THURSDAY, OCTOBER 13, 1904.

ŒCOLOGICAL PLANT-GEOGRAPHY.

Plant-Geography upon a Physiological Basis. By Dr. A. F. W. Schimper. Translated by W. R. Fisher, B.A. Revised and edited by Percy Groom, M.A., D.Sc., F.L.S., and I. Bayley Balfour, M.A., M.D., F.R.S. Pp. xxx+839. (Oxford: University Press, 1903.) Price 42*s.* net.

WE welcome most heartily the appearance of this translation of Schimper's great work, "Pflanzen-Geographie auf physiologischer Grundlage," and the more so as it stands alone in being the only comprehensive work on œcological plant-geography in the English language.

The beginnings and gradual development of the study of œcology may be traced during the course of the last century in the writings of Humboldt, the De Candolles, Darwin, Grisebach, Drude, Kerner, Engler, and others. A new phase was marked by the appearance in 1896 of Warming's "Lehrbuch der ökologischen Pflanzen-Geographie" (the original Danish edition was published in 1895), and in 1898 of the larger work of Schimper. The latter, which forms the subject of this notice, possesses a wealth of well chosen illustrations absent from the text-book of Warming. But even these later works are, in spite of the undoubted advance which they mark, to be regarded largely as pioneers, for, to quote from the author's preface to the book before us:—

"A satisfactory general survey of œcological plant-distribution cannot be attempted with the material at present available. This book is therefore chiefly of a tentative nature, and attempts by a precise statement of pending questions to stimulate further research."

The work is divided into three parts. In the first (pp. 1–156) the various factors affecting plant-life are considered. The second (pp. 159–206) discusses the arrangement of vegetation into "formations" and "guilds"; while the third and largest part (pp. 209–839) is less general, and is largely occupied with a description of the vegetation of the zones and regions, thermal and other, into which the surface of the earth may be divided.

At the outset the author emphasises the fact that "the characteristics of organisms are physiological," and this application of the principles of physiology to the problems of morphology and distribution forms the idea underlying the whole of the book.

In addition to the generally accepted classes of "hygrophytes" and "xerophytes," Schimper recognises a third or intermediate type, which he calls "tropophytes." Under the latter term are included "all plants whose conditions of life are, according to the seasons of the year, alternately those of hygrophytes and xerophytes." Good examples of this class are our deciduous trees; these possess hygrophilous leaves, which are shed periodically, while the axes and buds, which alone are called upon to endure the "physiologically dry" conditions of winter, are distinctly xerophilous in character. Warming's class of "mesophytes," or plants adapted to medium conditions as regards moisture, was a convenient one, but the term "tropophytes" is to be preferred, as it directs attention to the physiological significance of many adaptations correlated with an alternation of wet and either dry or cold seasons.

Just as humidity is the dominant factor in determining the form of plants, so temperature plays the most important part in their distribution. The œcological importance of light, in spite of its powerful influence on the form and life of plants, is, according to the author, less than that of heat and rainfall, because the amount of light in different climatic regions is less variable than is the supply of the other two factors.

The remaining chapters of part i. are devoted to a discussion of the air, the soil, and animals as œcological factors.

In part ii., under the heading of "Formations and Guilds," the conditions which determine the differentiation of the earth's vegetation are dealt with. According to Schimper there are three controlling factors—the type of "vegetation" in the tropical and temperate zones is determined by the climatic humidity; the type of the "flora," especially as regards the larger systematic groups, is, so far at least as existing factors are concerned, dependent primarily on heat; while "the soil as a rule merely picks out and blends the material supplied by these two climatic factors, and on its own account adds a few details."

Two œcological groups of "formations" are distinguished:—(1) "climatic or district formations, the character of whose vegetation is governed by atmospheric precipitations"—these include three main types, woodland, grassland, and deserts—and (2) "edaphic or local formations, whose vegetation is chiefly determined by the nature of the soil"; such edaphic formations are moors, swamps, sand-dunes, &c. This grouping is an excellent one, but some will regret the use by the author of the term "formations"; admittedly it is difficult of definition, but as used here the term is unnecessarily wide, and includes groups of very unequal value. Another objection to its use is the fact that it has been employed by different authors in a variety of senses. Perhaps it would have been better to have followed the usage of Warming in the work cited above, and applied the term "vegetation" to the larger groups such as woodland, grassland, &c.; while for the smaller local ones, which are characterised by the presence of one or more dominant species, "plant-associations" ("Pflanzenvereine") could perhaps have hardly been improved upon.

Part iii. contains a masterly description of the vegetation of the globe from the œcological point of view. The primary division is into "zones," dependent on temperature, *i.e.* tropical, temperate, and arctic, and these occupy respectively the first three of the five sections which make up this part of the work. Each section begins with a general discussion of the characters of the climate of the particular zone under consideration, and stress is laid on the fact that periodic phenomena, or alternations of rest and activity in the functions of plants, occur as generally, though less obviously, in tropical as in temperate climates. Some

200 pages, or nearly a quarter of the whole work, are occupied by an excellent account of the tropical zones. Much of the recent advance in our knowledge of these regions is due to the establishment in the tropics of such botanical laboratories as those of Buitenzorg and Peradeniya: a research laboratory has also been recently established in the temperate desert regions of Arizona, and it is much to be hoped that the author's wish for the foundation of a similar institution in the arctic zone may ere long be realised.

The concluding sections of the book are devoted to a discussion of mountain and aquatic vegetation.

To sum up, the work is a thoroughly scientific exposition of our present knowledge of the factors which control the distribution of plants, and though the book in no sense expresses finality, yet, to quote from the editors' preface to the English edition, "its 'precise statement of pending questions' should not only 'stimulate research,' as the author hoped, but should also have a steadying influence in a field of investigation which tempts to trifling."

The usefulness of the book is greatly enhanced by the illustrations, which are admirably reproduced, and form, perhaps, its most striking feature; and also by the presence of numerous meteorological and other tables, and of a bibliography at the close of each chapter.

For the rest, the translator and the editors are to be congratulated on the successful completion of their task, which adds another standard work to the useful and important series of translations issued by the Clarendon Press.

To the contents of the original German edition have been added an "appreciation" by Prof. Percy Groom, which gives an interesting sketch of the life and work of the late Prof. A. F. W. Schimper; and a frontispiece, consisting of a photogravure portrait of the author, whose "untimely death," to quote once more from the editors' preface, "has robbed the English edition of modifications and improvements which he had intended to make." R. H. Y.

THE COMPARATIVE HISTOLOGY OF VERTEBRATES.

Lehrbuch der vergleichenden mikroscopischen Anatomie der Wirbeltiere. Herausgegeben von Prof. Albert Oppel. Vierter Teil. Ausführapparat und anhangsdrüsen der mannlichen Geschlechtsorgane. By Prof. Rudolph Disselhorst. Pp. x+432. (Jena: Gustav Fischer, 1904.) Price 20 marks.

IT is now nearly eight years since the appearance of the first volume of the "Lehrbuch der vergleichenden mikroscopischen Anatomie der Wirbeltiere." In the preface to that volume Prof. Oppel gave an account of the general scope and object of the work, which was to provide a comparative description of the minute anatomy of every organ of the body throughout the entire vertebrate series. Vol. i., which deals with the histology of the stomach and is unequalled for its wealth of detailed information, was followed in the next year by a second part, giving an account of the œsophagus and intestine, while in 1900 the third volume, which is devoted to the consideration of the mouth, pancreas, and liver, and concludes the description of the alimentary tract, was issued. These three very elaborate volumes are from the pen of the editor. But at the outset it was obvious that the task was too gigantic for one man alone, and Prof. Oppel in the preface to the original volume refers to the almost certain necessity of obtaining collaboration. Thus the preparation of the fourth part—the one under review—which deals with the accessory glands and ducts of the male reproductive system, was entrusted to Prof. Disselhorst, and of this volume it is high praise to say that it maintains the level of achievement reached by its predecessors.

The book is divided into seventeen sections, and of these the first fifteen deal with the minute anatomy of the organs, each section being devoted to a particular group or order of the vertebrate phylum. Thus the first two sections contain accounts of the accessory ducts and glands in the two main divisions of the pisces; the third, fourth, and fifth deal respectively with these structures in the amphibians, reptiles, and birds, while the following ten sections comprise descriptions of the same organs in the chief groups of the mammalia. The last two sections consist respectively of a condensed summary of the previous part of the volume and a short sketch of the history of the subject, to which are appended some notes on the physiology of the structures described.

