected with masses which are about 500 times smaller than a hydrogen atom. So far no good reason has been given for believing that the electric charges that move about among the molecules of a gas carry any matter along with them. There does not seem any difficulty in supposing that the electric charge of an atom can exist independently of the atom. All theories of electrolysis have supposed that electric charges are transferred within the liquid along with material atoms, but from the liquid to the electrodes all theories have supposed that the electric charges jump from the liquid atom to the electrode; and if it can jump from one atom to another, there seems no reasonable objection to believing in its independent existence. On account of the difference between the nature of the conductivity of a gas and of a liquid, it would be well to confine the term ionisation to the case of conductivity due to the mobility of charged atoms or groups of atoms, and to call the conductivity due to the existence of these mobile electric charges which are not connected with atoms by another name, such as "electronisation."

One of the most remarkable results of the study of these mobile electric charges which are unconnected with atoms is that only negative electric charges have as yet been discovered to be free from atoms; the corresponding positive charges seem to be always attached to atoms or groups of atoms. This has naturally led to a rehabilitation of the old single fluid theory of electricity in which matter plays the part of the positive fluid in the old double fluid theories, and the phenomena of electronisation, so far known, certainly lend support to this hypothesis. But we really know so little about the subject, that it is rather too soon to form anything beyond a rough working hypothesis. So long as we know that there exist outstanding, second order effects like gravitation, we are premature in concluding that the connection between positive electrification and matter proves any first order difference between positive and negative electricity, as it may be a second order effect.

The conductivity of gases produced by the pressure of these movable electric charges is in some respects more analogous to that of metals than to that of liquids. In liquids an electric current is accompanied by streams of matter, while in the electronised gas, so far as it has been observed, there may be no stream of matter attached to the electric charges which carry the current. It has consequently been suggested, and with good reason, that in solids and melted metals, which conduct metallically, the electrons are freely movable, and that this is the cause of their conductivity. There is some reason to believe that in this case also it is the negative electron which is most freely movable. Some most interesting calculations have been made upon this hypothesis, in which it has been supposed that there was something like a gaseous pressure of these mobile electrons in the metal. Thermo-electric effects have been attributed to the dependence of this pressure upon temperature, and the convection of heat accompanying electric currents has been attributed to the convection of energy of irregular motion by these electrons. The Hall effect has also been shown to be a possible consequence of a different mobility of the positive and negative electrons.

Upon these principles it is natural to attribute the magnetic properties of iron and other substances to electrons describing orbits round the atoms. These revolving electrons, in this case, represent the amperean atomic currents to which magnetisation has long been attributed. A remarkable confirmation of this has been derived from the Zeeman effect, which can be explained by the supposition that negative electrons are describing orbits round the atoms. Further, the mass that moves with these electrons has been shown to be of the same order of magnitude as the 500th part of the mass of an atom of hydrogen, which, from experiments on gaseous electronisation, seems to accompany the free electrons in a gas when it conducts.

There seems to be some reason to think that in a highly magnetisable material, such as iron, either there are more than the four electrons corresponding to its atomicity in rotation, or else that these are rotating very much more rapidly than corresponds to the vibrations of ordinary light. Some objection may be taken to the latter hypothesis from the difficulty of explaining why enormously rapid ether waves are not thereby generated in the surrounding medium, and the energy of the motion thereby lost by radiation. There are suggested explanations of this difficulty, but the other hypothesis, that matter has in it many more electrons than correspond to its atomicity, and that these latter are merely peculiar in being removable, agrees with a very interesting suggestion that all matter is built up of electrons. That an atom of hydrogen, for example, consists of some 500 electrons, one of oxygen of some 8000, and so forth. This is a natural deduction from these speculations, and receives some confirmation from its being consistent with the change in dimensions of a body as it moves in different directions through the ether which has been assumed in order to explain the experiment on the motion of the earth through the ether, which Michelson and Morley conducted. A supposition such as this naturally suggests that atoms could be built up of electrons as well as the electrons separated from matter; and if that be so, there seems no impossibility in the dreams of the alchemist, and an element of one kind may some day be transmitted into that of another. What is as yet known is, however, a very slender foundation for these speculations, and it is quite likely that matter and electricity are distinct in kind, and cannot be transmuted into one another in the way suggested.

Enough has been said in this very sketchy description of ionic theory to show how far-reaching it is; how it touches upon the confines of our knowledge and upon the borderland between physics and chemistry. Advances in our knowledge of ionic theory are likely to dispel many of the clouds surrounding the connection of matter and ether, and may lay the foundations for an intelligible structure of the physical universe. G. F. F. G.

THE RECENT CRETAN DISCOVERIES AND THEIR BEARING ON THE EARLY CULTURE AND ETHNOGRAPHY OF THE EAST MEDITERRANEAN BASIN.

WHILE recently excavating the prehistoric Palace of Knossos, which lies in the great central gap between the higher ranges of Crete, mid-way between the peaks of Ida and Dicta, I was much struck by the almost continuous dualistic style of the elements. But in this case the "eternal struggle" was not between East and West. It was North and South that here fought it out. The boreal blasts which have collected from the steppes of Eastern Europe sweep almost unopposed across the Ægean, and find their first obstacle in the long mountain wall of Crete. They pour through the central gap. Not unopposed, however; they are beaten back, and their place triumphantly taken for weeks at a time, by the parching South wind—the *Notios* of the Cretan natives—which is really the *Khamsîn* of the Libyan Desert. Owing to the fact that the shoot and dumping-ground of the excavations was, perforce, at the southern end, the works were interrupted for days at a time by an overwhelming dust-cloud due to this cause, for the *Khamsîn* seems to have an affinity for dust out of proportion to its actual strength. Disagreeable, however, as were these hindrances to the work of the spade, one had at least leisure to reflect on the historic lessons supplied by these natural phenomena. Crete certainly stands geographically in closer relation to Asia Minor than it does to Africa. Carpathos and Rhodes, not to speak of minor islands, afford natural stepping-stones of intercourse. The actual relations between Crete and Anatolia, ethnic and other, must not be underrated. Yet in a broad historic point of view Crete stands apart from it. It was not like Cyprus, which, although at different times it has become an outpost of Egypt and of Europe, has always remained essentially a part of Western Asia. But the main currents of Cretan history, like those of its two prevalent winds, have been Northern and Southern—European and African. Of its two direct geographical connections, that with Greece and that with Anatolia, it has consistently held to the former. On the other hand, its intercourse with the opposite Libyan coast—the Cyrenaica—and with Egypt has been singularly continuous from a very remote period. And in this lies the high importance of the part played by the island in the early history of European culture. Germs received here from the Nile Valley and its borderlands, at a time when the greater part of Europe was still in its Stone Age, were propagated northwards and westwards, and seedlings hence derived spread in prehistoric times, and by more than one channel, as far as the British islands.

During five successive campaigns of preliminary exploration in Crete, I was able to collect a variety of evidence establishing the very early derivation of certain indigenous forms of stone vases and decorative motives from those of Egypt. A series of archaic Cretan seals exhibited designs copied almost directly from those of Twelfth Dynasty scarabs, and approximately dating, therefore, from the middle of the third millennium before our era, while steatite vases were found almost indistinguishable in form from Old Empire types of considerably earlier date. The primitive three-sided seal-stones, on which appear the first rudiments of Cretan script, reproduce the type of a three-sided seal, apparently of Libyan origin, which, from its analogy with a special class of Egyptian cylinders, approximately date from the middle of the fourth millennium B.C. So long, however, as the early archæological strata of the Cyrenaica are left as at present wholly unexplored, a great blank is still left in the materials for comparison on the Libyan side. It remains to be seen whether the Danish expedition now organising will be able to overcome the hitherto insuperable obstacles to the thorough scientific exploration of that region, but the fanatical spirit of the Senoussi is of ill omen.

What the results of these Cretan observations have certainly ascertained is that whether directly from the Nile Valley, or indirectly through Libyan intermediaries, Egyptian elements were making their way into Crete at a period which must carry back by over a thousand years the materials for approximate chronology in the Ægean world. The derivation, on steatite seals and vases of Egyptian forms, of the Twelfth Dynasty spiral ornament (only at the beginning of the Mycenæan period taken over upon metal work) is of extraordinary importance as supplying the "missing link" in the origin and diffusion of the spiral system in the early European Metal Ages. By the Danube Valley and the course of the Elbe, the old route of the amber traffic brought this spiraliform system to the Bronze Age population of North Germany and Scandinavia, and was by them in turn diffused, as has been shown by Mr. Coffey, to Ireland, whose wealth in gold made it the Rand of prehistoric Europe. On the other side, survivals of the Mycenæan adaptations of the primitive spiral ornament, which had lingered on among the Illyrian tribes of the North-West corner of the Balkan peninsula, gained a new vitality in contact with the artistic genius of the invading Celtic tribes. Assimilated by these, and transported on the wave of Belgic conquest to the North-West, the spiraliform system of design re-entered the British Isles in another form; and in Ireland, where the elder spiral branch of the Bronze Age had long since expired—lived on to supply designs to St. Columba and his missionary fellow-workers. The chains are long ones that connect the carvings of New Grange on the one side and the illuminations of the Book of Durrow on the other with the art of Twelfth Dynasty Egypt; but they run through prehistoric Crete.

Of the intercourse between Crete and the Egypt of the Middle Kingdom the Palace of Knossos has supplied a new and striking piece of evidence in a diorite figure with hieroglyphic inscriptions, which give the character of the names it bears; its good style and material have been recognised by Egyptologists as a Twelfth, or at most, early Thirteenth Dynasty work. In other words, the latest date to which it can safely be referred hardly comes down to 2000 B.C. We have here therefore a valuable indication for the approximate chronology of the earlier elements of the Palace of Knossos itself, which in any case go back beyond the period to which the remains of Mycenæ have given a name. The high level of civilisation, however, already attained in the City and House of Minos at this remote date is shown, not only by such an artistic importation from the land of the Pharaohs as the diorite figure, but by fragments of wall-painting in an already fully developed style—one represents a boy placing crocus-like flowers in an ornamental vase—and by ceramic fabrics of great beauty. In order not to confuse the evidence, I endeavoured in this year's excavations within the Palace walls, as far as possible, to confine myself to the upper and purely Mycenæan layer, and the relics found of this earlier period have therefore been comparatively limited in number. But beneath the floors of houses immediately below the Palace and on the opposite hill, Mr. D. G. Hogarth, the Director of the British School at Athens, found a whole series of vases of this early painted class, many of them showing naturalistic designs of lilies, tulips, and other flowers, presenting shapes in some cases so graceful as never to have been surpassed in any later age of Greece. This style of Cretan pottery, which has received the name of Kamáræs from the grotto where its first occurrence was described by Mr. J. L. Myres, has been found by Mr. Petrie at Kahun in Egypt, again in a Twelfth Dynasty connection. The intercourse between Crete and the Nile Valley in the third millennium before our era has thus left its traces on both shores of the Libyan sea. The approximate date thus ascertained for the earlier part of the Palace at Knossos gives additional interest to the fact that this in turn overlays a vast Neolithic settlement, for which it supplies a chronological *terminus à quo*. In the Central Court a trial shaft was excavated, which went down 24 feet through continuous Stone Age deposits containing incised, chalk-inlaid pottery, axes and mace-heads of serpentine and other materials, obsidian knives and cores, and primitive images of clay and marble akin to those from the earliest settlement of Troy.

But the great bulk of the remains of the Palace of Knossos as yet brought to light belong to the most flourishing days of the better-known Mycenæan civilisation, and are contemporary with the Eighteenth and Nineteenth Dynasties of Egypt. The building itself is of vast extent—about two acres have already been uncovered, and beside it the Palaces of Mycenæ itself, of Tiryns, and of all other such buildings on the mainland of Greece shrink into comparative insignificance. We have not here the same mighty bastions, though the megalithic gypsum blocks of the lower part of the walls are sufficiently imposing. What we see here is the island capital of a great maritime power, the memory of which survives in that of the traditional "thalassocracy" of Minos, and which seems to have rather relied on its "wooden walls." Here are vast paved courts, propylæa, spacious corridors, and successions of magazines, and, amidst a maze of lesser passages and rooms, the actual council chamber of the prehistoric kings, with its curiously carved gypsum throne in the centre. There can be little doubt that this building was the prehistoric original of the fabled "Labyrinth," the etymological meaning of which is the house of the *labrys* or double-axe, the emblem of the Cretan Zeus. This symbol is carved on the principal blocks and corner-stones, and repeated on every side of every slab of what appear to be the sacred columns of two inner shrines. The legendary fame of Dædalus, to whom both the building itself and the works of art it contained were traditionally ascribed, is fully borne out by the actual remains. Both in painting and sculpture we see here a higher level than was reached either at Mycenæ or Tiryns. For monuments of Mycenæan painting, indeed, the Palace of Knossos stands almost alone. On many of the walls the frescoes were still found adhering, almost as brilliant as when they were executed, and we have here a new revelation of ancient painting. Quite new in ancient art were certain miniature groups of ladies in fashionably dressed though somewhat *décolleté* attire, seated in animated conversation apparently in the courts and balconies of the Palace itself. In the decorative designs and the fabulous animals, such as the griffins and sphinxes, the influence of Eighteenth Dynasty Egyptian models is evident; but these foreign elements are adapted in an independent manner. Of more special interest are life-size processions of youths bearing various vases, who display a singular general resemblance to the procession of the tribute-bearing Keft chieftains on the tomb of Rekhmara at Thebes, which dates from the first half of the fifteenth century B.C. It is known that the Kefts of the Egyptian monuments represent the Mycenæan race of the Ægean isles and coast-lands. On the Knossian wall-painting, we see them in their home.

The upper part of one of these Knossian figures, which is well preserved, is of the highest ethnographic interest, as presenting for the first time a careful naturalistic pourtrayal of a Mycenæan man. The profile is of a pure European character, almost classically Greek in its regularity. The lips are somewhat full; the eyes and hair are dark—the latter somewhat curly. The head is of the high brachycephalic type. The skin shows the reddish-brown hue of Egyptian convention, just as the women are in the Egyptian manner painted white. The type of head delineated is essentially that of the race which, through all the changes of Cretan history, still remains predominant in the island. The finely-cut profile, the dark hair, the high brachycephalic skull, are as characteristic now as they were over three thousand years ago when the painting was executed. It is interesting to note that the physiognomy is distinct from the more hawk-like Armenoid type which, as Von Luschan has shown, represents the underlying ethnic element of a large part of Anatolia. It is equally non-Semitic. That this Cretan type represents that of the pre-Hellenic occupants of mainland Greece is highly probable. It still survives intact in the Illyric part of the peninsula, and I have myself been again and again struck in Cretan mountain villages with resemblances to the highland population of Albania. The Slav-speaking Montenegrins, like the Herzegovinians, so far as race and physique go, largely represent the same Illyrian element; and it was curious to notice among the Montenegrin gensdarmes recently established by the Powers in Crete the striking points of similarity to the natives of the island. Here and there, in Crete and elsewhere, varieties of the predominant "Mycenæan" type take a more aquiline cast, and show points of transition to the Armenoid race of Anatolia. The cranial type is essentially the same, and on the whole the finely-cut European physiognomy, of which this Mycenæan fresco supplies the first authentic record, may be regarded as a Western differentiation of the more Eastern form.

This ethnographic result curiously corresponds with the earliest philological evidence at our disposal. A whole series of local names in Crete, Greece proper and the Macedonian and Thoracian lands to the North, represent allied but differentiated versions of names common to Caria and a large tract of Asia Minor. Thus, to take a conspicuous instance, the Western area supplies a variety of names in *-nth*, like Korinthos, Erymanthos, Perinthos, Labyrinthos, answering to others on the Anatolian side having the *-nd-* sound, such as Kalandos, Oromandos, Pyrindos, and Labrandos. In this, as in its physical type and in other respects, Crete, it will be seen, cleaves to the Greek and Thraco-Illyrian world.