A work like the present is necessarily of the nature of a compilation. Thus there occur frequent references to such books as Oudemans's "Die accessorischen Geschlechtsdrüsen der Säugetiere," and to Prof. Disselhorst's own work on the same subject. The references on the whole are extremely full, but it is inevitable that there should be some omissions. For instance, I find no mention of Dr. Nicolas's "Contribution à l'Étude des Organes érectiles," published in the *Journal de l'Anatomie et la Physiologie* (1887), neither is Garrod's paper entitled "Notes on the Osteology and Visceral Anatomy of Ruminants" (*P.Z.S.*, 1877) referred to, in spite of the fact that it contains the best and indeed practically the only comparative account of the curious modifications undergone by the copulatory organ in the Ruminantia. Perhaps it is hardly reasonable to expect a complete series of references to papers dealing mainly with the anatomy of animals in a book professedly devoted to histology, yet the titles of a great number of less important papers treating in many cases of single species duly appear in the bibliographical lists. It cannot be said, however, that omissions such as those mentioned detract seriously from the value of the book as a whole. It is to be noted that the lists of references, instead of forming one long bibliography at the end of the book, as in the previous parts of the work, in this volume are appended to the various sections, so that the titles of papers referring to any one particular group occur together. The book is copiously illustrated by zincographs and by reproductions from photo. process blocks. In addition to the 435 figures appearing in the text, the chapter on the monotremes and marsupials, which is perhaps the most interesting

and at the same time the most complete, is further illustrated by seven large folding lithographed plates. These are bound at the end of the volume.

Suffice it to say that this piece of work is a matter for congratulation to Prof. Disselhorst, and its publication a credit to all concerned.

FRANCIS H. A. MARSHALL.

SPECTRUM ANALYSIS.

An Introduction to the Study of Spectrum Analysis. By W. Marshall Watts, D.Sc., F.I.C. Pp. vii+325. (London: Longmans, Green and Co., 1904.) Price 10*s.* 6*d.* net.

IT is somewhat remarkable that, in spite of the great interest and importance of the subject, there are few, if any, text-books on spectrum analysis which really meet the requirements of beginners who desire to take up the matter practically. The announcement of an introductory work by the well-known compiler of the "Index of Spectra," however, led to the hope that this gap in the literature of the spectroscope would at last be adequately filled, but it is disappointing to find that the needs of the practical student are again almost disregarded.

The book includes a brief account of the optical principles underlying the different forms of spectroscope, and general explanations of the methods of producing and mapping spectra, besides which there are short statements relating to the arrangement of lines in series, and the applications of the spectroscope to the study of the heavenly bodies. When it is stated that nearly half the book is occupied by wave-length tables, and that there are 135 illustrations—many of them large ones—it will be seen that the general treatment can scarcely be otherwise than sketchy. The descriptions of the modes of procedure are consequently often lacking in details which would have been of the greatest use to the student. Thus, with reference to the spectra of gases, the only method of observation indicated is that of a ready-made Geissler tube, which, as the author remarks, does not always show the spectrum of the gas present in the greatest proportion; it would have been useful to explain how the student might examine the spectrum of a gas collected or prepared by himself. Later on, there is a short account of stellar spectra, but no directions whatever as to how such a spectrum may be observed.

Another very serious defect from the student's point of view is the use of the arbitrary scale of Bunsen in the maps and earlier descriptions of the characteristic lines of the different elements. It is afterwards shown how such measurements may be reduced to wave-lengths, but surely it would have been better to define the various lines by their wave-lengths from the very beginning; as it stands, a great deal of unnecessary labour is involved in the comparison of the descriptions and maps with the wave-length tables given at the end of the book.

The book, in fact, leaves a great deal to be desired, whether considered as a laboratory guide or as a descriptive work. Many important facts are left unnoticed, though space might have been found for some of them by the omission of superfluous or insufficiently described illustrations. In the section on nebulæ, for instance, there are no less than eight diagrams showing the telescopic appearances of these objects, but no reference to the fact that all nebulæ do not exhibit bright line spectra; the reader is, moreover, likely to get the wrong impression that the chief nebular line is due to nitrogen.

Though brought well up to date in some respects, the book is far behind the times in others. It is erroneously stated (p. 106) that the spectrum of the solar corona includes lines of helium, hydrogen, and calcium, and the important subject of enhanced lines in relation to many celestial spectra is overlooked altogether.

Many other examples of the shortcomings to which attention has been drawn might be given, but the above will sufficiently indicate that the selection of material has not been judiciously made. By far the most valuable feature of the book is the series of abridged tables of wave-lengths, showing the more important lines in the spectra of nearly all the known chemical elements.

OUR BOOK SHELF.

Text-books of Physical Chemistry.—Electrochemistry. Part i. General Theory. By R. A. Lehfeldt, D.Sc. Pp. viii+268. (London: Longmans, Green and Co., 1904.) Price 5*s.*

STUDENTS of physical chemistry have to-day no cause to complain of a dearth of books upon the subject. There are a considerable number of large volumes treating of this branch, and now we have the series of text-books edited by Sir William Ramsay. The book under review is the second of the series, and has been entrusted to Dr. Lehfeldt, who is well known as a worker on the physical side of electrochemistry.

Dr. Lehfeldt has not followed any hard or fast line laid down by previous writers upon the subject, and for this reason the book may be read with more than ordinary interest. The book is divided into three chapters, which might perhaps better be designated parts i., ii., and iii. Chapter ii. is written by Mr. T. S. Moore, and deals with the relation of chemical constitution to conductivity. This chapter is very carefully thought out and arranged, and the author has consulted the latest literature. It deals, in the first place, with the relation of charge carried to constitution, this portion being really a repetition and enlargement of what has already been dealt with in the previous chapter. In fact, chapter ii. is to a certain extent an addendum to the first chapter, but it should in no wise be skipped by the student who desires to comprehend the bearing of electrochemistry on chemical problems. Other points treated in this chapter are relation of the number of ions in solution to constitution, pseudo acids and bases, amphoteric electrolytes, and so on.

Chapter i. commences with a description of certain voltameters. We would rather that the author had adopted the term coulommeter, because the instruments are for measuring current and not potential.

although, of course, the author is only using the term commonly applied to these instruments.

Dr. Lehfeldt then discusses the mechanism of electrolytes. We are not sure what a certain school of chemists will say to the following rather didactic statement:—

"It was Arrhenius who first put forward reasons for supposing that an electrolyte might be largely, . . . dissociated in solution . . . this view has gradually gained support from experiment since, and may be looked upon as thoroughly established."

Dr. Kahlenberg, for instance, would hardly subscribe to this statement. In this chapter the author also deals, among other subjects, with the conductivity of the electrolyte, ionic velocities, and electrolysis in non-aqueous solutions.

The last chapter is devoted to the theory of chemico-electromotive force. The section on thermodynamic theory and the calculation of electromotive force of a voltaic cell well repays perusal, as does the section on standard cells.

Dr. Lehfeldt is thoroughly at home with his subject; we are not, however, sure whether the average student will find the style very interesting. Of course, a book of this kind cannot be read in a cursory way; if it could, we doubt whether it would be worth reading, but we are of the opinion that it will be welcomed by all interested in the subject.

Traces of the Norse Mythology in the Isle of Man. By P. M. C. Kermode. Pp. 30. (London: Bemrose and Sons, Ltd., 1904.) Price 2*s.* 6*d.*

In this work Mr. Kermode, whose name is well known in connection with Manx archæology, has printed a lecture delivered to the Antiquarian Society of his native island in December of last year. The Isle of Man contains a large number of cross-bearing gravestones, which, as the inscriptions clearly show, belong to the period when the Scandinavian element was predominant in the island. It is not improbable that in some cases the symbols on these stones may refer to the old Scandinavian mythology rather than to Christian belief and legend, and Mr. Kermode has endeavoured to determine how far this is the case. After a very brief sketch of the Scandinavian settlements in the west, and more especially in Man, a short account is given of some leading details of the old Norse mythology as preserved in the Eddas. Both here and in the following section an interest in the subject is sometimes more evident than familiarity with it in all its bearings. It is, for example, quite erroneous to state that "of the seven days of the week all but the first two are called after Scandinavian gods." Even on his own lines, Mr. Kermode cannot thus account for *Saturday*, and a closer study of the old English forms would have shown him the true origin of the other names. The influence of the Scandinavian tongues on English has been very great, but it requires a close study of philology to decide the particular cases in which it appears.