My own previous researches had been a good deal occupied with a class of early Cretan seal-stones containing signs both linear and pictographic in which I ventured to detect the rudiments of a pre-Phœnician form of writing. In regard to this matter the excavation of the Palace at Knossos produced a real revelation. In chamber after chamber whole deposits came to light of inscribed clay tablets undoubtedly representing the Royal archives. The character of the writing was of two altogether distinct classes—one hieroglyphic and one linear. The hieroglyphic script answered to that of the groups of characters that I had already noticed on a series of seal-stones of Mycenæan fabric chiefly found in Eastern Crete. The ruder prototypes of these with simple pictographic designs go back on Cretan soil to a much more remote period, and find, as already noticed, very early analogies on the other side of the Libyan sea. There can be no doubt that this script in its conventionalised form is the property of the old indigenous race of the island, the Eteocretes of the Odyssey. The linear writing, on the other hand, which forms the bulk of these Knossian archives, is of a very much more developed form. It is upright, of great elegance and curiously European in aspect, a certain proportion of the signs—some seventy of which were in common use—showing correspondences with the syllabic characters of Cyprus and also with the later Greek.

The pictorial illustrations which not infrequently accompany the linear inscriptions enable us in many cases to learn the purport of these clay documents. They thus are often seen to refer to the Royal stores and arsenals, and show a decimal system of numbers akin to the Egyptian. Others, no doubt, are deeds and correspondence like the contemporary cuneiform tablets of Babylonia. Those relating to the Royal treasure show ingots, vases and ox-heads of precious metal identical with those borne by the Keft tributaries on the wall-paintings of Rekhmara's tomb belonging to the early part of the fifteenth century B.C., a valuable indication as to date. The Palace of Knossos contains no element as late as the latest prehistoric period represented at Mycenæ itself, and the date of its destruction can hardly be brought down later than, at most, the twelfth century B.C. The most recent of the clay documents contained within it lie at least behind that date.

The result of these discoveries is therefore to carry back the existence of written documents on Greek soil some eight centuries beyond the earliest known monuments of Greek writing, and five even beyond the earliest dated Phœnician record, as seen on the Moabite stone. The whole question of the origin of writing is thus placed on a new basis. The hieroglyphic Cretan forms supply, in fact, exact correspondence with what in virtue of their names we must suppose to have been pictorial originals of the Phœnician letters. *Aleph*, the ox's head; *Beth*, the house; *Daleth*, the door; *He*, the window; *Vaa*, the peg—and indeed over two-thirds of the Phœnician series find obvious prototypes among the Cretan forms. The ingenious theory of De Rougé, which has so long held the field, and by which the Phœnician letters were derived by a selected process from early hieratic Egyptian forms signifying quite different objects, becomes henceforth untenable. The analogy supplied by the Cretan hieroglyphs in favour of a simple and natural derivation is at all events overwhelming.

It does not necessarily follow that the Phœnician letters were directly derived from the Cretan; some signs, like that of the camel's head, certainly point to the accretion of Syrian elements. But the correspondences are still so great as to point at any rate to some kind of collateral relationship. Elsewhere I have ventured to suggest that these points of community may be due to the great Ægean settlement on the coast of Canaan, of which the Philistines stand forth as the representatives, and which has left its abiding record in the name of Palestine. The Biblical traditions, as is known, give the name of "Cherethim," or Cretans to a branch of the Philistine race; and Caphtor, the isles or coastlands from which the Philistines traditionally came, has been plausibly identified with Keftô, the Ægean maritime realm of the Kefts, who on Egyptian monuments appear as the representatives of the Mycenæan civilisation. Of this special connection with Crete, the finds at Knossos already referred to afford convincing evidence. Other recent discoveries afford a singular support to these conclusions. It has been pointed out by Dr. Wilhelm Max Müller that in an Egyptian list of Keft names, going back to the Eighteenth Dynasty, appears the most characteristic of all Philistine name-forms, Achish; and it thus appears that the name was known in prehistoric Knossos earlier than in Gath. Not less significant in its way is the discovery made during the recent excavations of the Palestine Exploration Fund on, or near, the site of Gath, of imported Mycenæan pottery in the pre-Israelite stratum. More and more it appears that the high early Ægean civilisation, of which Crete is now seen to be the centre, was exercising a far-reaching influence on the coasts of Canaan before the rise of the Phœnician commercial power. Cadmus had sat at the feet of Minos, and the priceless gift which in darker days of her history he bore to Hellas, was in some respects at least a restitution of what Greece herself had given long before.

Gaza, the chief Philistine emporium—the crossing point of the caravan routes between Egypt, Syria and Southern Arabia—owed its traditional foundation to Minos, and continued down to Roman times to worship the Cretan Zeus. The great cave on Mount Dicta, which was the legendary scene of the infancy of this indigenous divinity, to whom, as we have seen, the Palace of Knossos was also consecrated, has now been thoroughly explored by Mr. Hogarth, and has produced a vast mass of votive relics illustrating the prehistoric culture of Crete from the earliest Metal Age onwards. The crevices of the stalactite columns of the lower part of the cave were found to have been utilised for the insertion of bronze offerings, especially miniature figures of the double axe, which was the particular symbol of this God. Many stone libation tables were also found representing the adaptation of early Egyptian forms, and among the votive bronzes an Egyptian figure of the god Amon Ra, whose personality presents some points of affinity to the chief Cretan God. Another bronze from this site, a miniature chariot, drawn by an ox and a ram, has a special interest as an early example of a series of votive bronzes on wheels, in the shape of cars and tripods, supporting bowls, birds and other objects, which form a feature in the remains of a wide European zone during the Late Bronze and Early Iron Age. That their ultimate source was Egypt appears probable from the four-wheeled car with the silver boat of Queen Aah-hotep; but here again we see among Cretan remains what is probably the earliest European example of the class. Once more the archæological phenomena bring home to us the fact that we stand here at the meeting-place of the North and South wind.

ARTHUR J. EVANS.

THE ASCENT OF MOUNT ST. ELIAS (ALASKA).[1]

THE Italian original of this work was reviewed in our columns a short time ago (see NATURE, May 3), and we now welcome the English translation. In the preface we are informed that "the whole profit on the sale of the Italian edition, together with all royalties and rights on foreign editions, will be dedicated to an Insurance Fund for Italian Guides."

In its present garb the story of the expedition is told in simple and straightforward language, with only here and there an unaccustomed term to show its foreign origin; *e.g.* "In September snow-storms continue almost without *cease*" (p. ix.), and (in reference to rock-systems) "the different components of the *soil* of South Alaska are all stratified" (p. 232). The picturesque passages in the descriptions of the scenery have, however, lost their glow and read somewhat flat, as indeed can scarcely be avoided in a close translation. The distinctiveness of Prof. Israel C. Russell's name seems lost under the unfamiliar initials J. C., which are used throughout the book (except in the appendix, p. 232), although the full name is given correctly on p. 3. Considering the high estimation in which the citizens of San Francisco hold their business energy, it is rather amusing to read Dr. Filippi's impression that their city "being an agricultural centre, is very quiet and exempt from the feverish turmoil of the industrial Eastern States" (pp. 9-10).

FIG. 1.—Mount St. Elias from the third Newt on Cascade.

The profuse illustrations of the original are all reproduced; and in other respects this English edition is almost, but not quite, as sumptuous as its Italian forerunner. In fact so handsome is it, that in spite of the great mountaineering achievement which it chronicles, one cannot help harbouring, like a well-known essayist under similar circumstances, a lurking desire to strip it of its fine coat to re-clothe some ragged veteran of greater intrinsic consequence.

G. W. L.

[1] "The Ascent of Mount St. Elias (Alaska)." By H.R.H. Prince Luigi Amedeo di Savoia, Duke of the Abruzzi; narrated by Filippo de Filippi: illustrated by Vittorio Sella: and translated by Signora Linda Villari with the author's supervision. Pp. xii + 241. 34 photogravure plates, 4 panoramic views, and 117 illustrations in text. (Westminster: Archibald Constable and Co., 1900.)

JOHN ANDERSON, M.D., LL.D., F.R.S., &c.

BY the death, on August 15, of Dr. John Anderson, in his sixty-seventh year, a serious loss has been inflicted on zoological science. Amongst the zoologists of this and other countries, Dr. Anderson was widely known and warmly esteemed. The particular branch of inquiry to which for many years before his death he had devoted himself, the investigation of the Vertebrata of Egypt, could only be successfully carried on by a naturalist who, in addition to experience in collecting, had both time and funds at his command, and who also possessed sufficient energy and tact to ensure the assistance of highly-placed Government officials. All these advantages Dr. Anderson combined in an unusual degree, and although it is to be hoped that the work he left unfinished will not be brought to an end by his death, there can be no question that the want of his guiding hand in the enterprise will be severely felt.

Dr. Anderson's scientific work consisted of two distinct parts. From 1865 to 1886 he was at the head of the Indian Museum, Calcutta, and chiefly engaged in the collection, arrangement and study of Indian and Burmese Vertebrata. After his retirement from India, in 1886, the subject which occupied him principally, and of late years exclusively, was, as already mentioned, the study of the fauna inhabiting Egypt and the Nile valley.

He was the son of Thomas Anderson, a banker of Edinburgh, and was born on October 4, 1833. His elder brother, Dr. T. Anderson, was in the medical service of the East India Company, became well known as a botanist, and was for some years superintendent of the Botanical Gardens, near Calcutta. After passing through the medical course in the University of Edinburgh, John Anderson received a gold medal and the degree of Doctor of Medicine in 1861. For a couple of years he held the Professorship of Natural Science at the Free Church College, Edinburgh, and he went to Calcutta in 1864.

His arrival in Calcutta was at a fortunate time. The Asiatic Society of Bengal had gradually come into the possession of a large collection, not only of the archæological remains, manuscripts, coins and similar objects, for the study of which the Society was originally established, but also of zoological and geological specimens in large numbers. In the course of the preceding quarter of a century the collections had increased, chiefly through the work of Edward Blyth, the curator, until the Society's premises were crowded, and the Society's funds no longer sufficed for the proper preservation and exhibition of the specimens collected. After long negotiations, interrupted by the disturbances of 1857, arrangements were completed in 1864 by which the archæological and zoological collections of the Society (the geological specimens had been previously transferred) were taken over by the Government of India, who undertook to build a new museum in Calcutta, of which the Society's collections would form the nucleus. The trustees appointed by the Government to manage the new museum asked the Secretary of State for India to select a curator, and Dr. J. Anderson was nominated for the post early in 1865. His status was changed, a few years later, to that of superintendent of the museum, and in addition to his museum work he became Professor of Comparative Anatomy at the Medical College, Calcutta. He held both offices until his retirement from India in 1886.

The time at which Dr. Anderson arrived in India was fortunate in another respect. It coincided with a great impulse given to Indian zoology by the publication of Jerdan's "Birds of India," the last volume of which appeared in 1864, and with the presence in Calcutta of a larger number of men interested in the study of the fauna than were assembled there at any time before or since. Amongst these men were Jerdan himself, Ferdinand Stoliczka, Francis Day, and Valentine Ball, all of whom have now passed away. Probably at no time has so much progress been made in the study of Indian Vertebrata as in the years 1864-74, and in this work Dr. Anderson took an important part.

The new Indian Museum, which now towers over the other buildings of Chowringhee, was not ready for occupation till 1875, but meantime Dr. Anderson had been busily engaged in adding to the zoological collections and in getting them into order. One of his first tasks was the bringing together of an ethnological series, for which the conditions of Calcutta are favourable. Amongst other important additions made by him was that of a fine series of human skulls representing various Indian races. Another very valuable museum series brought together by him consisted of a good collection of Indian Chelonia; skeletons, carapaces and stuffed specimens.

The work in Calcutta was interrupted by two important expeditions to Upper Burma and Yunnan, to both of which Dr. Anderson was attached as naturalist and medical officer. Both expeditions were designed to pass through China to Canton or Shanghai, but in neither case was it found practicable to carry out the original plan. The first expedition, commanded by Colonel E. B. Sladen, left Calcutta at the end of 1867, proceeded as far as Momein in Yunnan, and returned to India in November 1868; the second, under the command of Colonel Horace Browne, left in January 1875, but was treacherously attacked by the Chinese before it had proceeded more than three marches beyond the Burmese frontier, and compelled to return, Mr. Margery, of the Chinese Consular Service, who had been despatched to accompany the mission, and who had preceded it by a march, being murdered with several of his followers. The difficulties experienced by both missions from the time they crossed the frontier between Burma and China, and the opposition of the inhabitants of the country, seriously interfered with zoological observations, and the collection of specimens was generally impossible; but still some important additions were made to the previous knowledge of the fauna. A full account of the journey was given in Dr. Anderson's reports and in a work by him, entitled "Mandalay to Momein," published in 1876. The detailed observations on zoology, supplemented by important notes on some Indian and Burmese mammals and chelonians, were published in 1878-9, under the title of "Anatomical and Zoological Researches, comprising an Account of the Zoological Results of the two Expeditions to Western Yunnan in 1868 and 1875, and a Monograph of the two Cetacean Genera, Platanista and Orcella." The work appeared in two quarto volumes, one consisting of plates. Dr. Anderson was the first who succeeded in obtaining specimens of the porpoise (*Orcella*) inhabiting the Irrawaddi, and the examination of this previously undescribed form led him to make a thorough anatomical investigation of an allied species occurring in the Bay of Bengal and in the estuaries of rivers flowing into the bay, and also of the remarkable cetacean, *Platanista*, inhabiting the Ganges, Brahmaputra and Indus.

The only other important collecting expedition undertaken by Dr. Anderson during his tenure of the superintendentship of the Indian Museum was to Tenasserim and the Mergui Archipelago in 1881-2. This journey was chiefly, though by no means exclusively, undertaken for the collection of marine animals, and the descriptions of the results, to which several naturalists contributed, were published first in the *Journal* of the Linnean Society, and subsequently as a separate reprint in two volumes, under the title of "Contributions to the Fauna of Mergui and its Archipelago." This appeared in 1889. Dr. Anderson's share was the description of the Vertebrata and an account of the Selungs—a curious tribe inhabiting some of the islands; but in connection with his visit to Mergui, and as part of a general description of the fauna which he had at first proposed to publish, he prepared an account of the history of Tenasserim, formerly belonging to Siam. This historical *résumé*, which deals especially with British commercial and political intercourse with Siamese and Burmese ports, was compiled mainly from the manuscript records of the East India Company, preserved in the library of the India Office, and was published in 1889 in a separate volume, entitled "English Intercourse with Siam." The book forms a well-written and interesting chapter of the history of British progress in Southern Asia.

Besides the works already mentioned and many papers, descriptive of mammalia and reptiles, which were published in the *Journal* of the Asiatic Society of Bengal and in the *Proceedings* of the Zoological Society of London, Dr. Anderson wrote two catalogues on very different subjects for the museum under his charge in Calcutta. Of these, one was the first part of the "Catalogue of Mammals," published in 1881, the other the "Catalogue and Handbook of the Archæological Collection" which appeared in 1883.

Dr. Anderson was elected a Fellow of the Royal Society in 1879, and retired from the Indian Service in 1886. He had married a few years previously, and after retiring he travelled with his wife to Japan. Finally he settled in London, but for the remainder of his life his health was somewhat precarious, and he passed several winters in Egypt. Here he took up the study of the mammals and reptiles, which had received but scant attention since the early part of the century, when the great and superbly illustrated French work on Egypt appeared—a work which, brilliantly begun by Savigny and others, was never adequately completed.