The concluding section consists of a detailed description of the illustrations, under eight heads, and with references to the ten plates at the end of the booklet. These are neatly executed, and exhibit typical specimens of Celtic crosses and ornamentation, as well as the symbolic figures which Mr. Kermode believes to represent subjects taken from the old mythology. In many cases the explanation he offers is extremely doubtful, as there is always an equal, if not greater, possibility that the symbols are of Christian origin. Thus, what Mr. Kermode takes to be an eagle (=Suttung) pursuing a falcon (=Odin), might equally well, for all one can see, represent Noah's raven and dove. The harper whom he identifies with the "gladsome Eggthér" of *Völuspá* may just as well be King David; and if the fish is a Christian symbol on Plate X., why not also on Plate III.? In many of these cases it is probably hopeless to determine what the sculptor had in his mind, and there is no particular gain in making guesses at it.

In minor points there is not always as much precision as is desirable. The Icelandic words and names are too frequently misprinted, while such equations as *Hnikarr* and *nykr*, *Rig* and *Eirlk*, are evidence of shaky philology. Mr. Kermode's lecture, however, may be of service in helping to waken or encourage interest in that Scandinavian influence on Britain which is an important factor in the history of our country. W. A. Craigie.

Eton Nature-study and Observational Lessons. Part ii. By M. D. Hill and W. M. Webb. Pp. xvi+174. (London: Duckworth and Co., 1904.) Price 3*s.* 6*d.* net.

Part ii. of this book, like part i., is excellent. That nature-study as here recommended is educationally sound is beyond dispute. What makes instruction so wearisome to the learner is often, to put it plainly, the unceasing sound of the schoolmaster's voice. What a boy, if he has any go in him, wants, is to do something for himself. It would be best if he could make out everything unaided. "I never tell my pupils anything," once said a mathematician devoted to the maieutic method; and Hesiod quaintly remarks, "The best man of all is he who finds out everything for himself." But this is hardly possible for us moderns, and the authors of this book are wise enough not to make a craze of a sound principle. In the chapters, to take examples, on earthworms, woodlice, the defensive armour of plants, and plants that have no flower, there is plenty of information given to stimulate interest. If the pupil is the right kind of boy, he will be keen to follow some of the lines of investigation pointed out. Many persons are led to the out-of-doors study of natural history by reading. They want to see some of the wonderful things that naturalists have seen, not always to get them at second hand. Indeed, the importance of reading in connection with observation should be insisted on. Many boys, though full of zeal, never get beyond a very restricted field in natural history, because they will not read in order to discover how the little that they have learnt by the use of their own eyes finds its place in the vast accumulation of knowledge. The observer should be a reader, and the reader an observer.

A great deal may be learnt by trying the experiments recommended in this book, *e.g.* by hatching trout eggs, by keeping a fresh-water aquarium or an observatory hive of bees, by making a formicarium, by photographing such things as birds and birds' nests. But here a difficulty arises. At school, how is a boy to keep an observatory hive of bees or to hatch trout eggs? In fact, some of the suggestions bring out sadly the limitations of school life. Others, no doubt, are quite possible. But headmasters might well study a book like this. If teaching is to proceed on a truer and more natural plan than hitherto, something must be done to remove existing restrictions.

The subjects for observation (*e.g.* a frog's egg, a hen's egg, the development of tadpole and chick, a silk worm, an opening flower) are well chosen. The illustrations are all good. Some of the photographs ought to induce boys to make their photography a help to accurate observation instead of a mere amusement.

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.*]

The Forest-pig of Central Africa.

IT may interest many of your readers to know that the "forest-pig" heard of, at the same time as the okapi, by Sir Henry Stanley, and later on by Sir Harry Johnston, has at last been obtained and presented to the National Museum by Mr. R. Meinertzhagen.

This gentleman first had news of it from the natives of Mount Kenya, and took great pains to secure a specimen, but only succeeded in obtaining pieces of skin, from which no idea of its affinities could be gathered. At last, however, in the Nandi Forest, near the Victoria Nyanza, at an altitude of 7000 feet, he received two skulls, one quite perfect, and some further portions of skin.

These trophies show that the animal represents a most interesting new genus connecting the aberrant wart-hog (Phacochærus) with the more ordinary Suidæ, such as Sus and Potamochærus. It agrees with the first named in the number of its incisors, and shows a tendency towards it in the development of the canines and the structure of the molars. On the other hand, in the general proportions of the skull it is more like Sus.

Altogether, if it cannot be called absolutely ancestral to Phacochærus, it must at least be looked upon as representing an early stage in the specialisation of that most remarkable type.

The animal itself is about as large as a wart-hog, and is well covered with long coarse black hair.

It is proposed to be called *Hylochoerus meinertzhageni*, and I hope to give a full description of it at an early meeting of the Zoological Society.

OLDFIELD THOMAS.

British Museum (Natural History), October 7.

Appeal for Cooperation in Magnetic and Allied Observations during the Total Solar Eclipse of August 29–30, 1905.

THOSE who are in a position to take part in the above cooperative work are earnestly requested to make the necessary preparations and to put themselves in communication with the undersigned.

As this will be the best opportunity for some time to come to test and observe further the magnetic and electric phenomena which have been found to occur in connection with total solar eclipses, and as these phenomena are destined to play an important *rôle* in the theory of those variations of the earth's magnetism and electricity ascribed to outside forces, it is very much hoped that all countries through which or near which the belt of totality passes will organise and send in the field observing parties.

Owing to the minuteness of the expected magnetic effect, the burden of proof as to its association with the eclipse will largely consist, as in the two previous eclipses, in the connection of the times of the magnetic effects with the times of passage of the shadow cone at the various stations. The observing parties, therefore, should be distributed at intervals along as much of the entire belt as possible.

The above is merely a preliminary notification of the work proposed. Fuller details and suggested directions to be followed will be given later. L. A. BAUER.

Department of Terrestrial Magnetism, The Ontario, Washington, D.C., U.S.A.

Instinct and Reason in Dogs.

THE following statements may be of interest to those of your readers who have at times discussed the question of instinct and reason in dogs.

A friend of mine was in a strange town, having with him an Irish terrier. Finding it necessary to fasten the dog up outside a house, he did so by tying it with a piece of cord. On coming out of the house he was just in time to see his own dog being led away by a strange dog holding the cord in his mouth, having bitten it through. My friend often takes this same terrier, together with a fox terrier, out with him when calling. He ties the fox terrier by a cord to the scraper; as often as not the Irish terrier bites through the cord and frees his friend.

My own fox terrier seldom if ever goes to the stables, and whilst I am absent from home for a few days remains in his usual place; but almost invariably on the day when I am expected back he pays frequent visits to the stable, and is anxious to go with the carriage if he sees it being got ready; at all other times he is not willing to go with the carriage unless I am in it. On the two last occasions when I was expected home the dog acted as previously, but, in addition, jumped into the carriage as soon as it was brought out of the coach-house, a thing which he has never done before. E. W. P.

October 8.

Misuse of Words and Phrases.

As a constant reader of NATURE and of papers read before scientific societies, I have been struck by what seems to me an inaccurate use of language by English men of science which is rarely chargeable upon Americans—which is, at any rate, at variance with American usage. I will illustrate with the following examples:—

One star is five light-years distant; another is twenty-five light-years distant. The English astronomer will say that the second is *five times farther away* than the first.

A mass of aluminium weighs one pound; a mass of lead of equal size weighs something more than four pounds. The English physicist will say that aluminium is *more than four times lighter* than lead.

Both expressions seem to me incorrect and unworthy of a man of science who endeavours to express himself accurately. In the one case he should say that one star is five times *as far away* as the other. In the other case the whole expression is vicious. Weight, heaviness, is an attribute of matter; lightness is absence, or deficiency, of weight. To say that one article is a certain number of times *lighter than* another is like saying of two vessels unequally exhausted of air that one is four times emptier than another.

It is good English—is it not?—to say that one article is twice as heavy as another. If it is twice heavier, it is three times as heavy.

I submit this criticism of an Anglicism as an offset to some one of many criticisms of Americanisms.

Boston, U.S.A. E. S.

NATURAL HISTORY ESSAYS.[1]

ON the whole, Mr. Renshaw appears to have been well advised in re-issuing in book form the sixteen articles and lectures which constitute the volume before us, since several of them contain much important information with regard to species now verging on extinction, or which have been already exterminated, while all are eminently readable and full of interest. Whether the author has quite done himself justice in the title he has chosen for his work may be open to question, seeing that all the articles relate to a single subject, namely, the mammals of Africa. Undoubtedly the most generally interesting and important articles of the series are the two dealing with the quagga and the blaauwbok, next to which may perhaps be ranked those on the white rhinoceros, the pigmy hippopotamus, and the giraffe. The book is abundantly illustrated with reproductions from photographs, many of which, like the one here shown, are excellent examples of animal photography.

While there is much to commend in the work before us, there are also matters with which to find fault. In the first place, the author has not revised his articles

1 "Natural History Essays." By G. Renshaw. Pp. xiv+218; illustrated. (London and Manchester: Sherratt and Hughes, 1904.) Price 6*s*. net.

so as to bring them up to date. A striking instance of this is afforded by the one on giraffes, which takes no notice of the new forms described in "Animal Life" for 1903, and in the *Proceedings* of the Zoological Society for the present year. A minor instance is the statement (p. 212) that the aard-vark is represented in the exhibition galleries of the Natural History Museum by a specimen mounted in 1841, that specimen having been removed considerably more than a year ago, and replaced by a new one. Again, on p. 56, Mr. Renshaw repeats his statement that an antelope skull in the Museum of the Royal College of Surgeons is that of the extinct blaauwbok, whereas Mr. O. Thomas has expressly stated in the *Field* that it pertains to the roan antelope. If the author adheres to his original view, he should at least have attempted to refute the statement of an expert like Mr. Thomas.

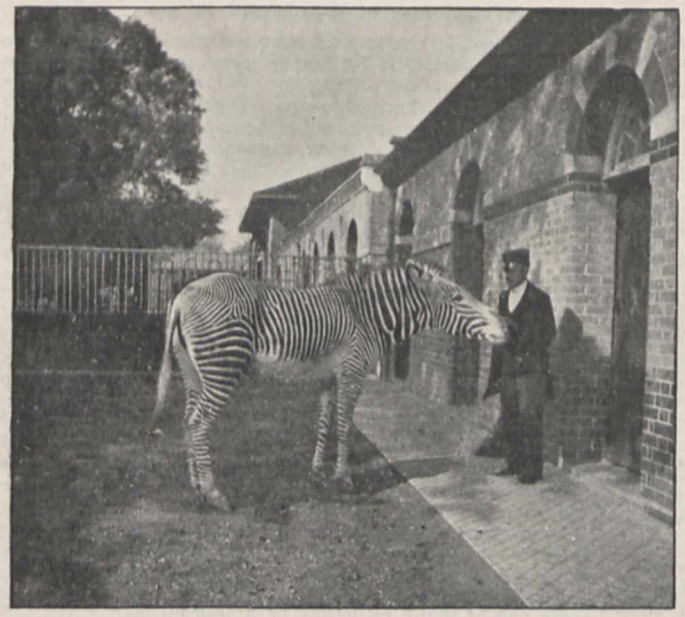

FIG. 1.—A Grévy's Zebra. From Renshaw's "Natural History Essays."

A further instance of what may be called "opinionism" on the part of an amateur is afforded by the case of the quagga in the Natural History Museum, which Mr. Renshaw, in opposition to the museum authorities, believes to be one which was brought to London in 1831. The evidence indicates, on the contrary, that this specimen is without doubt one received by the Zoological Society in September, 1858, which died, or was killed, in June, 1864, and was acquired by the museum in July of the same year, as is indicated by its register number (64.7.2.3). Equally erroneous, unfortunately, is the statement on p. 191 that the Amsterdam quagga was a Knowsley Menagerie specimen, as has been pointed out in a recent issue of the *P.Z.S.* *Per contra*, Mr. Renshaw is to be credited with pointing out that the quagga depicted in "Wood's Natural History" is one of the specimens living in the "Zoo" during the 'sixties, since the figure indicates an animal clearly identical with those represented in the "Knowsley Menagerie," and thus serves to identify the quaggas of the 'sixties with those figured in older works, which have been thought to be different. The reference to a statement made in 1801 as to the protective nature of the markings of the zebra (p. 165) is likewise a point on which the author is to be congratulated.

Reverting to errors, we may direct attention to the misappropriation of the name *Felis pardina* (p. 19) to the ocelot, of which the proper title is *F. pardalis*, *pardina* being the appellation of the Spanish lynx. In popular works the use of scientific names should, in our opinion, be mostly avoided, but if they are used they should be correct; a transposition of names like the above is every bit as bad as calling a lion a tiger! Another example of the necessity for care in the employment of scientific names in works of this nature occurs on p. 133. In one sentence on that page we find the name *Rhinoceros antiquitatis*, and later on the title "woolly rhinoceros," but there is nothing to indicate to the uninitiated that these denote one and the same animal.

If only the author had paid a little more attention to the revision of his articles he might have converted a very interesting volume into a really valuable record of the past history of several extinct and waning forms. R. L.

DEVELOPMENTS OF THREE-COLOUR PHOTOGRAPHIC PROCESSES.[1]

II.

HAVING obtained the three colour records it remains to use them for locating the colour in the production of the final print. If the coloured lights are to be added, as in Ives's chromoscope, then a transparency is made from each colour record (which is, of course, a negative), and each transparency is made to furnish light of a similar colour to that of which it is the record. If the colours are to be superposed, as when they are printed one over the other, or when coloured transparencies are made and superposed in the method of making coloured lantern-slides, then a complementary colour to that of each record must be used, because the absorptions are added instead of the lights. In the chromoscope the colours are in the form of screens; they remain in the instrument, and therefore are provided once for all. In the other cases they are stains or inks, and an amount is used up in the production of each print; they are therefore used in quantity. In the choice of inks and stains, the perfection of colour is only a matter of degree, and those colours that most nearly approach perfection may not be suitable otherwise. The best colours may be (and in some cases are) fugitive, so that for practical purposes an inferior colour has to be used. If the colour is perceptibly different from the theoretical tint, then the colour records must be adjusted to make the best of the available colours. When the colours are superposed, as in printing on paper, at least two of the three inks must be made of transparent colours, or obviously the top colour would hide those beneath. This last matter is, as Hübl remarks, one of the most important difficulties in trichromatic work, and, he adds, the colour last printed will always predominate over those previously applied. Hübl, in his treatise, describes how to select the inks by means of his circular spectrum colour scheme, and how to mitigate the errors due to the defects of the selected colours, chiefly by retouching and by setting off one defect against another. The inks may be selected also by the use

1 "The Water-Colour Drawings of J. M. W. Turner, R.A., in the National Gallery." By T. A. Cook. Pp. vi+86 and 58 plates. (London: Cassell and Co., Ltd., 1904.) Price 3 guineas net.

"Three-Colour Photography." By A. F. von Hubl. Translated by H. O. Klein. Pp. 148. (London: A. W. Penrose, Ltd., 1904.)

"Photography in Colours." By R. C. Bayley. 2nd edition. Pp. 151. (London: Iliffe, Ltd., 1904.) Price 1s. net.

Continued from p. 555.

of Abney colour sensitometers, or by spectroscopic methods, but it is not sufficient to judge of the colour by the eye alone. It is necessary that the colours shall not only look right, but that they shall be right when analysed spectroscopically. Each colour is used, not so much for its own sake, as to give the proper tints when the light it reflects or transmits is mixed with the light from the other colours.