To the work of collecting, examining, figuring and describing the Mammalia, Reptilia and Batrachia of Egypt, the later part of Dr. Anderson's life, when he was well enough for work, was mainly devoted. He also paid some attention to the fauna of the neighbouring countries, and in 1898 published "A Contribution to the Herpetology of Arabia," founded on the collections of the late Mr. J. T. Bent and others. The first part of the important work he had intended to produce on the zoology of Egypt, containing an account of the physical features of the country and descriptions of the Reptilia and Batrachia, appeared in 1898. It is a fine quarto volume with excellent figures, many of them coloured. He had made large collections and notes for the volume on Mammalia, and these it is hoped will be published in due course.

One of the last undertakings in which Dr. Anderson engaged, as soon as the Upper Nile valley was once more thrown open to civilisation, was the systematic collection and description of the fish inhabiting the river and its tributaries. That this important work (of which a notice appeared in NATURE of February 23, 1899) is now being carried out with warm interest and assistance from the Egyptian Government, must be attributed to Dr. Anderson's foresight, zeal and skilful advocacy. Both in our Indian Empire and in North-eastern Africa, Dr. Anderson contributed much to the solution of one of the chief biological questions of the present day, an accurate knowledge of the distribution of animal life.

W. T. B.

NOTES.

A NEW instance of the want of encouragement, and often opposition, which scientific work receives in this country is given by Major Ronald Ross in a letter in Monday's *Times*. It appears from a correspondence just published, that in 1898 the Secretary of State for India refused to permit officers and soldiers to undergo voluntary inoculation against typhoid. It is known to our readers that Dr. Wright, professor of pathology at Netley, elaborated the system of inoculation against typhoid so long ago as 1896. The treatment is based on the soundest scientific principles, and substantial evidence of its value as a preventive measure had been obtained by laboratory experiments. It is entirely free from danger, and there would have been no difficulty in obtaining numerous soldiers to undergo inoculation with Dr. Wright's typhoid vaccine. From the results of the inoculations which might thus have been made three years ago, results would have been obtained which could have been utilised in the recent war in South Africa, and might have been the means of saving hundreds of lives. But unfortunately for the army as well as for science, officers and soldiers appear to have been forbidden to submit themselves for inoculation. In other words, a real success against disease might have been scored, and in any case the information gained would have been of value in making further efforts to diminish mortality from typhoid, but the officials who should have done everything in their power to assist the work, deliberately stopped it by hampering the freedom of the persons who would most benefit by the treatment. It is difficult to understand this singular action, and Major Ross has done a public service by directing attention to it.

IT was announced in NATURE several months ago (p. 230) that Dr. L. Sambon and Dr. G. C. Low, of the London School of Tropical Medicine, had arranged to live from May to the end of October—that is, during the malarial season—in a part of the Roman Campagna, near Ostia, where scarcely a person spends a night without contracting malarial fever of a virulent type. No quinine or other drug was to be taken as a precautionary measure, but the investigators were to live in a mosquito-proof hut from an hour before sunset to an hour after sunrise, so as to avoid being bitten by mosquitoes, which only feed during the night. The experiment was planned to test the reality of the connection between malaria and mosquitoes, and we learn from the *British Medical Journal* that it has been most successful. On September 13, Prof. Grassi visited the residence of the investigators with several other men of science, and gave his testimony as to the value of the experiment in the following telegram to Dr. Manson: "Assembled in British mosquito-proof hut, having verified perfect health experimenters amongst malarial stricken inhabitants, I salute Manson who first formulated mosquito malarial theory.—Grassi." So far as the experiment has gone, therefore, the result is entirely satisfactory, and affords the strongest support to the mosquito theory of malaria. Additional evidence is given by Dr. Elliott, a member of the Liverpool expedition sent to Nigeria some time ago to investigate the subject of malarial fever, who has recently returned to this country. He reports that the members of the expedition have been perfectly well, although they have spent four months in some of the most malarious spots. They lived practically amongst marshes and other places hitherto supposed to be the most deadly, and they attribute their immunity to the careful use of mosquito nets at night.

ANOTHER experiment arranged in connection with their malarial investigation in the Campagna is described in the *British Medical Journal*. Drs. Sambon and Low have shown that by avoiding mosquitoes they avoid malaria; but this is, after all, only negative evidence, and its full value can only be appreciated in connection with the actual production of malaria in a healthy person in this country by the bites of mosquitoes containing the germ of the disease. This evidence is now forthcoming. We learn from our contemporary that a consignment of mosquitoes which had been fed on the blood of a sufferer from malaria in Rome, under the direction of Prof. Bastianelli, was received in London early in July. A son of Dr. Manson, who offered himself as a subject for experiment, allowed himself to be bitten by these insects, and, though he has never been in a malarious country since he was a child, he is now suffering from well-marked malarial infection of double tertian type, and microscopical examination shows the presence of numerous parasites in his blood. Full details of the experiments will be published in due course; meanwhile, they must be regarded as affording the most striking confirmation of the transmission of malaria by mosquito bites that has yet been obtained.

DR. L. A. BAUER, in charge of magnetic work of the U.S. Coast and Geodetic Survey, has gone to Alaska and to the Hawaiian Islands, in order to select the sites for the magnetic observatories in those regions. The principal or standard magnetic observatory is now being erected sixteen miles to the south-east of Washington City, and a fourth observatory is, temporarily, in operation at Baldwin, Kansas. The last named observatory is central to the area being surveyed by four magnetic parties, and it will be shifted about in the western States according to the requirements of the magnetic survey. It is the intention to have the four observatories ready in time to co-operate with the Antarctic expeditions.

IN connection with the usurpation of swallows' nests by house sparrows, Mr. J. H. Allchin sends a description of a swallow-cum-sparrow's nest seen by him at Dymchurch, in the Romney Marsh. The original nest was built on a beam immediately under the corrugated iron roof of a shed, but the usurpers had so completely covered it with straw, grass, feathers, fibres and other materials, that it was almost impossible to see any portion of it. Mr. Allchin remarks: "I have seen other nests of swallows which had been taken possession of by sparrows, but in those instances the only evidences of occupation were bits of straw or grass sticking out of the entrance; this is the first one I have seen covered over so thoroughly as to completely hide the work of the original builders.

ANOTHER successful experiment with electric traction on railways is reported from Germany, the line being from Berlin to Zehlendorf on the new Wannsee railway. The train in question (says *Feilden's Magazine* for September) was equipped as if actually running to scheduled time. It was furnished with a motor car at each end, the work of propulsion being divided equally between them, the advantage claimed for this being that the reversing of the train becomes unnecessary at the end of each journey. Eight ordinary cars were employed in addition, seating in all 400 passengers. These experiments are to be continued over a period of one year, at the termination of which it is expected that the question will be decided whether or not electric propulsion is to be wholly substituted for steam power, while at the same time much useful data will be gathered. An advantage already claimed is that electric motive power is about 15 per cent. cheaper than steam, and also at higher velocities the chance of accidents is supposed to be less. A train of this description is at present on trial in this country, and it will be useful to compare notes from each when the material is available.

FROM all quarters we learn that the present season has been remarkable for the appearance of numerous specimens of the clouded yellow butterflies (*Colias edusa* and *C. hyale*), as well as the holly-blue (*Lycaena argiolus*). During one country walk of three miles in Cambridgeshire, on August 13, the present writer saw three *hyale* and one *edusa*; in a garden near Brighton a holly-blue was seen on September 4, and many collectors report having obtained fair series of one or both of the two yellows in a day's hunting. From *Science Gossip* we learn that the variety *helice* of *C. edusa* has occurred in some numbers in clover fields in east Essex. The year 1892 will be remembered as the last occasion on which *C. edusa* occurred in abundance, but the present season is characterised by the comparative frequency of the pale species *hyale*, which was far less plentiful in 1892. The humming-bird moth (*Macroglossa stellatarum*) appears to have been gaining rather more than the usual notoriety in the daily papers which it has received ever since, some thirty years ago, the late Rev. J. G. Wood, in his "Common British Moths," wrote: "This moth, which is tolerably common, has been very familiar to the public of late years on account of the many letters which have appeared in the daily journals, much to the amusement of practical entomologists, who have been too familiar with the insect in question to think it worth a special notice."

DR. ANTONIO PORTA communicates to the *Rendiconti del R. Istituto Lombardo* certain studies on the anatomy of the common frog-hopper (*Aphrophora spumaria*, L.) having especial reference to the secretion of froth, so well known to all gardeners. The author finds that the apparatus which secretes the frothy liquid in *A. spumaria*, and possibly in other species, consists of hypodermal glands scattered over the back and especially near the stigma, that the *corpus ovalis* is perhaps in relation with the secretion of froth, that the mass of cells found in the latero-ventral position collect and perhaps produce material of which the animal makes use in the elaboration of the secretions, and that the glandular epithelium of the seventh and eighth segments serve as supports for minute appendages of a branchial character, which have disappeared in *Cicada* and *Nepa*, thus confirming the hypothesis of Wheeler.

IN view of our knowledge of the influence of radiant energy on electrically charged bodies, much interest attaches to the question whether a solar eclipse has any marked effect on atmospheric electricity. Dr. Julius Elster made observations during the last total eclipse at Algiers, and remarked an important fall of the potential of atmospheric electricity at and slightly after the totality. The observations are given in the last number of the *Memoirs* of the Società degli Spettroscopisti Italiani. On the other hand, Dr. Emilio Oddone describes, in the *Rendiconti del R. Istituto Lombardo*, observations made with an electrometer at Pavia, where during the last eclipse eight-tenths of the solar diameter were obscured. The results were of a negative character. Before the eclipse, high negative potentials were observed, which were attributable to clouds accompanying a distant thunderstorm; but during the eclipse the variations in the electrostatic potential seem to have been similar to the ordinary diurnal variations. It thus appears that the eclipse exercised no very marked influence on the electric state of the air; but whether any portion of the observed variations was attributable to this cause is a question which it would be difficult to answer.

MR. DAVID ROBERTSON has communicated to the *Proceedings* of the Philosophical Society of Glasgow a short note on the equilibrium of a column of air and the atmospheric temperature gradient, in which the adiabatic formula for the maximum gradient consistent with stability is established in a simple manner.

PARTS 10 to 12 of the *Meddelanden från Lunds Astronomiska Observatorium* contain several papers on mathematical astronomy. One, by T. Brodén, deals with some probability considerations relating to the convergence of certain continued fractions, a problem treated by Gyeldén in 1898. Certain librations in the planetary system are the subject of a paper by C. V. L. Charlier, while G. Norén and J. A. Wallberg contribute lengthy formulæ for the development of the disturbing function in its canonical elements.

NO. 110 of Ostwald's "Klassiker der exacten Wissenschaften" (Leipzig, Wilhelm Engelmann, 1900) is a reprint of J. H. van 't Hoff's papers on the laws of chemical equilibrium. The three papers in question are those communicated in French to the Swedish Academy of Sciences about the year 1885, and deal with the laws of chemical equilibrium in attenuated systems, a general property of attenuated media, and the electric conditions of chemical equilibrium. The present book is a translation of these papers by Georg Bredig, and an appendix of twenty pages contains a brief biographical notice of van 't Hoff and numerous notes, both historic and explanatory.

IN the course of a paper on the various forms of phosphorescence, in the *Revue Scientifique* for September 8, M. Gustave Le Bon describes a dark lamp ("lampe noire") for the production of invisible radiations of great wave-length in connection with the study of phosphorescence. Among other experiments performed with this lamp, the following is very striking:—In an absolutely dark room, a dark lamp is placed on a table, this lamp not transmitting any trace of visible light. In front of it, M. Le Bon places a statuette covered with sulphide of lime that has been left in darkness for several days, and consequently retains no trace of phosphorescence. After about a couple of minutes the statuette becomes luminous, and appears to emerge from the darkness.

THE director of the Meteorological Observatory at Ponta Delgada, St. Michael, has published an interesting report on the proposed establishment of an international meteorological service at the Azores, including a history of the observations in those islands, and a chart showing the tracks of a number of storms which have visited that part of the North Atlantic during the last five years. The first regular observations were made at Angra (Terceira) in 1864, at Ponta Delgada in 1865, and at Santa Cruz (Flores) in 1897. The observations at Ponta Delgada are now regularly published in the Daily Weather Report issued by the Meteorological Council. Since the year 1893 six of the islands have been in telegraphic communication with Lisbon, and eventually cables will be laid to England, Germany, and the United States, and Flores will be connected with the other islands. The direct communication of observa-vations between America, the Azores and this country cannot fail to be most useful both to science and to shipping; and, although the chart above referred to shows that most of the depressions passing the archipelago strike the coasts of Europe considerably south of the British Islands, a knowledge of the positions and movements of the larger areas of high and low barometric pressures in the North Atlantic must be of prime importance for the purpose of storm prediction.

IT is well known that while country-folk adhere to the old idea that adders when frightened are in the habit of protecting their young by swallowing them, a large number of naturalists regard the feat as an impossibility. In the September number of *The Zoologist* Mr. G. Leighton, a well qualified anatomist, has set himself the task of ascertaining whether there is any foundation for the objection. And he arrives at the conclusion that there is no anatomical reason why the oft-repeated statement of country observers should not be founded on fact. The author concludes by stating that the objection raised on the ground that the swallowing is unnecessary is a mere matter of opinion, adding that all that is now necessary is for a competent authority to dissect an adder which has been observed to swallow its young. "Until this is done scientific naturalists will continue to regard the question as one capable of proof, if true, but hitherto unproved."

THE eminent physiologist Dr. Gustave Loisel has communicated to the *Revue générale des Sciences* of September 15 a long and able letter urging the importance of establishing a course of instruction in practical embryology in the new French Universities. For a considerable time it appears that this subject has been taught to a certain extent in some of these institutions; but, for various reasons, it has not hitherto been made a part of the regular curriculum in all. After pointing out its extreme importance to students of medicine, anatomy, and gynæcology, Dr. Loisel formulates his appeal as follows: (1) That a single course of elementary embryology, embracing both that of man and of other vertebrates, should be established in each University, and that the necessary apparatus should be provided; (2) that this course should be instituted in a manner which would serve the needs of all students to whom a knowledge of this subject is of importance in their future career. These resolutions, we are glad to see, have been unanimously adopted by the Section of Medicine at the recent Congress, and we may therefore hope that this important addition to the teaching of the Universities may shortly be in working order.

WE have received vol. vii. pt. 1 of the *Transactions* of the Norfolk and Norwich Naturalists' Society, which contains a number of papers on local topics.

IN the *Victorian Naturalist* for August, Mr. A. J. North describes a new genus and species of Australian Passerine bird as *Eremiornis carteri*, while Mr. R. Hall continues his valuable notes on the distribution of the birds of Australia.

WE have received the autumn number of *Bibby's Quarterly*, a journal issued at Liverpool ostensibly for the advertisement of certain agricultural and other commodities, but which contains a number of very interesting and well illustrated articles dealing with stock-raising and kindred subjects. Among these, one treating of ostrich-farming should attract general attention.

THE September issue of the *Annals* of the South African Museum is devoted to the commencement of a synopsis of the moths of South Africa, by Sir G. F. Hampson. South Africa is the oldest British possession of any considerable size which has hitherto never had a catalogue of its indigenous moths, and as there are now many collectors in the country, Sir George Hampson has been well advised in endeavouring to supply an acknowledged want.

THE "British Anti-Dubbing Association" has forwarded to us an influentially signed letter respecting the cruel practice of cutting the combs and wattles of game-fowls. In spite of the fact that the practice is already illegal, and that birds which have been "dubbed" are ineligible for prizes at the British Dairy Farmers' Association show, it is still largely prevalent. It is now hoped that by bringing the matter into prominent notice, the pressure of public opinion may be brought to bear upon the promoters of poultry-shows, so as to disqualify all mutilated birds from being classed.

THE present boundaries in North-west Bohemia between the districts in which pure German, pure Tschech (Chekh), and the various mixtures of these languages are spoken, are clearly indicated by Dr. J. Zemmrich on a map in *Globus* (Bd. lxxviii. p. 101) which illustrates his paper on that subject.

THE disposal of the dead is an important subject of ethnographical inquiry; therefore thanks from students are due to Mr. W. Crooke for his paper on "Primitive rites of disposal of the dead, with special reference to India," in the *Journal* of the Anthropological Institute (vol. xxix. p. 271). Nearly every form of burial is practised in India, and Mr. Crooke has given full references for every statement he has made.

FROM Dr. Thurston's report on the administration of the Madras Museum for the year 1899–1900, we learn that the general progress of that institution is satisfactory. Anthropologists will be pleased to hear that the superintendent has found time to continue his valuable investigations concerning the various races met with in the Presidency, those which have recently engaged his attention being the Pathan, Sheik and Saiyad Muhamadans of Madras city.

IN the *Abhandlungen der Naturwiss. Gesellsch.*, *Isis*, 1900, Prof. J. Deichmüller describes a find of three broken urns and a stone axe of Neolithic age from near Dresden; these urns and two others described in the paper are decorated with incised lines. The same author also describes a late Slavic cemetery at Niedersedlitz of a date about 1100 of our era. The single measurable skull was meso-orthocephalic, with a cephalic index of about 78·7.

A RECENT number of the *Abhandlungen* of the Vienna Geographical Society consists of an important paper, by Prof. Dr. J. Cvijik, of Belgrade, forming the first part of a study of the glaciation and morphology of parts of Bosnia, Herzegovina and Montenegro. The memoir, which it is impossible to summarise in a note, is illustrated by nine maps.

CHIEF CONSTRUCTOR KRETSCHMER publishes in the *Marine-Rundschau* a paper on the German Antarctic Expedition. The paper deals first with the chief difficulties of Antarctic exploration, the achievements of former expeditions, and the general scheme of work to be undertaken by the expeditions now being fitted out. The second part is of special interest from the minute details and numerous drawings given of the design and construction of the vessel now being built for the German Expedition. We have also received a reprint of Mr. W. S. Bruce's paper in the June number of the *Scottish Geographical Magazine*, giving an account of the proposed Scottish National Antarctic Expedition.

A DESCRIPTIVE catalogue of a collection of the economic minerals of Canada, exhibited at the Paris Exhibition, has been prepared under the direction of Dr. G. M. Dawson. This will be a useful work of reference. It is interesting to note that the collection includes samples of lithographic stone.

THE *Proceedings* of the Geologists' Association for August 1900 contains some highly interesting notes on the geology of the English Lake District, by Mr. J. E. Marr. The notes, which were prepared for the summer excursion of the Association, embody the results of work carried out for many years by Mr. Marr, partly in conjunction with Mr. A. Harker. While supporting the generally accepted views of the succession of the older Palæozoic rocks, the facts now brought forward indicate that the disturbances to which these rocks have been subjected are due to the pushing forward of the strata in a northerly direction *at unequal rates*. Under these conditions the Skiddaw Slates moved furthest forward, causing the Green Slates and Porphyries to "lag behind," and the Upper Slates (Silurian, with Coniston Limestone at base) to lag behind the Green Slates and Porphyries. The peculiar faulting attending these disturbances is specially described. The intrusive igneous rocks and their metamorphic effects and other subjects are also dealt with.

IN the same number of the *Proceedings* there is a paper, by Mr. G. E. Dibley, on zonal features of the chalk pits in the Rochester, Gravesend and Croydon areas. The author has laboured long and enthusiastically in collecting from the various zones, and the results which he now publishes in notes, and in a carefully arranged list of fossils, form an important addition to our knowledge of the life-history of the chalk. An interesting bone, which he obtained from the Middle Chalk of Cuxton, is described by Mr. E. T. Newton as probably belonging to the Rhynchocephalia, a group of lizard-like animals, which includes the living New Zealand *Hatteria* and the Triassic *Hyperodapedon*.

THE *Transactions* of the American Microscopical Society for 1899 (vol. xxi.), contains a number of interesting articles on microscopic objects, zoological and botanical, together with a smaller number on microscope construction and laboratory apparatus.

IN the *Agricultural Gazette* of New South Wales for August, we notice a number of papers of interest and value for farmers and horticulturists in the Colony. Much information is contained in this and in previous numbers on the diseases to which domestic animals and cultivated crops are liable, and on the best methods for their treatment.

THE parts most recently received of Engler's *Botanische Jahrbücher* are Heft 4 of vol. xxviii. and Heft 2 of vol. xxix. Besides a few shorter articles, these parts are almost entirely occupied by two important descriptive papers—a continuation of the editor's report on the results of the German Nyassa expedition, and one by D. Diels on the flora of Central China.

THE *Bulletin* of the Imperial Society of Naturalists of Moscow, No. 4 for 1900, contains several interesting botanical papers in German. Of these the most important is the second of a series by W. Arnoldi on the morphology and history of development of the Gymnosperms. The present paper is devoted to the process of fertilisation in *Sequoia* (*Wellingtonia*), and is a link in the chain of the numerous and most important observations of recent years which connect the process of impregnation in Gymnosperms with that in Vascular Cryptogams on the one hand, and that in Angiosperms on the other hand.

THE third annual dinner of the association of old students of the Central Technical College will be held on Tuesday, October 2nd, at the Restaurant Frascati, Oxford-street. Old students can obtain further particulars from the honorary secretary, Mr. M. Solomon, 12, Edith-road, West Kensington, W., to whom all applications for tickets should be made.

THE three parts of vol. xxxix. of the *Transactions* of the Royal Society of Edinburgh, which have just been issued, contain several very valuable papers read before the Society during the sessions 1897–98 and 1898–99. All the papers have been published separately, and most of them have been reviewed in NATURE, or briefly described in the reports of the meetings of the Society.

MESSRS. BAILLIÈRE, TINDALL AND COX have published the fifth edition of "A Synopsis of the British Pharmacopœia," compiled by Mr. H. Wippell Gadd, with analytical notes and suggested standards by Mr. C. G. Moor. This little pocket-book is widely appreciated: it contains a complete table of chemicals, drugs and preparations in the official "Pharmacopœia," with their character, doses, &c., as well as other information arranged in a convenient form.

THE additions to the Zoological Society's Gardens during the past week include a Mona Monkey (*Cercopithecus mona*, ♀) from West Africa, presented by Mrs. C. Campbell; a Red-footed Ground Squirrel (*Xerus erythropus*) from West Africa, presented by Dr. Oswald Horrocks; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Captain W. H. Rotheram, R.E.; a Plantain Squirrel (*Sciurus plantani*) from Java, presented by Mr. H. H. Goodwin; two Dusky Ducks (*Anas obscura*) from North America, presented by Mr. W. H. St. Quintin; a Peregrine Falcon (*Falco peregrinus*), European, presented by Mr. A. L. Jessopp; three Jays (*Garrulus glandarius*), British, presented by Dr. R. B. Sharpe; four Pheasants (*Phasianus colchicus*), British, presented by Mr. F. Larratt; two Western Yellow-winged Laughing Thrushes (*Trochalopterum nigrimentum*), a Rufous-chinned Laughing Thrush (*Ianthocincla rufigularis*), a Slaty-headed Scimitar Babbler (*Pomatorhinus schisticeps*), a Black-throated Ouzel (*Merula strigularis*), two Tickell's Ouzels (*Merula unicolor*), a Spotted wing (*Psaroglossus spiloptera*) from British India, presented by Mr. E. W. Harper; a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Mr. Randolph Berens; a Red Tiger Cat (*Felis chrysothrix*), a Leopard (*Felis pardus*), two Rose-ringed Parrakeets (*Palaeornis docilis*) from West Africa, a Yellow-crowned Troupial (*Icterus chrysocephalus*), a Yellow-backed Troupial (*Icterus croconotus*) from South America, an Alpine Marmot (*Arctomys marmotta*), two Crossbills (*Loxia curvirostra*), European; ten Elephantine Tortoises (*Testudo elephantina*) from the Aldabra Islands, deposited.

OUR ASTRONOMICAL COLUMN

ASTRONOMICAL OCCURRENCES IN OCTOBER.

Oct. 6. 13h. 35m. to 14h. 29m. Moon occults κ Piscium (mag. 5).
9. 10h. 42m. Minimum of Algol (β Persei).
11. 6h. 51m. Transit (egress) of Jupiter's Sat. III.
11. 8h. 47m. to 9h. 25m. Moon occults ω^2 Tauri (mag. 4·6).
12. 7h. 30m. Minimum of Algol (β Persei).
12. 18h. 36m. to 19h. 23m. Moon occults ζ Tauri (mag. 3).
13. 15h. to 15h. 43m. Moon occults ν Geminorum (mag. 4).
15. Venus. Illuminated portion of disc = 0·637.
15. Mars. ,, ,, ,, = 0·902.
16. 17h. 26m. to 18h. 30m. Moon occults κ Cancri (mag. 5).
17. Saturn. Outer minor axis of outer ring = 16″·68.
19. 10h. Conjunction of Jupiter and Uranus. Jupiter, 0° 25′ N.
19–21. Epoch of Orionid meteoric shower. (Radiant 91°+15°.)
26. 12h. Conjunction of Jupiter and moon. Jupiter, 0° 27′ S.
28. 6h. 21m. Jupiter's Sat. IV. in conjunction S. of planet.
28. Probable date of perihelion of Barnard's comet (1884 II.).
29. 8h. 27m. to 8h. 46m. Moon occults *d* Sagittarii (mag. 4·9).
29. 16h. Mercury at greatest elongation (23° 46′ E.).

THE FIREBALL OF SUNDAY, SEPTEMBER 2, 6h. 54m.—A very large number of observations of this brilliant object were made, but they were not very exact, as the meteor appeared in daylight. The radiant point was probably in Cepheus at about 334°+57°. The object, during its visible flight, appears to have descended from a height of eighty-five miles over Richmond, Yorks., to twenty miles over Fleetwood, Lancs., and to have traversed a path of eighty-four miles. Another fine meteor was observed on Sunday evening, September 16, at 8h. 44m., and descriptions have come from London, Birmingham, Oxford and Llanelly. The radiant was in the southern sky between Capricornus and Piscis Australis at 324°−25°. The meteor fell from about fifty miles over Bewdley to thirty-two miles over Wigan, and had a visible course of eighty-six miles. The velocity is somewhat doubtful.

EPHEMERIS FOR OBSERVATIONS OF EROS:—

1900.		R.A. h. m. s.		Decl. ° ′ ″
Sept. 27	...	2 43 7·41	...	+43 27 2·0
28	...	43 25·24	...	43 49 43·2
29	...	43 40·01	...	44 12 20·4
30	...	43 51·63	...	44 34 52·7
Oct. 1	...	43 59·96	...	44 57 18·9
2	...	44 4·92	...	45 19 38·2
3	...	44 6·44	...	45 41 50·2
4	...	2 44 4·44	...	+46 3 53·8

The co-operative observations for determinations of parallax will commence about the beginning of October. The planet is at present in the constellation Perseus, and passes the meridian of London about 2·40 a.m.

EPHEMERIS OF COMET BORRELLY-BROOKS (1900*b*).—This comet is now rapidly becoming fainter, and the following abridgment from a complete Ephemeris furnished by Herr A. Scheller (*Astronomische Nachrichten*, Bd. 153, Nos. 3660, 3663) will doubtless suffice for observers possessed of the necessary optical power:—

Ephemeris for 12*h. Berlin Mean Time.*

1900.		R.A. h. m. s.		Decl. ° ′		Br.
Sept. 29	...	14 26 34	...	+69 7·7	...	0·07
Oct. 3	...	32 53	...	68 11·0	...	·06
7	..	38 55	...	67 24·5	...	·06
11	...	44 50	...	66 47·3	...	·05
15	...	50 38	...	66 18·7	...	·04
19	...	14 56 27	...	65 58·3	...	·04
23	...	15 2 16	...	65 45·6	...	·03
27	...	8 8	...	65 40·4	...	·03
31	...	15 14 2	...	+65 42·4	...	0·03

AUTOMATIC PHOTOGRAPHY OF THE CORONA.—Mention has often been previously made of Prof. C. Burckhalter's ingenious apparatus for obtaining photographs of the solar corona during an eclipse, and it now appears that he was extremely successful at the eclipse in May last. *Popular Astronomy*, vol. viii., contains reproductions from two negatives of the corona secured by him, one uncontrolled as has hitherto been usual, the other the result of intercepting part of the coronal light for varying periods of time during the total exposure. The total exposure in each case was 8·0 seconds, but by means of a system of revolving diaphragms arranged in one of the cameras, the image was shielded in various regions for different times, thus permitting the details of the inner corona to be photographed on the same plate as the outermost faint streamers. The following are the calculated effective exposures at the several stated distances from the moon's centre (moon's semi-diameter = 15′ 58″).

Distance from moon's centre	16′	...	20′	...	32′	...	50′	...	110
Exposure	... 0·04s.	...	0·23s.	...	1·76s.	...	3·20s.	...	8·00s.

The photograph shows the inner coronal detail close to the limb of the moon, the outer streamers extending for more than a lunar diameter. Several of the inner coronal tufts appear to be projected on the long broader streamers as background.

THE IRON AND STEEL INSTITUTE.

THE Iron and Steel Institute held its autumn meeting in Paris on September 18 and 19, under the presidency of Sir William Roberts-Austen, K.C.B., F.R.S. Besides a long programme of ten papers, visits to the Exhibition, to the works at St. Chamond, at Hayange in Lorraine, and at St. Denis near Paris, were arranged by an influential reception committee, of which Mr. Robert de Wendel was president and Mr. Henri Vastin honorary secretary. The attendance was unusually large, and the meeting was in every respect a successful one. The proceedings began on September 18 at the house of the Société d'Encouragement, with an address of welcome by Mr. Robert de Wendel, president of the French Association of Ironmasters. Sir William Roberts-Austen, having acknowledged the welcome, delivered a presidential address dealing in faultless literary style with the history of metallurgy in France.

The first paper read by the secretary, Mr. Bennett Brough, was by Mr. H. Pinget, secretary of the Comité des Forges, and dealt with the development of the iron industry in France since the Institute's last visit to Paris in 1889. The increase in output of iron and steel has been much greater than it was in the interval between the two previous exhibitions in Paris. No striking technical invention has been made, but great progress has been effected in increasing the power of the appliances used and in improving the quality of the products. There is a marked tendency to replace cast iron by cast steel, and success has attended endeavours to cast complicated forms in metal which is both tough and of high tensile strength. Moreover, special steels are now available for the requirements of particular applications, such as the growing exigencies of armour plate. The discussion on this paper was confined to complimentary remarks from Sir Lowthian Bell, F.R.S., Mr. Greiner and others.