But supposing that the inks or stains selected were theoretically perfect in colour, and perfectly transparent, so that when superposed the lowest produced its full effect, it still remains to see that each is laid on in its due proportion, for if one is in error the whole will be thrown out, and what should be neutral greys will be tinted with colour. And there is still another difficulty to consider. The gradation produced by the same treatment of a sensitive plate generally becomes more steep as the wave-length of the light used increases. This is certainly the rule, though there may be exceptions to it. Therefore, if the pink, yellow, and blue inks are properly proportioned to give a neutral black where the colours are in full quantity, the greys may be expected to be bluish, and in the lighter colours there may be expected a deficiency of red. To overcome these difficulties, some have sought to use four, or even five, colours instead of three, and others have used a fourth plate with black ink to give the blacks and greys, removing from the plate those parts where pure colours are required. Obviously, the use of additional printing plates is a confession that the three-colour process cannot be worked on the theoretical lines, but such variations as these do not appear to be at all generally adopted.

There are many methods by which the three colours may be brought together to make the final picture. The simplest of all, both theoretically and practically, and at the same time perhaps the most perfect and therefore the most beautiful, appears to be the production of transparencies by the superposition of gelatine reliefs produced from the colour records, each appropriately stained by immersion in a suitable dye solution. There is nothing to regulate the depth of colour to which each relief should be stained but the judgment of the worker, and the fact that the greys and blacks of the original should be untinted by colour in the reproduction. A relief may be more highly coloured by a further immersion in the dye solution, or lightened by immersion in water.

For printing on paper, either the collotype process, lithography, or typographic blocks may be employed. Some very excellent work has been done by the first of these methods, but in both collotype and lithography, as already stated, it is difficult to regulate, to a nicety, the amount of ink applied, and the successful impressions generally form only a small proportion of the whole. The process that is the most used, and that certainly at the present is the most suitable, consists in printing from typographic blocks as ordinary letterpress is printed. The photographic production of blocks from half-tone negatives is practised to so great an extent, and the machinery for letterpress printing is so perfect, that uniformity is more easily secured by this than by other methods. In pointing out the advantages of this process, Colonel Hübl states that it gives a better blending of the colours, and that the inks are not brought into contact with water so that they remain pure, and as the paper remains dry during the printing a better register is secured. But the process has its own defects—Hübl says that "the gradation is limited and incorrect," and that "the final result depends more on the clever work of the retoucher than on the perfection of the photographic negative." This last statement conveys, perhaps, rather an exaggerated view of the facts of the case.

The dots in the impression from a half-tone block are, as is well known, in lines, as determined by the ruling of the screen that is placed in front of the plate when the grained negative is made. Now when lines at regular intervals cross each other at a small angle a pattern is produced known as a "moire" or "watering" effect, from its similarity to the appearance of "watered" silk. The effect can easily be seen by looking through two pieces of muslin superposed with the threads not quite parallel. Two rows of park railings, if near enough, will often show it, the railings in each row being parallel to each other, but not quite parallel to those in the other row. In superposing three impressions from blocks made by means of cross-lined screens, it is important to avoid any approach to parallelism of any set of lines or rows of dots with any other, especially as regards the relative positions of the red and blue impressions, as these are darker than the yellow, and therefore more conspicuous. It is obvious that if the screen used has its crossing lines at right angles, the three impressions will give six sets of lines, and an angle of 30° between each and the next if the angles of crossing are kept equal. Circular lined screens mounted in aluminium cells, so that they can be rotated to any desired angle with precision, are much used in America and are coming into use here. A common method, which is being superseded by the circular screen, is to use two rectangular screens, one of which is ruled at such angles that, by turning it round from back to front, it gives the rulings in the third position. Other methods are sometimes used for the purpose, for the shape of the aperture in the diaphragm affects the character of the dots, and it is possible to use a slit diaphragm and rotate the lens that carries it. But the most notable variation in the preparation of the blocks is to get rid of the lines, or even rows of dots, altogether, by using an irregular grained screen. Of the many attempts that have been made in this direction, the one that seems to offer the greatest promise of success is Wheeler's "metzograph" screen, in which an irregular wavy surface of the glass gives the concentrations of the light required.

There is one matter in connection with three-colour printing by means of half-tone blocks that sometimes presents a difficulty to the minds of those who have a slight acquaintance with the subject, and certainly is not altogether without effect, namely, the fact that the dots of the different colours are sometimes superposed and sometimes side by side, according to accident in printing. This difference is not very important. The colours are arranged on the supposition that they are superposed. If otherwise, much the same tint results, but it is mixed with white, because the result is the sum of the lights instead of the sum of the absorptions. But if the dots were completely superposed, then there would be a greater area of white paper between the dots, and the white light from this source doubtless about compensates for the other. Perhaps, in the circumstances, the juxtaposition is advantageous, as the tendency for the ink last applied to show more conspicuously than the others would not hold in this case.

A notable example of the excellence that is now possible by three-colour typographic printing may be seen in "The Water-Colour Drawings of J. M. W. Turner, R.A.," a selection of fifty-eight subjects, published by Messrs. Cassell and Company, the reproductions being made by Messrs. André and Sleigh at their works at Bushey. In such a case the question that is naturally asked is, Are the colours of the reproductions similar to those of the original? Of course they are not the same pigments—this is not intended; the only aim of the printer is to give colours

that cannot be distinguished from the original by simple observation. Mr. Theodore Andrea Cook, in his preface to the volume, refers to "mechanical accuracy, assisted and improved by skilfully delicate and reverentially careful handiwork," and thus sums up the position according to the facts of the case. The colours are not accurate by reason of the fact that the printing blocks are made by photographic means, although this may be claimed for the drawing—that is, the outline. In describing the process of three-colour printing, we have endeavoured to show how that imperfection and compromise qualify every step of the work. It is therefore necessary to examine the first proof by critically comparing it with the original, and then to make such alterations as are required in the three printing plates, by re-etching wholly or partially, by hand engraving, burnishing, and similar methods, continuing to make proofs and effect the needed changes until the differences are eliminated. At Messrs. André and Sleigh's this examination and hand work are carried out by trained artists, as distinguished, that is, from photographers and printers, and it is to the scrupulous care bestowed upon this adjustment of the plates by hand that the perfection of the prints depends. The justification lies in the result, and, whatever may be said for or against any principle of work, it is by the practical result only that it can, at present, be finally judged. If a copyist were to paint a copy of a picture, we should naturally seek the opinion of eminent painters as to the merits of the copy. Three-colour reproductions put forward as these are must naturally be judged in the same way, and it is a source of gratification to all interested in the technics of three-colour work to know that these reproductions have received the warm approval of many of our best known painters. But it is easy to believe that there is room for a little difference of opinion, and that a critical comparison with the originals would reveal possibilities of improvement. Such have been pointed out, and presumably no three-colour work will ever be done for which absolute faultlessness can be rightly claimed. But there is a possibility of error even in this criticism. For as the reproduction is not done in the same pigments as the original it follows that the effect of a difference of illumination will not be the same on both. If the reproduction were perfect as compared with the original by ordinary good daylight, there would probably be differences noticeable to a trained eye if they were compared on a dull day; and this probability must exist however the copy is made if the pigments used are different from those in the original. Moreover, no work in colour appears as it is intended to unless it is illuminated by the light by means of which it was produced or a quite similar light, and this is a physical law which must ever obtain.

There have been a few attempts to simplify the three-colour process by the use of one screen only, the three colours being arranged upon it. Perhaps the best known of these is due to Prof. Joly, who arranges his colours in triple parallel lines. The most recent, and the boldest in its conception, has only just been published by Messrs. Lumière. They sort out from potato starch granules from 0.015 to 0.02 mm. in diameter, and colour separate lots of these red, green, and violet respectively. When quite dry the coloured granules are mixed in such proportions that the mass appears grey, with no predominance of either colour, and a waxed glass is coated with them to form a layer only one granule thick. To prevent the interstices from passing white light, they are filled up with a fine black powder. There is next applied a varnish which has as nearly as possible the same refractivity as the starch. By this means is obtained an irregular-grained triple-colour screen. To prepare it for producing the picture it is coated with a suitably sensitised emulsion. The plate is exposed through the glass, developed, the silver image dissolved away, and the remaining silver salt reduced to the metallic state to form the image. Thus is obtained the completed transparency. It is obvious that if such plates ready for exposure were supplied commercially, the making of coloured transparencies would be much more simple than when three negatives and three prints have to be made. There must be many practical difficulties to surmount in the preparation of such compound plates, and, as in all cases of three-colour work, the process must at present be judged by the results that it yields rather than by the apparent soundness or otherwise of the theories upon which it is based.

The small volume by Mr. R. Child Bayley forms a good introduction to the subject of colour photography, as it is written in such simple language that it may be "understood and followed by any reader, even by one without the slightest acquaintance with photography," as the author states in his preface. At the same time sufficient formulæ and precise details are given for the practical working of those processes that are within the experimental possibilities of the photographer.

CHAPMAN JONES.

NOTES.

THE French physicians and surgeons who are visiting London arrived on Sunday. On Monday the president and council of the Royal College of Surgeons received the visitors, who were shown the collections in the museum. Parties have during the past three days visited the principal hospitals, general and special, the physiological laboratories of the University of London and the laboratories of the Cancer Research Fund, the Lister Institute, the Middlesex Hospital cancer department, the pathological laboratory of the County Council Asylum at Claybury, and the London School of Tropical Medicine. Receptions have been given by the editors of the *Lancet*, Dr. and Mrs. Dundas Grant, and the Dean of the Faculty of Medicine of the University of London and Mrs. Butlin. On Wednesday night the visit was brought to a close by a banquet at the Hotel Cecil.

THE Government of the Federated Malay States has decided to establish an agricultural department in Malay, and has appointed Mr. J. B. Carruthers, the Government mycologist and assistant director of the Royal Botanic Gardens of Ceylon, to be director of agriculture and Government botanist. The Federated Malay States have an area of more than 25,000 square miles, and the agricultural potentialities are very promising. Large areas are being planted with rubber plants, and sugar and cocoanuts are extensively cultivated. There are two botanic gardens and a rubber experiment station in the Malay States, and all three are, we understand, to be administered by the new department.

ON October 6 the Antarctic relief ship *Morning* arrived at Plymouth from Lyttelton after an absence of about two and a half years.

THE first monthly general meeting of the new session of the Institution of Mechanical Engineers will be held on Friday, October 21. A paper by Mr. R. M. Neilson on "A Scientific Investigation into the Possibilities of Gas Turbines" will be read and discussed.

ACCORDING to the Paris correspondent of the *Daily Chronicle*, Dr. Laveran, of the Pasteur Institute, has discovered a remedy for sleeping sickness, and has already tried it with success upon animals previously inoculated with the disease.

AT the meeting of the Royal Microscopical Society on Wednesday, October 19, a demonstration entitled "The Re-construction of a Fossil Plant" will be given by the president, Dr. Dukinfield H. Scott, F.R.S.

A REUTER telegram from Paris states that a radiographic station has been opened at Ushant for the purpose of communicating with ships at sea. The station will transmit messages from the mainland, and will receive messages for addresses in France, Algeria, Tunis, Monaco, and Andorra.

THE *Chemist and Druggist* states that a congress of chemistry and pharmacy, organised under the auspices of the Pharmaceutical Association of Liège and the Chemical Society of Belgium, will be held in connection with the International Exposition to be held at Liège in July, 1905. Communications should be addressed to one of the secretaries, M. J. Raymond, 16 Place des Carmes, Liège, or M. J. Wauters, 83 rue Souveraine, Brussels.

THE Childhood Society announces that a course of four public lectures will be delivered at the Parkes Museum, Margaret Street, W., on Thursday evenings at 8 p.m. The dates, subjects, and lecturers are:—on October 20, discussion on physical deterioration, to be opened by Mr. E. W. Brabrook, C.B.; on October 27, physical condition of working class children, by Dr. T. J. Macnamara, M.P.; on November 10, mental hygiene in childhood, by Dr. T. B. Hyslop; and on November 24, education of girls, by Miss M. E. Findlay.

THE session of the London School of Tropical Medicine was opened on Friday last with an inaugural address by Sir Charles Bruce, G.C.M.G., ex-Governor of Mauritius, Sir John Craggs presiding. Sir Charles Bruce detailed some of his experiences in the colonies, and gave interesting particulars, from the layman's point of view, of tropical diseases with which he had come in contact, notably the remarkable outbreaks of malaria and of surra in Mauritius. Sir Patrick Manson, in the course of proposing a vote of thanks, directed attention to the munificence of Sir John Craggs in giving a scholarship and prize to the school, and expressed a hope that funds for endowment might soon be forthcoming.

IN the October number of the *Century Magazine* Mr. Gilbert Grosvenor, in an article entitled "Inoculating the Ground," describes the method of preparing and using the cultures of nitrifying micro-organisms which are now being employed as fertilisers under the name of nitragin; photographs are given of two plots side by side, one of which had been planted with inoculated and the other with uninoculated seeds, also of the average plants from each plot. There is a surprising difference between the two, the crop from the inoculated plot being much the more luxuriant, and Mr. Grosvenor expresses the opinion that there is not a section of the United States which will not profit by the use of nitragin.

THE New York correspondent of the *Lancet* announces that the Bureau of Chemistry of the National Department of Agriculture is about to establish a laboratory in New York for the examination of imported foods and the detection of adulterations and imperfections. The occasion which led the national authorities to create this laboratory was the result of a recent investigation which proved that in the last two months three shiploads of food products imported into New York were returned to the ports whence they came on account of the adulterations found. The new law requiring a thorough examination of the food products imported into the United States is being rigidly enforced, and this new laboratory is a proof that the investigation is to be on a large scale.

WE have seen with regret the announcement of the death of Mrs. Isabella Bishop, the well known traveller and author, at the age of seventy-two. Mrs. Bishop was the eldest daughter of the Rev. Edward Bird, and became a traveller on account of her continued ill-health. A visit to Prince Edward Island resulted in her first book of travel. Later sea voyages were ordered to the Mediterranean, America, Australia, and New Zealand, and Miss Bird returned by way of the Sandwich Islands, where she spent some months, and she also visited the Rocky Mountains, describing her adventures in two books which were published in 1873 and 1874. Miss Bird next began her travels in the East. She seems to have been the first European woman who made her way into the heart of Japan, and her "Unbeaten Tracks in Japan" (1880) records her experiences. Her "Journeys in Persia and Kurdistan," in two volumes, appeared in 1892—the year when she was elected the first lady fellow of the Royal Geographical Society—and "Among the Tibetans" in 1894. In 1896 she published an interesting collection of photographs which she had herself taken in western China and Korea. Her travels in Korea, Siberia, and China lasted for three years, and their results are shown in "Korea and her Neighbours" (1898). Since then have appeared from her pen "The Yangtse Valley and Beyond" (1899), and "Pictures from China" (1900).

PROF. FRIEDRICH RATZEL, whose death occurred on August 9, was one of the foremost in the band of ardent geographical students who have done so much, on the Continent at least, to win for their subject recognition, both as a valuable intellectual discipline and as a fundamental part of the training of all who aspire to a leading place in public affairs. While not confining himself to any one branch of the subject, it is as an exponent of the geography of man that Ratzel will be principally remembered. By his development and clearer definition of the principles enunciated by Carl Ritter and his school, of the influence exercised throughout human history by natural environment, he may almost be said to have created a new department of study, which, under the somewhat clumsy name of anthropogeography, has taken a firm hold in the educational curricula not only of Germany, but of France and other European countries, while his influence has likewise been felt, if in a less degree, in our own country. Brought up as an apothecary's assistant, Ratzel seized every opportunity of improving his scientific knowledge, zoology being in these early days his favourite study. But it was as a travelling correspondent (1869–75) in central and southern Europe, in the United States, Mexico, and the West Indies that his geographical leanings first found scope, the utilisation of which brought him eventually, as university professor, to the distinguished chair at Leipzig, where for the rest of his life he continued to exercise a predominant influence on the progress of higher geographical education in Germany. In addition to his "Anthropogeographie," by which he is perhaps best known, Ratzel was the author of important works on the United States, on the races of man, and on political geography from the comparative standpoint.

IN its September issue, the *Field Naturalists' Quarterly* publishes the first two of a series of plates (reproduced from photographs) illustrative of the development of the frog. Among the other contents, we may allude to an illustrated article by Miss O. Hill on the acquisition of a portion of Ullswater for the nation, and to the fifth part of Mr. J. L. Kershaw's "The Naturalist in China," which is illustrated with exquisite portraits of the "rainbird" and the Chinese francolin.