The second paper, the most important submitted to the meeting, was that by Mr. J. E. Stead on iron and phosphorus. It is typical of modern metallurgical research, and contains a mass of original observations showing how phosphorus occurs in iron and steel. The subject is dealt with in four sections: (1) the constitution, properties and microstructure of iron containing form traces to 24 per cent. of phosphorus; (2) the effect of carbon when introduced by the fusion or cementation process into iron containing phosphorus; (3) the microstructure of pig iron containing phosphorus; and (4) the diffusion of solid phosphide of iron into iron. There are appended to the paper useful notes on eutectics, on solid solutions, on the method of determining free phosphide of iron in iron and steel, and on heat-tinting metal sections for microscopic examination. The observations recorded show that iron will retain as much as 1·75 per cent. of phosphorus as phosphide in solid solution, and that when more than that is present, the excess separates and is found as free phosphide of iron mixed up with the mass of iron. It is also shown that carbon added to solid solutions of phosphorus in iron throws out of solution the dissolved phosphide, which appears in a separate state. The most remarkable result given indicates that when carbon is added by the cementation process, the phosphide, when in large quantity, is thrown, not only out of solution, but escapes entirely out of the metal as a liquid eutectic leaving a constant residuum behind. A method is described by which phosphorus compounds in pig iron can be identified by means of the microscope. This consists in simply heating the polished surfaces to about 300° C. for a few minutes, when each constituent takes a different oxidation tint. The iron acquires a sky-blue colour, the carbide a red-brown and the phosphide compound a pale yellow. The coloured sections are of great beauty. Many results are given showing how the solid phosphide diffuses in solid iron, and showing that under suitable conditions well-formed crystals will grow in solid metal.

Mr. H. Bauerman's paper on iron and steel at the Universal Exhibition, Paris, 1900, was prepared mainly for the use of the members of the Institute visiting the Exhibition during the meeting. It contained a critical description of the more prominent metallurgical exhibits, and forms a valuable record of the condition of the metallurgical industry at the close of the century.

On September 19, the remaining papers on the programme were dealt with. Chief among these was that by Mr. E. F. Lange, on a new method of producing high temperatures. The principle underlying the process, which is the outcome of researches made by Dr. H. Goldschmidt of Essen, is not new, as it is based upon the heat energy developed by the chemical action of aluminium upon oxygen, or rather that between aluminium and certain metallic oxides. The practicability of the process was clearly shown by the welding together during the meeting of two short lengths of heavy girder rails. The method not only opens up a new field for aluminium but also promises to be of considerable importance in engineering work. In the discussion Sir William Roberts-Austen pointed out the extreme precision with which the reduction took place, and Sir Lowthian Bell dwelt on the value of the process if it should prove that carbonless iron could be obtained by it for electrical purposes.

The paper by Mr. A. L. Colby, of Bethlehem, United States, on American standard specifications and methods of testing iron and steel, embodied the results of over a year's work by a committee of American experts, conducted with a view to the adoption of international standards. Some of the specifications were criticised by Mr. R. A. Hadfield. The engineer, he thought, was encroaching on the field of the metallurgist. Interesting contributions to the discussion were made by Mr. C. P. Sandberg and by Dr. Dudley, of Pennsylvania.

In a paper on the influence of aluminium on the carbon in cast-iron, Mr. G. Melland and Mr. H. W. Waldron gave the results of an elaborate research in which they endeavoured to determine the amount of aluminium which is necessary to produce the maximum separation of graphite in a white pig-iron as free as possible from silicon and other impurities, and to ascertain, by casting every melting both in sand and in chill moulds, the effect produced by slow and rapid cooling upon the mode of existence of the carbon in the metal with amounts of aluminium varying from 0·02 to 12 per cent.

In the paper by Mr. Louis Katona, of Resicza, Hungary, the various disadvantages of the rolling-mills now in use were discussed, and suggestions were made for obviating them with a view to increasing the output and lessening the fuel consumption.

In a lengthy paper on the constitution of slags, which was taken as read, Baron H. von Jüptner discussed iron slags from a modern point of view, and described the varying reactions which take place between them and iron. The slags considered are divided into three groups—silicate slags, phosphate slags and oxide slags. The results of the investigation tend to show that slags should be regarded as solutions, and not as complicated chemical compounds.

The "phase-rule" of Gibb has served as a guide to the authors of two well-reasoned papers of great scientific interest—one on iron and steel from the point of view of the phase doctrine, by Prof. Bakhuis-Roozeboom, of Amsterdam, and the other on the present position of the solution theory of carburised iron, by Dr. A. Stansfield. The phase rule says in effect that in a system such as that of the carburised irons, in which two distinct substances (carbon and iron) are involved, but in which certain forms or phases of carbon or iron, or carbon-iron solution, or carbon-iron compound, are present, no more than two of these phases can exist in equilibrium with each other at a particular temperature. In the case of a solution of salt in water, this would mean that there could only be salt and ice and solution together at a particular temperature (the eutectic temperature), and that at any other temperature there could only be ice and solution or salt and solution (at temperatures above the eutectic), or ice and salt (at temperatures below the eutectic). In the case of a salt solution this is quite evident, but the value of the phase rule is that we can apply it with equal confidence in cases where we do not, to begin with, know the answer to our question. Applying the rule to the case of solid carburised iron at temperatures above that of all the known allotropic charges—we have the four possible substances of iron, graphite, cementite and solid solution of carbon (either graphite or cementite) in pig-iron. The rule states that only two of these can in general exist permanently together. The general conclusions to be drawn from Dr. Stansfield's researches are:—

(1) That carbon is less soluble in iron when presented in the form of graphite than when presented in the form of cementite.

(2) That the apparent reversal of this in steel is due partly to the absence of nuclei of graphite on which further deposits might take place; partly to the length of time required for the separation of the graphite, involving, as it does, the gradual passage of carbon through the iron to reach the nuclei, and partly to the mechanical pressure which must oppose the formation of graphite in solid steel.

The meeting was brought to a close by a vote of thanks to the French authorities and societies, whose hospitality had been enjoyed, proposed by the president and seconded by Mr. W. Whitwell, president-elect. A vote of thanks to the president was proposed by Mr. Greiner, of Seraing, Belgium, and seconded by Mr. Nordenfelt. The social functions in connection with the meeting were of a very attractive character. They included an operatic entertainment organised by the Comité des Forges, a reception by the Commissioner-General and Mrs. Jekyll at the British Royal Pavilion, a banquet at the Hôtel Continental, a reception by Mr. E. Schneider in the Le Creusot pavilion, a reception at the Hôtel de Ville by the president of the Municipal Council, and a reception on September 24 by the Minister of Public Works.

THE BRADFORD MEETING OF THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. S. H. VINES, M.A., D.SC., F.R.S., PRESIDENT OF THE SECTION.

THERE has been considerable difference of opinion as to whether the present year marks the close of the nineteenth or the beginning of the twentieth century. But whatever may be the right or the wrong of this vexed question, the fact that the year-date now begins with 19, instead of with 18, suggests the appropriateness of devoting an occasion such as the present to a review of the century which has closed, as some will have it, or, in the opinion of others, is about to close. I therefore propose to address you upon the progress of Botany during the nineteenth century.

I am fully conscious of the magnitude of the task which I am undertaking, more especially in its relation to the limits of time and space at my disposal. So eventful has the period been that to give in any detail an account of what has been accomplished during the last hundred years would mean to write the larger half of the entire history of Botany. This being so, it might appear almost hopeless to attempt to deal with so large a subject in a Presidential Address. But I trust that the very restrictions under which I labour may prove to be rather advantageous than otherwise, inasmuch as they compel me to confine attention to what is of primary importance, and thus to give special prominence to the main lines along which the development of the science has proceeded.

Statistics.

We may well begin with what is, after all, the most fundamental matter, viz. the relative numbers of known species of plants at the beginning and at the end of the century. It might appear that the statistics of plants was a subject susceptible of very simple treatment, but unfortunately this is not the case. It must be remembered that a "species" is not an invariable standard unit, like a pound or a pint, but that it is an idea dependent upon the subjectivity of individual botanists. For instance, one botanist may regard a certain number of similar plants as all belonging to a single species, whilst another may find the differences among them such as to warrant the distinction of as many species as there are plants. It is this inevitable variation in the estimation of specific characters which renders it difficult to deal satisfactorily with plants from the statistical point of view. However, the following figures may be regarded as giving a fair idea of the increase in the number of "good" species of living plants.

It is generally stated that about 10,000 species of plants were known to Linnæus in the latter half of the eighteenth century, of which one-tenth were Cryptogams; but so rapid was the progress in the study of new plants at that time that the first enumeration of plants published in the nineteenth century, the "Synopsis" of Persoon (1807), included as many as 20,000 species of Phanerogams alone. Turning now to the end of the century, we arrive at the following census, for which I am indebted mainly to Prof. Saccardo (1892) and to Prof. de Toni who has kindly given me special information as to the Algæ:—

Species of Phanerogams indicated in Bentham and Hooker's "Genera Plantarum" (Durand, "Index," 1888).

Dicotyledons	78,200
Monocotyledons	19,600
Gymnosperms	2,420
	100,220
Estimated subsequent additions (Saccardo) ...	5,011
Total Phanerogams ...	105,231

Species of Pteridophyta (indicated in Hooker and Baker's "Synopsis"; Baker's "New Ferns" and "Fern Allies").

Filicinæ (including Isoëtes), about	3,000
Lycopodinæ, about	432
Equisetinæ, about	20
Total Pteridophyta	3,452

Species of Bryophyta (Saccardo's Estimate).

Musci	4,609
Hepaticæ	3,041
Total Bryophyta	7,650

Species of Thallophyta.

Fungi (including Bacteria) (Saccardo) ...	39,663
Lichens (Saccardo)	5,600
Algæ (incl. 6000 Diatoms) (de Toni)... ...	14,000
Total Thallophyta	59,263

Adding these totals together—

Phanerogams	105,231
Pteridophyta	3,452
Bryophyta	7,650
Thallophyta	59,263
we have a grand total of	175,596

as the approximate number of recognised species of living plants.

These figures are sufficiently accurate to show how vast have been the additions to the knowledge of plants in the period under consideration, and they afford much food for thought. In the first place, they indicate how closely connected has been the growth of this branch of Botany with the exploration and opening-up of new countries which has been so characteristic a feature of the century. Again, no one can consider these figures without being struck by the disparity in the numbers of species included in the different groups; a most interesting topic, which cannot, however, be entered upon here. It must suffice to point out in a general way that the smaller groups represent families of plants which attain their numerical zenith in long past geological periods, and are now decadent, whilst the existing flora of the world is characterised by the preponderating Angiosperms and Fungi.

We may venture to cast a forward glance upon the possible future development of the knowledge of species. Various partial estimates have been made as to the probable number of existing species of this or that group, but the only comprehensive estimate with which I am acquainted is that of Prof. Saccardo (1892). He begins with a somewhat startling calculation to the effect that there are at least 250,000 existing species of Fungi alone, and he goes on to suggest that probably the number of species belonging to the various other groups would amount to 150,000; hence the total number of species now living is to be estimated at over 400,000. On the basis of this estimate it appears that we have not yet made the acquaintance of half the contemporary species; so that there remains plenty of occupation for systematic and descriptive botanists, especially in the department of Fungology. It is also rather alarming, in view of the predatory instincts of so many of the Fungi, to learn that they constitute so decided a majority of the whole vegetable kingdom.

In spite of the great increase in the number of known species, it cannot be said that any essentially new type of plant has been discovered during the century. So far as the bounds of the vegetable kingdom have been extended at all, it has been by the annexation of groups hitherto regarded as within the sphere of influence of the zoologists. The most notable instance of this has occurred in the case of the Bacteria, or Schizomycetes, as Naegeli termed them. These organisms, discovered by Leeuwenhoek 200 years ago, had always been regarded as infusorian animals until, in 1853, Cohn recognised their vegetable nature and their affinity with the Fungi. These plants have acquired special importance, partly on account of the controversy which arose as to their supposed spontaneous generation, but more especially on account of their remarkable zymogenic and pathogenic properties, so that Bacteriology has become one of the new sciences of the century.

Classification.

Having gained some idea of the number of species which have been recognised and described during the century, the next point for consideration is the progress made in the attempt to reduce this mass of material to such order that it can be intelligently apprehended; in a word, to convert a mass of facts into a science; "Filum ariadneum Botanices est systema, sine quo chaos est Res Herbaria" (Linnæus).

The classification of plants is a problem which has engaged attention from the very earliest times. Without attempting to enter into the history of the matter, I may just point out that, speaking generally, all the earlier systems of classification were more or less artificial, the subdivisions being based upon the distinctive features of one set of members of the plant. When I say that of all these systems that proposed by Linnæus (1735) was the most purely artificial, I do not imply any reproach: if it was the most artificial, it was at the same time the most serviceable, and its author was fully aware of its artificiality. This system is generally regarded as his most remarkable achievement; but the really great service which Linnæus rendered to science was the clear distinction which he for the first time drew between systems which are artificial and those which are natural. Recognising, as he did, his inability to frame at that period a satisfactory natural system, he also realised that with the increased number of known plants some more ready means of determining them was an absolute necessity, and it was for this purpose that he devised his artificial system, not as an end, but as a means. The end to be kept in view was the natural classification: "Methodus naturalis est ultimus finis Botanices" is his clearly expressed position in the "Philosophia Botanica."

There is a certain irony in the fact that the enthusiastic acceptance accorded to his artificial system throughout the greater part of Europe contributed to postpone the realisation of Linnæus's cherished hopes with regard to the attainment of a natural classification. It was just in those countries, such as Germany and England, where the Linnean system was most readily adopted that the development of the natural system proceeded most slowly. It was in France, where the Linnean system never secured a firm hold, that the quest of the natural system was pursued; and it is to French botanists more particularly that our present classification is due. It may be traced from its first beginnings with Magnol in 1689, through the bolder attempts of Adanson and of Bernard de Jussieu (1759), to the relatively complete method propounded by Antoine Laurent de Jussieu in his "Genera Plantarum," just 100 years later.

The nineteenth century opened with the struggle for predominance between the Jussiean and the Linnean systems. In England the former soon obtained considerable support, notably that of Robert Brown, whose "Prodromus Floræ Novæ Hollandiæ," published in 1810, seems to have been the first English botanical work in which the natural system was adopted; but it did not come into general use until it had been popularised by Lindley in the 'thirties.

Meantime the Jussiean system had been extended and improved by Auguste Pyrame de Candolle (1813–24). It is essentially the Candollean classification which is now most generally in use, and it has been immortalised by its adoption in Bentham and Hooker's "Genera Plantarum," one of the great botanical monuments of the century. In Germany, however, it has been widely departed from, the system there in vogue being based upon Brongniart's modification (1828, 1850) of de Candolle's method as elaborated successively by Alex. Braun (1864), Eichler (1876–83) and Prof. Engler (1886, 1898). It must be admitted that for the last fifty years the further evolution of the natural system, at any rate so far as Phanerogams are concerned, has been confined to Germany.

One of the most important advances in the classification of Phanerogams was based upon Robert Brown's discovery in 1827 of the gymnospermous nature of the ovule in Conifers and Cycads, which led Brongniart (1828) to distinguish these plants as "Phanérogames gymnospermes"; and although the systematic position of these plants has since then been the subject of much discussion, the recognition of the Gymnospermæ as a distinct group of archaic Phanerogams is now definitely accepted.

Moreover, the greatly increased knowledge of the Cryptogams has involved a considerable reconstruction in the classification of that great sub-kingdom. One of the most striking discoveries is that first definitely announced by Schwendener (1869) concerning Lichens, to the effect that the body of a Lichen consists of two distinct organisms, an Alga and a Fungus, living in symbiosis; a discovery which was so nearly made by other contemporary botanists, such as de Bary, Berkeley and Sachs, and which can be traced back to Haller and Gleditsch in the eighteenth century.

But the discoveries which most affected the classification of the Cryptogams are those relating to their reproduction. Whilst it had been recognised, almost from time immemorial, that Phanerogams reproduce sexually, sexuality was denied to Cryptogams until the observations on Liverworts and Mosses by Schmidel and by Hedwig (of whom it was said that he was born to banish Cryptogamy) in the eighteenth century; and even as late as 1828 we find Brongniart classifying the Fungi and Algæ together as "Agames." But in the middle third of the nineteenth century, by the labours of such men as Thuret, Pringsheim, Cohn, Hofmeister, Naegeli and de Bary, the sexuality of all classes of Cryptogams was clearly established. It is worthy of note that, although the sexuality of the Phanerogams had been accepted for centuries, yet the details of sexual reproduction were first investigated in Cryptogams. For it was not until 1823 that Amici discovered the pollen-tube, and it was more than twenty years later (1846) before he completed his discovery by ascertaining the true significance of the pollen-tube in relation to the development of the embryo; whilst it remained for Strasburger to observe, thirty years later, the actual process of fertilisation.

The discovery of the reproductive processes in Cryptogams not only facilitated a natural classification of them, but had the further very important effect of throwing light upon their relation to Phanerogams. Perhaps the most striking botanical achievement of the nineteenth century has been the demonstration by Hofmeister's unrivalled researches (1851) that Phanerogams and Cryptogams are not separated, as was formerly held, by an impassable gulf, but that the higher Cryptogams and the lower Phanerogams are connected by many common features.

The development of the natural classification, of which an account has now been given, proceeded for the most part on the assumption of the immutability of species. As Linnæus expressed it in his "Fundamenta Botanica," "species tot numeramus, quot diversæ formæ in principio sunt creatæ." It is difficult to understand how, with this point of view, the idea of affinity between species could have arisen at all; and yet the establishment of genera and the attempts at a natural system prove that the idea was operative. The nature of the prevalent conception of affinity is well conveyed by Linnæus's aphorism, "Affines conveniunt habitu, nascendi modo, proprietatibus, viribus, usu."

But a conviction had been gradually growing that the assumed fixity of species was not well founded, and that, on the contrary, species are descended from pre-existent species. This view found clear expression in Lamarck's "Philosophie Zoologique," published early in the century (1809), but it did not strongly affect public opinion until after the publication of Darwin's "Origin of Species" in 1859. Regarded from this point of view, the problems of classification have assumed an altogether different aspect. Affinity no longer means mere similarity, but blood-relationship depending upon common descent. We no longer seek a "system" of classification; we endeavour to determine the mutual relations of plants. The effect of this change has been to stimulate the investigation of plants in all their parts and in all stages of their life, so as to attain that complete knowledge of them without which their affinities cannot be accurately estimated. If the classification of Cryptogams is, at the present moment, in a more satisfactory position than that of Phanerogams, it is just because the study of the former group has been, for various reasons, more thorough and more minute than that of the latter.

Palaeophytology.

The stimulating influence of the new doctrine was not, however, confined to the investigation of existing plants; it also gave a remarkable impulse to the study of fossil plants, inasmuch as the theory of descent involves the quest of the ancestors of the forms that we now have around us. Marvellous progress has been made in this direction during the nineteenth century, by the labours more especially of Brongniart, Goeppert, Unger, Schimper, Schenck, Saporta, Solms-Laubach, Renault, on the Continent, and in our own country of Lindley and Hutton, Hooker, Carruthers, and more especially of Williamson. So far-reaching are the results obtained that I can only attempt the barest summary of them. I may perhaps best begin by saying that only a small proportion of existing species have been found in the fossil state. In illustration I may adduce the statement made by Mr. Clement Reid in his recent work, "The Origin of the British Flora," that only 270 species, that is, about one-sixth of the total number of British vascular plants, are known as fossils. Making all due allowances for the imperfection of the geological record, for the limited area investigated, and for the difficulty of determination of fragmentary specimens, it may be stated generally that the number of existing species has been found to rapidly diminish in the floras of successively older strata; none, in fact, have been certainly found to persist beyond the Tertiary period. Certain existing genera, belonging to the Gymnosperms and to the Pteridophyta, have, however, been traced far down into the Mesozoic period. Similarly, the distribution in time of existing natural orders does not coincide with that of existing genera; thus the Ferns of the Carboniferous epoch apparently belong, for the most part, if not altogether, to the order Marattiaceæ, but they are not referable to any of the existing genera.

Moreover, altogether new families of fossil plants have been discovered: such are, among Gymnosperms, the Cordaitaceæ and the Bennettitaceæ; among Pteridophyta, the Calamariaceæ, the Lepidodendraceæ, the Sphenophyllaceæ and the Cycadofilices. It is of interest to note that all these newly discovered families can be included within the main subdivisions of the existing flora; in fact, no fossil plants have been found which suggest the existence in the past of groups outside the limits of our Phanerogamia, Pteridophyta, Bryophyta and Thallophyta.

It cannot be said that the study of Palæobotany has as yet made clear the ancestry and the descent of our existing flora. To begin with the angiospermous flowering plants, it has been ascertained that they make their first appearance in the Cretaceous epoch, but we have no clue as to their origin. The relatively late appearance of Angiosperms in geological time suggests that they must have sprung from an older group, such as the Gymnosperms or the Pteridophyta; but there is no evidence to definitely establish either of these possible origins. Then as to the origin of the Gymnosperms, whilst it cannot be doubted that they were derived from the Pteridophyta, the existing data are insufficient to enable us to trace their pedigree. The most ancient family of Gymnosperms, the Cordaitaceæ, can be traced as far back as any known Pteridophyta, and cannot, therefore, have been derived from them; but the fact that the Cordaitaceæ exhibit certain cycadean affinities, and the discovery of the Cycadofilices, suggest that what may be termed the cycadean phylum of Gymnosperms (including the Cordaitaceæ, Bennettitaceæ, Cycadaceæ, and perhaps the Ginkgoaceæ) had its origin in a filicineous ancestry, of which, it must be admitted, no forms have as yet been recognised.

Turning to the Pteridophyta, the origin of the Ferns is still quite unknown: the one fact which seems to be clear is that the eusporangiate forms (Marattiaceæ) are more primitive than the leptosporangiate. With regard to the Equisetinæ, the Calamariaceæ were no doubt the ancestors of the existing and of the fossil Equisetums. Similarly, in the Lycopodinæ, the palæozoic Lepidodendraceæ were the forerunners of the existing Lycopodiums and Selaginellas. The discovery of the Sphenophyllaceæ seems to throw some further light upon the phylogeny of these two groups, inasmuch as these plants possess characters which indicate affinity with both the Equisetinæ and the Lycopodinæ, thus suggesting the possibility that they may have sprung from the same ancestral stock.

To complete the geological survey of the vegetable kingdom I will briefly allude to the Bryophyta and the Thallophyta. Owing no doubt to their delicate texture, the records of these plants have been found to be very incomplete. So much is this the case with the Bryophyta that I forbear to make any statement concerning them. The chief point of interest with regard to the Fungi is that most of those which have been discovered in the fossil state were found in the tissues of woody plants on which they were parasitic. In this way it has been possible to ascertain, with some probability, the existence of Bacteria and of mycelial Fungi in the Palæozoic period. The records of the Algæ are more satisfactory; they have been traced far back into the Palæozoic age, where they are represented by siphonaceous forms and by the somewhat obscure plants known as *Nematophycus* and *Pachytheca*.

In a general way the study of Palæobotany has proved the development of higher from lower forms in the successive geological periods. Thus the Tertiary and Quaternary periods are characterised by the predominance of Angiosperms, just as the Mesozoic period is characterised by the predominance of Gymnosperms, and the Palæozoic by the predominance of Pteridophyta. And yet, as I have been pointing out, we are not able to trace the ancestry of any one of the larger groups of plants. The chief reason for this is that the geological record, so far as it is known, has been found to break off with such surprising abruptness that the earliest, and therefore the most interesting, chapters in the evolution of plants are closed to us. After the wealth of plant-forms in the Carboniferous epoch there is a striking falling-off in the Devonian, in which, however, plants of high organisation, such as the Cordaitaceæ, the Calamariaceæ and the Lepidodendraceæ, still occur. In the Silurian epoch vascular plants are but sparingly present—but it is remarkable that any such highly organised plants should be found there—together with probable Algæ, such as *Nematophycus* and *Pachytheca*. The Cambrian rocks present nothing but so-called "Fucoids," such as *Eophyton*, &c., some of which may be Algæ. The only known fossil in the oldest strata of all, the Archæan, is the much-discussed *Eozoon canadense*, probably of animal origin; but the occurrence here of large deposits of graphite seems to indicate the existence of a considerable flora which has, unfortunately, become quite undeterminable. Thus, whilst there is some evidence that the primitive plants were Algæ, there is at present no available record of the various stages through which the Silurian and Devonian vascular plants were evolved from them.

Morphology.

If inquiry be made as to the cause of the great advance in the recognition of the true affinities of plants, and consequently in their classification, which distinguishes the nineteenth century, I would refer it to the progress made in the study of morphology. The earlier botanists regarded all the various parts of plants as "organs" in relation to their supposed function; hence their description of plants was simply "organography." The idea of regarding the parts of the plant-body, not in connection with their functions, but with reference to their development and their mutual relations, seems to have originated with Jung in the seventeenth century (1687): it was revived by C. F. Wolff about seventy years later (1759), but it did not materially affect the study of plants until well on in the nineteenth century, after Goethe had repeatedly written on the subject and had devised the term "morphology" to designate it. For a time this somewhat abstract mode of treatment led to mere theorising and speculation, so much so that the years 1820-1840 will always be stigmatised as the period of the "Naturphilosophie." But fortunately this time of barrenness was succeeded by a veritable renascence. Robert Brown and Henfrey in England; Brongniart, St. Hilaire and Tulasne in France; Mohl, Schleiden, Naegeli, A. Braun, and, above all, Hofmeister in Germany, led the way back from the pursuit of fantastic will-o'-the-wisps to the observation of actual fact. Instead of evolving schemes out of their own internal consciousness as to how plants ought to be constructed, they endeavoured to discover by the study of development, and more particularly of embryogeny, how they actually are constructed, with the result that within a decade Hofmeister discovered the alternation of generations in the higher plants; a discovery which must ever rank as one of the most brilliant triumphs of morphological research.

With the knowledge thus acquired it became possible to determine the true relations of the various parts of the plant-body; to distinguish these parts as "members" rather than as "organs"; in a word, to establish homologies where hitherto only analogies had been traced—which is the essential difference between morphology and organography.

The publication of the "Origin of Species" profoundly affected the progress or morphology, as of all branches of biological research: but it did not alter its trend; it confirmed and extended it. We are not satisfied now with establishing homologies, but we go on to inquire into the origin and phylogeny of the members of the body. In illustration I may briefly refer to two problems of this kind which at the present time are agitating the botanical world. The first is as to the origin of the alternation of generations. Did it come about by the modification of the sexual generation (gametophyte) into an asexual (sporophyte); or is the sporophyte a new formation intercalated into the life-history? In a word, is the alternation of generations to be regarded as homologous or as antithetic? I am not rash enough to express any opinion on this controversy; nor is it necessary that I should do so, since the subject has twice been threshed out at recent meetings of this Section. The second problem is as to the origin of the sphorophylls, and, indeed, of all the various kinds of leaves of the sporophyte in the higher plants. It is suggested, on the one hand, that the sporophylls of the Pteridophyta have arisen by gradual sterilisation and segmentation from an unsegmented and almost wholly reproductive body, represented in our day by the sporogonium of the Bryophyta; and that the vegetative leaves have been derived by further sterilisation from the sporophylls. On the other hand, it is urged that the vegetative leaves are the more primitive, and that the sporophylls have been derived from them. It will be at once observed that this second problem is intimately connected with the first. The sterilisation theory of the origin of leaves is a necessary consequence of the antithetic view of the alternation of generations; whilst the derivation of sporophylls from foliage-leaves is similarly associated with the homologous view. Here, again, exercising a wise discretion, I will only venture to express my appreciation of the important work which has been done in connection with this controversy—work that will be equally valuable, whatever the issue may eventually be.

I will conclude my remarks on morphology with a few illustrations of the aid which the advance in this department has given to the progress of classification. For instance, Linnæus divided plants into Phanerogams and Cryptogams, on the ground that in the former the reproductive organs and processes are conspicuous, whereas in the latter they are obscure. In view of our increased knowledge of Cryptogams this ground of distinction is no longer tenable; whilst still recognising the validity of the division, our reasons for doing so are altogether different. For us, Phanerogams are plants which produce a seed; Cryptogams are plants which do not produce a seed. Again, we distinguish the Pteridophyta and the Bryophyta from the Thallophyta, not on account of their more complex structure, but mainly on the ground that the alternation of generations is regular in the two former groups, whilst it is irregular or altogether wanting in the latter. Similarly, the essential distinction between the Pteridophyta and the Bryophyta is that in the former the sporophyte, in the latter the gametophyte, is the preponderating form. It has enabled us further to correct in many respects the classifications of our predecessors by altering the systematic position of various genera, and sometimes of larger groups. Thus the Cycadaceæ have been removed from among the Monocotyledons, and the Coniferæ from among the Dicotyledons, where de Candolle placed them, and have been united with the Gnetaceæ into the sub-class Gymnospermæ. The investigation of the development of the flower, in which Payer led the way, and the elaboration of the floral diagram which we owe to Eichler, have done much, though by no means all, to determine the affinities of doubtful Angiosperms, especially among those previously relegated to the lumber-room of the Apetalæ.

Anatomy and Histology.

Passing now to the consideration of the progress of knowledge concerning the structure of plants, the most important result to be chronicled is the discovery that the plant-body consists of living substance indistinguishable from that of which the body of animals is composed. The earlier anatomists, whilst recognising the cellular structure of plants, had confined their attention to the examination of the cell-walls, and described the contents as a watery or mucilaginous sap, without determining where or what was the seat of life. In 1831 Robert Brown discovered the nucleus of the cell, but there is no evidence that he regarded it as living. It was not until the renascence of research in the 'forties, to which I have already alluded, that any real progress in this direction was made. The cell-contents were especially studied by Naegeli and by Mohl, both of whom recognised the existence of a viscous substance lining the wall of all living cells as a "mucous layer" or "primordial utricle," but differing chemically from the substance of the wall by being nitrogenous: this they regarded as the living part of the cell, and to it Mohl (1846) gave the name "protoplasm," which it still bears. The full significance of this discovery became apparent in a somewhat roundabout way. Dujardin, in 1835, had described a number of lowly organisms, which he termed Infusoria, as consisting of a living substance, which he called "sarcode." Fifteen years later, in a remarkable paper on *Protococcus pluvialis*, Cohn drew attention to the similarity in properties between the "sarcode" of the Infusoria and the living substance of this plant, and arrived at the brilliant generalisation that the "protoplasm" of the botanists and the "sarcode" of the zoologists are identical. Thus arose the great conception of the essential unity of life in all living things, which, thanks to the subsequent labours of such men as de Bary, Brücke, and Max Schultze, in the first instance, has become a fundamental canon of Biology.