THE *South-Eastern Naturalist* for the current year contains Mr. F. W. Rudler's presidential address to the South-Eastern Union of Scientific Societies, in which, after allusion to several points connected with the geology of the district, reference is made to the future of these and similar bodies. Now that many local societies have been relieved of the custody and up-keep of their museums by the county councils, it has been suggested that their work is practically over, and that they should prepare for winding-up their affairs. With this the president does not agree, pointing out that local societies have plenty to do in cataloguing the natural history and archæological products of their respective districts, to say nothing of recording the meteorology. The volume includes notes on the Lepidoptera of mid-Kent by Captain Savile Reid, and a list of localities for uncommon plants by Mr. W. H. Griffin.

PARTS ii. and iii. of the thirty-second volume of Gegenbaur's "Morphologisches Jahrbuch" contain several important papers on vertebrate morphology. In the first of these Dr. K. Kjellberg reopens the question of the homology of the various elements in the articular region of the jaw of mammals and sauropsidans, devoting special attention to the meniscus of cartilage found between the mandibular condyle and the glenoid cavity of the squamosal in many mammals. The author considers that the quadrate of sauropsidans represents the incus of mammals, and the articular of the former the malleus of the latter. The mammalian meniscus is, on the other hand, to a great degree a new element, since it is formed by the cutting off of the upper part of the external pterygoid muscle as it passes between the jaw-articulation to the malleus (its connection in the Sauropsida being with the articular). In another article Dr. A. Schumann points out the curious parallelism between the osteology of the hind-leg of the jerboa and that of birds. In a third Prof. H. Dexler describes the histology of the central nervous system of ungulates, while in a fourth Messrs. Fleischmann and Blendiger discuss the cribriform bones of the nasal cavity of mammals. A fifth article, by Dr. U. Böhi, is devoted to the study of the visceral cavity and genital appendages of the salmon.

IN the third part of vol. lxxvii. of the *Zeitschrift für wissenschaftliche Zoologie* Mr. L. Freund describes in detail the osteology of the flippers of the dugong as displayed in "sciograph" pictures, of which several are reproduced in the plates accompanying the article. It has long been known that the carpus of the adult consists of three large bones. Of the two in the first row, the one is now shown to consist of the fused radiale and intermedium, and the other of the ulnare plus the pisiform and the fifth carpale, the distal bone being composed of the four inner carpalia. In the manati the reduction of the carpus has been carried to a less extent, the radiale being in some instances distinct from the intermedium, while in other cases in which these two bones are fused the four inner carpalia remain separate. Studies in the oligochæte worms by Mr. A. Ditlevsen, and investigations into the development of the eye of the bee by Mr. O. Dickel, complete the contents of this number. In the fourth and concluding number of the same volume special reference may be made to a richly illustrated article by Dr. E. Mascha on the minute structure and development of the flight-feathers of birds. It is specially noteworthy that cells of two types are found in the medulla of the quills, those of one type being very common, while those of the second occur in the owls and the nightjars—a feature confirming the alliance of these two groups. Elaborate diagrams of the different types of feather-structure characteristic of various groups illustrate the memoir.

A PRICE list of botanical apparatus has been recently received from Messrs. Gallenkamp, Sun Street, Finsbury Square. The apparatus required for plant physiology is a special feature, and the various pieces have been prepared in accordance with Detmer's practical book. A particularly useful item is a standard barometer which is priced at 3*l.* 7*s.* 6*d.*, working on the Fortin principle.

THE latest number of the *Records* of the Botanical Survey of India, vol. iii., No. 1, contains an account by Captain A. T. Gage of the vegetation of the district of Minbu, in Upper Burma. The district shows three distinct regions, a mountainous zone of the Arracan Yomahs and parallel ridges, an alluvial belt fringing the Irawaddy, most of which is under cultivation, and an intermediate desert zone, which lies between the two former. The systematic census is confined to the plants collected on an expedition which only extended over one month. A list of economic and medicinal plants is appended.

THE exact nature and purpose of the spines which bristle on the surface of so many Cactaceæ and similar xerophytes must have puzzled many observers and have not been satisfactorily determined. Dr. Darbishire takes up this subject in the *Annals of Botany* (July), and bases his views on an investigation of *Mamillaria elongata*. His conclusions do not coincide with previous explanations, but he gives reasons for maintaining that the tubercle, from which the spines arise, represents a leaf base, and possibly also a part of the stem, while the spines are modified portions of the leaf-blade, and act as a *paraheliode* or screen against excess of sunlight.

WE have received from the Deutsche Seewarte the results of meteorological observations made at selected stations for the lustrum 1896–1900, and for the twenty-five years 1876–1900. The results for each lustrum, from 1876 to 1895, have been previously published; the present volume differs from those which have already appeared by giving the dates on which the extreme values were observed. A table has also been added showing the average number of days in each month, and for each station, on which the rainfall has exceeded 0·2 mm. (0·008 inch). The work is a valuable contribution to the climatology of the German Empire.

AT the jubilee meeting of the Central Meteorological Office of Vienna on October 26, 1901, the Minister of Public Instruction promised that the meteorological results of the previous fifty years should be published in a monumental work, giving an exhaustive representation of the climate of the various parts of the Austrian Empire. The first portion, dealing with the climatology of Lower Austria, has been published by the Vienna Meteorological Office, and has been prepared by Hofrath Dr. Hann, formerly director of the Austrian Meteorological Service, to serve as a pattern for the future discussion, on a uniform plan, of the meteorology of the fifteen other provinces. It is obvious that such a gigantic work would be beyond the powers of any one individual, and it is also desirable that the discussions relating to various districts

should be prepared by persons who have lived in them and have made special studies of the varied conditions of climate. Undoubtedly no meteorologist living could be found who is better qualified than Dr. Hann, whose laborious works are well known to our readers, to prepare a pattern for the guidance of the persons undertaking the subsequent parts. His memoir embraces 104 pages, containing fifty years' monthly and yearly means of different localities, a general summary, and special discussions of the more important phenomena. The work is in every respect worthy of the very high reputation of its author.

AN interesting note on the form of Britain, as described by Tacitus, is contributed to the Lombardy *Rendiconti* (xxxvii., 16) by Prof. Giovanni Ferrara, who considers that, of all the Romans, Tacitus had the clearest ideas as to the configuration of our island, and that Ptolemy's map was to a large extent founded on his descriptions.

PROF. LUIGI GABBA, writing in the Lombardy *Rendiconti*, (2) xxxvii., 16, discusses the problem of teaching chemistry for technical purposes in Italy, and strongly supports the recent resolutions proposed at the Turin Congress of 1902 by Prof. Cannizzaro urging the Government to provide instruction in technical chemistry, in addition to the existing university instruction of a more theoretical character.

THE learning of modern languages is of such importance to science workers that interest attaches to Prof. Charles C. Ayer's paper on the subject in the University of Colorado *Studies*. The author considers that the ability to speak a foreign language fluently depends very largely on a kind of dramatic instinct or power of imitation which seems to project the speaker into a new and foreign personality, and he instances the case of Americans who return from a comparatively short residence in England, letter perfect in the English pronunciation, vocabulary, phrasal intonation, and English manner generally.

WHAT is the "Codex Atlanticus"? is a question which Signor Luca Beltrami answers in a paper reprinted from *Lettura*, and published at the offices of the *Corriere della Sera* at Milan. The name has been given to one of the most interesting works of Leonardo da Vinci, on account of its resemblance in form to an atlas. In 1637 it was given to the Ambrosian Library at Milan, and a reprint has now been produced under the auspices of the Reale Accademia dei Lincei, of which Messrs. Hoepli, of Milan, have a few copies still in their hands. The thirty-five parts occupy more than 1300 pages, and contain 1384 heliotype illustrations, many of them in colours. The edition was limited to 280 copies, the first of which was presented to President Loubet on his visit to Milan. The work of transcription was undertaken by Dr. Giovanni Piumati, and an interesting feature of the first part is the preface, written by the late Prof. Francesco Brioschi, describing the history of the "Codex" from the death of Leonardo da Vinci to the present date.

M. CHARLES FÉRY describes in the September part of the *Journal de Physique* a convenient form of telescope pyrometer for measuring temperatures between 500° and 1200°. The heat rays are concentrated by a silvered concave mirror upon a thermo-couple placed at its focus; the reading of a galvanometer connected with the thermo-couple gives the temperature, and the instrument is so designed that the indications are independent of the dimensions of the source of heat and its distance.