A conspicious monument of this period of activity is the cell-theory propounded by Schwann in 1839. Briefly stated, Schwann's theory was that all living bodies are built up of structural units which are the cells: each cell possesses an independent vitality, so that nutrition and growth are referable, not to the organism as a whole, but to the individual cells. This conception of the structure of plants was accepted for many years, but it has had to give way before the advance of anatomical knowledge. The recognition of cell-division as the process by which the cells are multiplied—in opposition to the Schleidenian theory of free cell-formation—early suggested doubts as to the propriety of regarding the body as being built up of cells as a wall is built of bricks. Later the minute study of the Thallophyta revealed the existence of a number of plants, such as the Myxomycetes, the phycomycetous Fungi, and the siphonaceous Algæ, some of them highly organised, the vegetative body of which does not consist of cells. It became clear that cellular structure is not essential to life; that it may be altogether absent or present in various degree. Thus in the higher plants the protoplasm is segmented or septated by walls into uninucleate units or "energids" (Sachs), and such plants are well described as "completely septate." But in others, such as the higher Fungi and certain Algæ (e.g. *Cladophora*, *Hydrodictyon*), the protoplasm is septated, not into energids, but into groups of energids, so that the body is "incompletely septate." Finally there are the Thallophyta already enumerated, in which there is complete continuity of the protoplasm: these are "unseptate." Moreover, even when the body presents the most complete cellular structure, the energids are not isolated, but are connected by delicate protoplasmic fibrils traversing the intervening walls; a fact which is one of the most striking discoveries in the department of histology. This was first recognised in the sieve-tubes by Hartig (1837); then by Naegeli (1846) in the tissues of the Florideæ. After a long period of neglect the matter was taken up once more by Tangl (1880), when it attracted the attention of many investigators, as the result of whose labours, especially those of Mr. Gardiner, the general and perhaps universal continuity of the protoplasm in cellular plants has been established. Hence the body is no longer regarded as an aggregate of cells, but as a more or less septated mass of protoplasm: the synthetic standpoint of Schwann has been replaced by one as distinctively analytic.

Time does not permit me to do more than mention the important discoveries made of late years, mainly on the initiative of Strasburger, with regard to the details of cytology, and especially to the structure of the nucleus and the intricate dance of the chromosomes in karyokinesis. Indeed, I can do but scant justice to those anatomical discoveries which are of more exclusively botanical interest. One important generalisation which may be drawn is that the histological differentiation of the plant proceeds, not in the protoplasm, as in the animal, but in the cell-wall. It is remarkable, on the one hand, how similar the protoplasm is, not only in different parts of the same body, but in plants of widely different affinities; and, on the other, what diversity the cell-wall offers in thickness, chemical composition, and physical properties. In studying the differentiation of the cell-wall the botanist has received valuable aid from the chemist. Research in this direction may, in fact, be said to have begun with Payen's fundamental discovery (1844) that the characteristic and primary chemical constituents of the cell-wall is the carbohydrate which he termed cellulose.

The amount of detailed knowledge as to the anatomy of plants which has been accumulated during the century by countless workers, among whom Mohl, Naegeli, Unger and Sanio deserve special mention as pioneers, is very great—so great, indeed, that it seemed as if it must remain a mere mass of facts in the absence of any recognisable general principles which might serve to marshal the facts into a science. The first step towards a morphology of the tissues was Hanstein's investigation of the growing point of the Phanerogams (1868), and his recognition therein of the three embryonic tissue-systems. This has lately been further developed by the promulgation of van Tieghem's theory of the stele, which is merely the logical outcome of Hanstein's distinction of the plerome. It has thus become possible to determine the homologies of the tissue-systems in different plants and to organise the facts of structure into a scientific comparative anatomy. It has become apparent that, in many cases, differences of structure are immediately traceable to the influence of the environment; in fact, the study of physiological or adaptive anatomy is now a large and important branch of the subject.

The study of Anatomy has contributed in some degree to the progress of systematic Botany. It is true that some of the more ambitious attempts to base classification on Anatomy have not been successful; such, for instance, as de Candolle's subdivision of Phanerogams into Exogens and Endogens, or the subdivision of Cormophyta into Acrobrya, Amphibrya, and Acramphibrya, proposed by Unger and Endlicher. Still it cannot be denied that anatomical characters have been found useful, if not absolutely conclusive, in suggesting affinities, especially in the determination of fossil remains. A large proportion of our knowledge of extinct plants, to which I have already alluded, is based solely upon the anatomical structure of the vegetative organs; and although affinities inferred from such evidence cannot be regarded as final, they suffice for a provisional classification until they are confirmed or disproved by the discovery and investigation of the reproductive organs.

Physiology.

The last branch of botanical science which I propose to pass in review is that of physiology. We may well begin with the nutritive processes. At the close of the eighteenth century there was practically no coherent theory of nutrition; such as it was it amounted to little more than the conclusion arrived at by van Helmont a century and a half earlier, that plants require only water for their food, and are able to form from it all the different constituents of their bodies. It is true that the important discovery had been made and pursued by Priestley (1772), Ingen-Housz (1780) and Sénébier (1782) that green plants exposed to light absorb carbon dioxide and evolve free oxygen; but this gaseous interchange had not been shown to be the expression of a nutritive process. At the opening of the nineteenth century (1804) this connection was established by de Saussure, in his classical "Recherches Chimiques," who demonstrated that, whilst absorbing carbon dioxide and evolving oxygen, green plants gain in dry weight; and he further contributed to the elucidation of the problem of nutrition by showing that, whilst assimilating carbon dioxide, green plants also assimilate the hydrogen and oxygen of water.

Three questions naturally arose in connection with de Saussure's statement of the case: What is the nature of the organic substance formed? What is the function of the chlorophyll? What is the part played by light? It was far on in the century before answers were forthcoming.

With regard to the first of these questions the researches of Boussingault (1864) and others established the fact that the volume of carbon dioxide absorbed and that of the oxygen evolved in connection with the process are approximately equal. Further, the frequent presence of starch in the chloroplastids, to which Mohl first drew attention (1837), was subsequently found by Sachs (1862) to be closely connected with the assimilation of carbon dioxide. The conclusion drawn from these facts is that the gain in dry weight accompanying the assimilation of carbon dioxide is due to the formation, in the first instance, of organic substance having the composition of a carbohydrate; a conclusion which may be expressed by the equation

$$CO_2 + H_2O = CH_2O + O_2.$$

The questions with regard to chlorophyll and to light are so intimately connected that they must be considered together. The first step towards their solution was the investigation of the relative activity of light of different colours, originally undertaken by Sénébier (1782) and subsequently repeated by Daubeny (1836), with the result that red and orange light was found to promote assimilation in a higher degree than blue or violet light. Shortly afterwards Draper (1843), experimenting with an actual solar spectrum, concluded that the most active rays are the orange and yellow; a conclusion which was generally accepted for many years. But in the meantime the properties of the green colouring matter of plants (to which Pelletier and Caventou gave the name "chlorophyll" in 1817) were being investigated. Brewster discovered in 1834 that an alcoholic extract of green leaves presents a characteristic absorption spectrum; but many years elapsed before any attempt was made to connect this property with the physiological activity of chlorophyll. It was not until 1871–72 that Lommel and N. J. C. Müller pointed out that the rays of the spectrum which are most completely absorbed by chlorophyll are just those which are most efficient in the assimilation of carbon dioxide. Subsequent researches, particularly those of Timiriazeff (1877), and those of Engelmann (1882–84) based on his ingenious Bacterium-method, have confirmed the views of Lommel and of Müller, and have placed it beyond doubt that the importance of light in the assimilatory process is that it is the form of kinetic energy necessary to effect the chemical changes, and that the function of chlorophyll is to serve as the means of absorbing this energy and of making it available for the plant.

These are perhaps the most striking discoveries in relation to the nutrition of plants, but there are others of not less importance to which brief allusion must be made. We owe to de Saussure (1804) the first clear demonstration of the fact that plants derive an important part of their food from the soil; but the relative nutritive value of the inorganic salts absorbed in solution was not ascertained until Sachs (1858) reintroduced the method of water-culture which had originated centuries before with Woodward (1699) and had been practised by Duhamel (1768) and de Saussure. Special interest centres around the question of the nitrogenous nutrition of plants. It was long held chiefly on the authority of Priestley and of Ingen-Housz, and in spite of the contrary opinion expressed by Sénébier, Woodhouse (1803) and de Saussure, that plants absorb the free nitrogen of the atmosphere by their leaves. This view was not finally abandoned until 1860, when the researches of Boussingault and of Lawes and Gilbert deprived it of all foundation. Since then we have learned that the free nitrogen of the air can be made available for nutrition—not indeed directly by green plants themselves, but, as Berthelot and Winogradsky more especially have shown, by Bacteria in the soil, or, as apparently in the Leguminosæ, by Bacteria actually enclosed in the roots of the plants with which they live symbiotically.

We now turn from the nutritive or anabolic processes to those which are catabolic. The discovery of the latter, just as of the former, was arrived at by the investigation of the gaseous interchange between the plant and the atmosphere. In the eighteenth century Scheele and Priestley had found that, under certain circumstances, plants deteriorate the quality of air; but it is to Ingen-Housz that we owe the discovery that plants, like animals, respire, taking in oxygen and giving off carbon dioxide. And when Sénébier (1800) had ascertained for the inflorescence of *Arum maculatum*, and later de Saussure (1822) for other flowers, that active respiration is associated with an evolution of heat, the connection between respiration and catabolism was established for plants as it had been long before by Lavoisier (1777) in the case of animals.

Among the catabolic processes which have been investigated none are of greater importance than those which are designated by the general term *fermentations*. The first of these to be discovered was the alcoholic fermentation of sugar. Towards the end of the seventeenth century Leeuwenhoek had detected minute globules in fermenting wort; and a century later Lavoisier had ascertained that the chemical process consists in the decomposition of sugar into alcohol and carbon dioxide; but it was not until 1837–38 that, almost simultaneously, Cagniard de Latour, Schwann and Kützing discovered that Leeuwenhoek's globules were living organisms, and were the cause of the fermentation. Shortly before, in 1833, Payen and Persoz extracted from malt a substance named *diastase*, which they found could convert the starch of the grain into sugar. These two classes of bodies, causing fermentative changes, were distinguished respectively as *organised* and *unorganised* ferments. The number of the former was rapidly added to by the investigation more especially of the Bacteria, in which Pasteur led the way. The extension of our knowledge of the unorganised ferments, or enzymes, has been even more remarkable; we now know that very many of the metabolic processes are effected by various enzymes, such as those which convert the more complex carbohydrates into others of simpler constitution (diastase, cytase, glucase, inulase, invertase); those which decompose glucosides (emulsin, myrosin, &c.); those which act on proteids (trypsins) and on fats (lipases); the oxidases, which cause the oxidation of various organic substances; and the zymase, recently extracted from yeast, which causes alcoholic fermentation.

The old distinction of the micro-organisms as "organised ferments" is no longer tenable; for, on the one hand, certain of the chemical changes which they effect can be traced to extractable enzymes which they produce; and, on the other, as Pasteur has asserted, every living cell may become an "organised ferment" under appropriate conditions. The distinction now to be drawn is between those processes which are due to enzymes and those directly effected by living protoplasm. Many now definitely included in the former class were, until lately, regarded as belonging to the latter; and no doubt future investigation will still further increase the number of the former at the expense of the latter.

The consideration of the metabolic processes leads naturally to that of the function of transpiration and of the means by which water and substances in solution are distributed in the plant. This is perhaps the department of physiology in which progress during the nineteenth century has been least marked. We have got rid, it is true, of the old idea of an ascending crude sap, and of a descending elaborated sap, but there have been no fundamental discoveries. With regard to transpiration itself, we know more of the detail of the process, but that is all that can be said. As for root-pressure, Hofmeister (1858–82) discovered that "bleeding"—as the phenomena of root-pressure were termed by the earlier writers—is not confined, as had hitherto been thought, to trees and shrubs; but the current theory of the process, allowing for the discovery of protoplasm and of osmosis, has advanced but little upon that given by Grew in the third book of his "Anatomy of Plants" (1675). Again, the mechanism of the transpiration-current in lofty trees remains an unsolved problem. To begin with, there is still some doubt as to the exact channel in which the current travels. Knight (1801–8) first proved that the current travels in the alburnum of the trunk, but not, he thought, in the vessels, for he found them to be dry in the summer, when transpiration is most active; a view in which Dutrochet (1837) subsequently concurred. Meyen (1838) then suggested that the water must travel, not in the lumina, but in the substance of the cells of the vessels, and was supported by such eminent physiologists as Hofmeister (1858), Unger (1864, 1868) and Sachs (1878); but it has since been strongly asserted by Boehm, Elfving, Vesque, Hartig and Strasburger that the young vessels always contain water, and that the current travels in the lumina and not in the walls of the vessels.

Now as to the force by which the water of the transpiration-current is raised from the roots to the topmost leaf of a lofty tree. From the point of view that the water travels in the substance of the walls the necessary force need not be great, and would be amply provided by the transpiration of the leaves, inasmuch as the weight of the water raised would be supported by the force of imbibition of the walls. From the point of view that the water travels in the lumina, the force required to raise and support such long columns of water must be considerable. Dismissing at once as quite inadequate such purely physical theories as those of capillarity and gas-pressure, there remain two theories as to the nature of this force which resemble each other in being essentially vitalistic, but differ in that the one involves pressure from below, the other suction from above. In the one, suggested by Godlewski and by Westermaier (1884), the cells of the medullary rays and of the wood-parenchyma are supposed to absorb liquid from the vascular tissue at one level and force it back again by a vital act at a higher level: this theory was disposed of by the fact that the transpiration-current can be maintained through a considerable length of a stem killed by heat or by poison. In the other, suggested by Dixon and Joly (1895–99), and also by Askenasy (1895–96), it is assumed that there are, in the trunk of a transpiring tree, continuous columns of water which are in a state of tensile stress, the tension being set up by the vital transpiratory activity of the leaves. Some idea of the enormous tension thus assumed is given by the following simple calculation relating to a tree 120 feet high. Not only has the liquid to be raised to this height, but in its passage upwards a resistance calculated to be equal to about five times the height of the tree has to be overcome. Hence the transpiration-force in such a tree must at least equal the weight of a column of water 720 feet in height; that is, a pressure of about twenty-four atmospheres, or 360 lb. to the square inch. But there is no evidence to prove that a tension of anything like twenty atmospheres exists, as a matter of fact, in a transpiring tree; on the contrary, such observations as exist (*e.g.* those of Hales and of Boehm) indicate much lower tensions. Under these circumstances we must regretfully confess that yet one more century has closed without bringing the solution of the secular problem of the ascent of the sap.

The nineteenth century has been, fortunately, rather more fertile in discovery concerning the movements and irritability of plants. But it is surprising how much knowledge on these points had been accumulated by the beginning of the century: the facts of plant-movement, such as the curvatures due to the action of light, the sleep-movements of leaves and flowers, the contact-movements of the leaves of the sensitives, were all familiar. The nineteenth century opened, then, with a considerable store of facts; but what was lacking was an interpretation of them; and whilst it has largely added to the store, its most important work has been done in the direction of explanation.

The first event of importance was the discovery by Knight, in 1806, of the fact that the stems and roots of plants are irritable to the action of gravity and respond to it by assuming definite directions of growth. Many years later the term "geotropism" was introduced by Frank (1868) to designate the phenomena of growth as affected by gravity, and at the same time Frank announced the important discovery that dorsiventral members, such as leaves, behave quite differently from radial members, such as stems and roots, in that they are diageotropic

It was a long time before the irritability of plants to the action of light was recognised. Chiefly on the authority of de Candolle (to whom we owe the term "heliotropism"), heliotropic curvature was accounted for by assuming that the one side received less light than the other, and therefore grew the more rapidly. But the researches of Sachs (1873) and Müller-Thurgau (1876) have made it clear that the direction of the incident rays is the important point, and that a radial stem, obliquely illuminated, is stimulated to curve until its long axis coincides with the incident rays. Moreover, the discovery by Knight (1812) of negative heliotropism in the tendrils of *Vitis* and *Ampelopsis* really put the Candollean theory quite out of court; and further evidence that heliotropic movements are a response to the stimulus of the incident rays of light is afforded by Frank's discovery of the diaheliotropism of dorsiventral members.

The question of the localisation of irritability has received a good deal of attention. The fact that the under surface of the pulvinus of *Mimosa pudica* is alone sensitive to contact was ascertained by Burnett and Mayo in 1827; and shortly after (1834) Curtis discovered the sensitiveness of the hairs on the upper surface of the leaf of *Dionaea*. After a long period of neglect the subject was taken up by Darwin. The irritability of tendrils to contact had been discovered by Mohl in 1827; but it was Darwin who ascertained, in 1865, that it is confined to the concavity near the tip. In 1875 Darwin found that the irritability of the tentacles of *Drosera* is localised in the terminal gland; and followed this up, in 1880, by asserting that the sensitiveness of the root is localised in the tip, which acts like a brain. This assertion led to a great deal of controversy, but the researches of Pfeffer and Czapek (1894) have finally established the correctness of Darwin's conclusion. It is interesting to recall that Erasmus Darwin had suggested the possible existence of a brain in plants in his "Phytologia" (1800). But the word "brain" is misleading, inasmuch as it might imply sensation and consciousness: it would be more accurate to speak of centres of ganglionic activity. However, the fact remains that there exist in plants irritable centres which not only receive stimuli but transmit impulses to those parts by which the consequent movement is effected. The transmission of stimuli has been found in the case of *Mimosa pudica* to be due to the propagation of a disturbance of hydrostatic equilibrium along a special tissue; in other cases, where the distance to be traversed is small, it is probably effected by means of that continuity of the protoplasm to which I have already alluded.

Finally, as regards the mechanism of these movements, we find Sénébier and Rudolphi, the earliest writers on the subject in the nineteenth century, asserting, as if against some accepted view, that there is no structure in a plant comparable with the muscle of an animal. Rudolphi (1807) suggested, as an alternative, that the position of a mobile leaf is determined by the "turgor vitalis" of the pulvinus, and thus anticipated the modern theory of the mechanism. But he gives no explanation of what he means by "turgor"; and the term is frequently used by writers in the first half of the century in the same vague way. Some progress was made in consequence of the discovery of osmosis by Dutrochet (1828), and more especially by his observation (1837) that the movements of *Mimosa* are dependent on the presence of oxygen, and are therefore vital. But it was not, and could not be, until the existence of living protoplasm in the cells of plants was realised, and the movements of free-swimming organisms and naked reproductive cells had become more familiar, that the true nature of the mechanism began to be understood; and then we find Cohn saying, as long ago as 1860, that "the living protoplasmic substance is the essentially contractile portion of the cell." This statement may, perhaps, seem to put the case too bluntly, and to savour too much of animal analogy; but the study of the conditions of turgidity has shown more and more clearly that the protoplasm is the predominant factor. The protoplasm of plant-cells is undoubtedly capable of rapid molecular changes, which alter its physical properties, more particularly its permeability to the cell-sap. It may be that these changes cannot be directly compared with those going on in animal muscle; but if we use the term "contractility" in its wider sense, as indicating a general property of which muscular contraction is a special case, then Cohn's statement is fully justified. This is borne out by the observations of Sir J. Burdon-Sanderson (1882–88) on the electrical changes taking place in the stimulated leaf of *Dionaea*, and by Kunkel's (1878) corresponding observations on *Mimosa pudica*: in both cases the electrical changes were found to be essentially the same as those observable on the stimulation of muscle. We find, then, that the advances in Physiology, like those in Anatomy, teach the essential unity of life in all living things, whether we call them animals or plants.

With this in our minds we may go on to consider in conclusion, and very briefly, that department of physiological study which is known as the Bionomics of Œcology of plants. In the earlier part of the century this subject was studied more especially with regard to the distribution of plants, and their relation to soil and climate; but since the publication of the "Origin of Species" the purview has been greatly extended. It then became necessary to study the relation of plants, not only to inorganic conditions, but to each other and to animals; in a word, to study all the adaptations of the plant with reference to the struggle for existence. The result has been the accumulation of a vast amount of most interesting information. For instance, we are now fairly well acquainted with the adaptations of water-plants (hydrophytes) on the one hand, and of desert-plants (xerophytes) on the other; with the adaptations of shade-plants and of those growing in full sun, especially as regards the protection of the chlorophyll. We have learned a great deal as to the relations of plants to each other, such as the peculiarities of parasites, epiphytes and climbing plants, and as to those singular symbioses (Mycorhiza) of the higher plants with Fungi which have been found to be characteristic of saprophytes. Then, again, as to the relations between plants and animals: the adaptation of flowers to attract the visits of insects, first discovered by Sprengel (1793), has been widely studied; the protection of the plant against the attacks of animals, by means of thorns and spines on the surface, as also by the formation in its tissues of poisonous or distasteful substances, and even by the hiring of an army of mercenaries in the form of ants, has been elucidated; and finally those cases in which the plant turns the tables upon the animal, and captures and digests him, are now fully understood.

Conclusion.

Imperfect as is the sketch which I have now completed, it will, I think, suffice to show how remarkable has been the progress of the science during the nineteenth century, more particularly the latter part of it, and how multifarious are the directions in which it has developed. In fact Botany can no longer be regarded as a single science; it has grown and branched into a congeries of sciences. And as we botanists regard with complacency the flourishing condition of the science whose servants we are, let us not forget, on the one hand, to do honour to those whose life work it was to make the way straight for us, and whose conquests have become our peaceful possession; nor, on the other, that it lies with us so to carry on the good work that when this Section meets a hundred years hence it may be found that the achievements of the twentieth century do not lag behind those of the nineteenth.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

As was explained at length in our issue of March 22, in accordance with the new statutes of the University of London, a reconstituted Senate is to be elected shortly. The new Senate will be composed of the Chancellor, the Chairman of Convocation and fifty-four Senators, of whom sixteen are to be elected by Convocation. These sixteen members of the Senate will have, it would appear from the statutes, two distinct functions. They will, in addition to their general duties as senators, be required to form a special council for external students. This council, which is to consist of twenty-eight members of the Senate, will include the chancellor, the vice-chancellor, the chairman of Convocation, the sixteen senators elected by Convocation, and nine other members of the Senate elected by the Senate. Members of Convocation will, in a few days, proceed to choose their sixteen representatives; and, not unnaturally, there is considerable diversity of opinion as to the suitability of the nominated candidates. Two rival associations have sprung up. One body of graduates insists that the duties to be performed upon the council for external students should be considered of paramount importance in electing senators; the other, that their responsibilities as members of the Senate should be kept continually in view, because the work of the new University as a whole, but more especially the development of its teaching facilities, is of the most pressing nature. While admitting the necessity of safe-guarding the interests of the external student, and of ensuring the high value of the degrees of the University, it is desirable that every possible means of improving the higher education of London should receive primary consideration. It would be nothing less than a calamity were Convocation to elect sixteen irreconcilables with no ideas outside that of introducing the peculiar, though somewhat circumscribed, needs of the external student into all deliberations of the Senate. It is therefore to be hoped that the common-sense which attended the election of their representative in Parliament will characterise the selection of the sixteen senators chosen by Convocation. It is easily possible to find members of the University who, while fully aware of the needs, and in sympathy with the aims of the external student, have also broad views as to the work of a great teaching University.

DR. A. P. LAURIE, lecturer in physics and chemistry at St. Mary's Hospital Medical School, has been appointed principal of the Heriot Watt College, Edinburgh.

DR. SPENCER W. RICHARDSON, lecturer on physics at the University College, Nottingham, has been appointed principal and professor of physics at the Hartley College, Southampton.

THE Birkbeck Institution, London, which has now completed seventy-seven years of educational work in the metropolis, commences its new session on Monday, October 1. The Institution has had many additions to its appliances in recent years, and the physical, chemical and metallurgical laboratories are now very thoroughly equipped. The day classes provide courses in chemistry, biology, physics and mathematics for the science degrees of London University. During the recess considerable additions and improvements have been made by the aid of a gift of 2000 guineas from Mr. F. Ravenscroft, to commemorate his completion of a membership of fifty years.

ADDRESSES will be given at the opening of many of the metropolitan and provincial medical schools at the beginning of October. At Middlesex Hospital on October 1, Dr. T. Clifford Allbutt, F.R.S., will distribute the prizes gained during the previous year and deliver an address. At St. George's Hospital the introductory address will be delivered by Dr. Francis G. Penrose. At University College the session of the faculty of medicine will be opened by Prof. G. Vivian Poore; the session of the faculty of arts and laws, and of science, will be opened with an address by Prof. F. W. Oliver on October 2. At St. Mary's Hospital the introductory address will be given by Mr. H. S. Collier. At St. Thomas's Hospital the session will open on Tuesday, October 2, when the prizes will be distributed by Sir William MacCormac. At the opening of the session at Charing Cross Hospital on October 2, Lord Lister will deliver the third biennial Huxley Lecture. The London School of Tropical Medicine will open on October 1, and the introductory address will be delivered by Sir William MacGregor, K.C.M.G., C.B., on Wednesday, October 3. At the London School of Medicine for Women the introductory address will be given on October 1 by Miss Aldrich Blake, M.S., M.D., after which the prizes for the past year will be distributed. At the Royal Veterinary College the introductory address will be delivered by Prof. McFadyean. The winter session at the University of Birmingham will begin on October 1 with an address by Prof. B. C. A. Windle. At University College of South Wales and Monmouthshire, Cardiff, the address will be delivered on October 1 by Sir John Williams. At University College, Liverpool, the Bishop of Liverpool will deliver an address on October 13 and distribute the prizes.

A SUMMARY of the scheme of work carried on by the Essex Technical Instruction Committee for the promotion of interest in the science of agriculture and other branches of knowledge bearing upon rural industries, has been prepared by Messrs. T. S. Dymond and J. H. Nicholas. The work is in every respect satisfactory, and should do much to broaden the views of the practical farmers of the county as to the value of agricultural education and experiment. Every year an educational excursion extending over several days is organised, the one this year being to Denmark to study dairy farms and dairying, high school and agricultural education, co-operation and organisation of agricultural industry there. Field experiments are carried out by arrangement with farmers distributed in all parts of the county, the advantage being that as demonstrations of the effect of manures, &c., they receive wider attention, and also that the experiments can be made on each of the different classes of land occurring in the county. Meetings of farmers are held in the experimental fields in each district at the season most suitable for studying the results of the experiments. The County Technical Laboratories at Chelmsford are now recognised as a centre from which information upon agricultural matters can be obtained. The advice of the staff is frequently sought on insect and fungoid pests, on difficulties met with in the dairy, &c., and their opinion asked on the value of foods and of fertilisers, and the best manurial treatment of land. As occasion arises, inquiries are undertaken on matters of agricultural importance, such as the chemical and physical effect of the salt water inundation upon agricultural land on the coast of Essex, and the best method for its amelioration. The agricultural work of the Essex Technical Instruction Committee is thus of the same character as that carried on by the Government

Agricultural Experiment Stations in the United States and elsewhere.

THIS is the time of year when prospectuses and calendars of Technical Colleges, Schools, and Institutes are received from various parts of the country in such numbers that it is impossible to do justice to them in a short note. Several publications of this character recently received must, however, be mentioned. The Northampton Institute, Clerkenwell, the principal of which is Dr. R. M. Walmsley, has greatly developed, and has commenced a set of day courses in mechanical engineering, electrical engineering and horological engineering. These courses have already been announced in NATURE, and their scope described. Other changes tending to the greater efficiency of the Institute have been introduced. A noteworthy point is that in many parts of the prospectus notes are given which should be of real value in making students understand what true education means, and in directing their energies in proper channels. The notes are in complete accord with rational methods of instruction.

THE Merchant Venturers' Technical College at Bristol has for many years been prominent among the the technical schools of the country. It aims at providing a sound, continuous, and complete preparation for an industrial career, and has developed with the times. Among recent improvements mentioned in the calendar we notice that a much larger physical laboratory has been equipped and will be opened this session, and also an additional special laboratory for heat and mechanical physics.

THE prospectus of the Municipal Science, Art and Technical Schools of Devonport has been received. Remembering the tendency of students to skim over many subjects, instead of concentrating their attention on a few, we are glad to see among the regulations of the school the following note:—"Students are strongly advised not to attempt more than three subjects, one of which should be practical geometry or mathematics, and they should consult the teacher as to the course of study most suitable to their profession."

THE Municipal Technical School of Manchester is one of the finest in the country, and its syllabus for the session 1900–1901 is proportionally attractive. The following extract from the syllabus shows the relation of the work of the school to that of a University College. "The chief object of the school is to provide instruction in the principles of those sciences which bear directly or indirectly upon our trades and industries, and to show by experiment how these principles may be applied to their advancement. The aim of the school is distinct from that of the University Colleges, inasmuch as it is designed to teach science solely with a view to its industrial and commercial applications, and not for the purpose of educating professional scientific men. It, however, offers to students of the University Colleges the opportunity of technical instruction in the industrial applications of certain branches of science."

THE Calendar of the Royal Technical Institute, Salford, contains much good advice to students, and many sound remarks upon objects and methods of study. In the day classes of the Institute, the number of hours per week allotted to each subject in the first year is as follows:—mathematics 6; general physics (including mechanics) 4; practical physics 3; electricity (theoretical) 2; electricity (practical) 2; theoretical chemistry 2; practical chemistry 3; practical, plane and solid geometry 2½; drawing (freehand, model, &c.) 3; workshop practice 2; English and French 4; total 33½. The second and third years' courses become more specialised according to the department which the student proposes to enter. There is no compulsory course of instruction for evening students. Students are free to select those classes which will help them to make progress in their particular trade or business. They are warned, however, against strictly confining themselves to such classes; it is pointed out that if they desire to gain a thoroughly sound knowledge in technical subjects, the study of them should be preceded by several of the pure and applied sciences. Thus, for example, little real progress can be made in applied mechanics without a knowledge of theoretical mechanics: or in machine or building construction without geometry; and unless the student undergoes systematic instruction in mensuration, arithmetic and mathematics, he will derive very little benefit from such subjects as steam, machine design, physics, &c. Mathematics has been aptly termed the alphabet of science, and students should not fail to acquire mathematical knowledge if they wish to make satisfactory progress in science and technology. The work of an Institute inspired with this spirit cannot fail to be of value.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 17.—M. Maurice Lévy in the chair.—Remarks relating to the decomposition of nitric esters and of nitroglycerine by alkalis, and on the relative stability of explosive materials, by M. Berthelot. In certain cases, instead of the production of the alcohol and nitrate as in the normal reaction, an aldehyde is formed, together with some nitrite. The results of M. Leo Vignon upon the nitrocelluloses confirm these views.—On the nomographic resolution of the equation of the seventh degree, by M. Maurice d'Ocagne.—On the deformations of contact of elastic bodies, by M. A. Lafay. Spheres of bronze and steel were studied and the amount of compression under varying loads measured by optical arrangements analogous to the Fizeau apparatus for the measurement of the expansion of crystals. The application of the theory developed by Hertz showed differences between the calculated and observed values which increased with the radius of the sphere. Since this divergence might possibly be due to the mutual friction of the surfaces in contact, experiments were made with oiled spheres, but the results were not affected by the lubrication.—Action of iodine and yellow oxide of mercury upon styrolene and safrol, by M. J. Bougault. Styrolene with iodine and mercuric oxide yielded an addition product, not obtainable pure, but apparently $C_6H_5 \cdot CHI \cdot CH_2 \cdot OH$, from which phenylacetic aldehyde was obtained by the action of silver nitrate. Safrol gives a similar addition product, but no aldehyde could be obtained from this by the action of silver nitrate.—On the reduction of the nitrocelluloses, by M. Leo Vignon. It has been shown in a previous paper that the nitration of cellulose yields, not nitrocelluloses, but nitro-oxycellulose containing an aldehyde group. With ferrous chloride, these bodies are reduced, the nitro-group being eliminated but the aldehyde group left intact. With ammonium sulphide, the reduction takes place in a different manner, cellulose or hydrocellulose being produced, substances without reducing action.

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