THE August number of the *Physical Review* contains an interesting note by Mr. W. Coblentz on the infra-red absorption spectrum of selenium. Whereas commercial selenium, which contains sulphur, gives immediately after fusion and re-solidification an absorption which rapidly and regularly increases from 1μ to 14μ, after two days it shows nearly a constant transmission throughout the whole of the same range. This peculiar change in transparency is not observed with pure selenium, as the same transmission curves are obtained immediately after solidification and after an interval of thirty days. It is a striking fact that the transmission curves of sulphur are totally different in character from those of selenium.

A PAPER by Mr. F. E. Hackett on the photometry of the *n*-rays, which is published as part x. of vol. viii. of the *Transactions* of the Royal Dublin Society, appears at a very opportune moment. In view of the failure of Profs. Rubens and Lummer to reproduce M. Blondlot's results, and Prof. R. W. Wood's strictures on the methods hitherto employed in their investigation, a method for their quantitative measurement becomes particularly worthy of notice. Mr. Hackett has studied the variation of sensitiveness over the retina when habituated to darkness, and claims to have eliminated in this way all subjective variation. The method of measurement adopted shows that whilst the *n*-rays emitted by unannealed glass cause an increase of approximately 10 per cent. in the brightness of a phosphorescent screen, the increase produced by a silent tuning fork is very small, being about 3 per cent. The experiments described are stated to be of such a nature that any person without special training with a little patience may reproduce them.

IN the August number of the *Physical Review* Mr. K. E. Guthe has made a comparative study of the various types of silver voltameters which are used for measuring the strength of electrical currents. From the measurements which are recorded it appears that there are two distinct classes of silver voltameters, one class including the ordinary type and Leduc's modification, the other Richard's and the "large anode" types. The voltameters of the second class give a deposit weighing about 0·05 per cent. less than that given by the first class. It appears that in those types of voltameters in which the anode is enveloped merely by filter paper or muslin, the heavy liquid surrounding the anode penetrates through and reaches the kathode, depositing there a complex silver ion. As a consequence, the observed increase in weight is greater than that corresponding with the true electrochemical equivalent of silver. In Richard's voltameter and the "large anode" modification, the deposition of a complex ion is prevented by surrounding the anode with a porous pot so as to exclude contact between the anode-liquid and the kathode. As in this case the variation in the amount deposited by the same current in various experiments does not exceed 1 in 10,000, it is recommended that, in future, the "legal" form of silver voltameter should be superseded by the improved form. A re-determination of the electrochemical equivalent of silver gave a mean value of 1·11683 mg. per coulomb.

THE publication committee of the Chemical Society has adopted the word "radicle" in the place of "radical" in their publications. The alteration does not meet with the approval of a hundred and seventy-nine fellows of the Society, who have addressed a letter to the president of the society asking him to bring the matter before the publication committee with a view to its alteration. The signatories point out that:—(1) The new word "radicle" does not convey the sense which the authors of the word

"radical" intended, or that which is still attached to it in chemistry. (2) The use of "radical," though coming through the French, can be defended on purely philological grounds. (3) The original word should be retained out of regard for its historical origin for the same reason that we still employ the word oxygen, although the original meaning has been modified. (4) The original word "radical" is still retained by continental countries and America, and it is only in this country that the change has been made.

MESSRS. F. H. PARSHALL and H. M. Hobart have in hand a work on electric traction which will shortly be published by Messrs. Constable and Co.

A SECOND, revised edition of Dr. C. B. Davenport's "Statistical Methods with Special Reference to Biological Variation" has been published by Messrs. John Wiley and Sons in New York, and by Messrs. Chapman and Hall, Ltd., in this country. The first edition of the book was reviewed in our issue of December 14, 1899, when the opportunity was taken to suggest one or two directions in which improvement was desirable. In addition to the adoption of some of these suggestions, Dr. Davenport has embodied many of the new statistical methods elaborated by Prof. Karl Pearson and others in the new edition of his work.

THE new edition of Dr. A. R. Wallace's work on "Man's Place in the Universe," which has just been published by Messrs. Chapman and Hall, Ltd., at the price of six shillings, contains an appendix in which an argument based on the general theory of organic evolution is used to support the conclusion arrived at as to the unique development of man in the material universe. With this exception, the work remains practically in its original form; for Dr. Wallace remarks that few errors in his facts or fallacies in his conclusions have been brought under his notice, while as to the argument, no student of science has dealt with it in any detail, and "no biologist appears to have thought it worthy of careful consideration."

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A NOVA OR A NEW VARIABLE.—*Circular* No. 68 from the Kiel Centralstelle announces the discovery of a nova or a new variable star by Mr. Stanley Williams, of Hove, on September 20.

The object was first observed on a photograph taken with a 4·4-inch portrait lens between 15h. 59m. and 16h. 23m. (G.M.T.) on the date named, and was then of about the ninth magnitude, its approximate position being:—

R.A. = 22h. 19·0m., dec. = +29° 44′·(1855).

Eleven other plates of the same region, taken between September 27, 1899, and January 16 this year, show no trace of any object in that position, although most of them show stars of the eleventh magnitude or fainter, whilst two plates show stars down to the thirteenth magnitude.

On October 3 the star was observed visually with a 6·5-inch reflector, and was estimated as being about one quarter of a magnitude fainter than B.D.+29°.4655 (9·1 mag.). Its colour was recorded as intensely red, almost crimson, and was not unlike that of Nova Persei at the epochs when that object became red.

The above position lies in the constellation Pegasus, about 2° south of the middle of the straight line joining η and π Pegasi.

THE LICK OBSERVATORY PROGRAMME FOR NEXT YEAR'S SOLAR ECLIPSE.—Mr. William H. Crocker has generously undertaken to defray the cost of the Lick Observatory expeditions to observe the total solar eclipse of August 30, 1905. Three expeditions will be fitted out, one going to Labrador, another to Spain, and the third to Egypt.

At each of these stations the programme will include a photographic search for an intramercurial planet and the photographing of the corona with a camera of 5 inches aperture and 40 feet focus.

The Spanish expedition also proposes to make a study of the polarised light in the corona, and to obtain spectrograms of the sun's edge at second and third contacts and of the green coronal line; the latter are to be used expressly for the measurement of the wave-length of that line.

Attempts will also be made to secure spectra of the "flash" and of the general light of the corona at both the Spanish and the Egyptian camps (*Science*, September 23).

VISUAL OBSERVATION OF PHŒBE.—Whilst searching for Saturn's ninth satellite, Phœbe, with the Yerkes 40-inch telescope on August 8, Profs. Barnard and H. H. Turner found an object resembling a star of about 15·5 or 16·0 magnitude the apparent place of which at 18h. (G.M.T.) was

R.A. = 21h. 23m. 1·0s., dec. = −16° 36′ 8″.

On September 3 Prof. Barnard found that the object was missing from this place.

As the Harvard ephemeris for the satellite gives the approximate place on August 8 as

R.A. = 21h. 23m. 0s., dec. = −16° 36′·4,

the above was probably the first visual observation of this object.

An editorial note attached to the paragraph in the *Astronomische Nachrichten* (No. 3970) in which the above information is recorded enters a *caveat* as to the actual correctness of the figures given, because the manuscript received was very badly blotted.

THE ORBIT OF CASTOR.—A graphically determined orbit of Castor was published in No. 3525 (1898) of the *Astronomische Nachrichten*, but since its publication Prof. Doberck, of Hong Kong Observatory, has determined the three sets of possible elements given below by purely analytical methods, and now publishes them in No. 3970 of the same journal, together with a five-yearly ephemeris calculated from the set of elements No. 4.

The observed angles can be represented equally well by orbits having periods of 200 to 600 years, or even more, but the observed distances are best given by the No. 4 set of elements, which also appears to represent correctly the present decrease in distance.

Elements.

	III.	IV.	V.
☊ =	29° 29′	33° 56′	42° 34′
λ =	84° 44′	82° 26′	118° 11′
γ =	73° 3′	63° 37′	61° 56′
e =	0·7513	0·4409	0·2321
P =	268·16 years	346·82 years	501·80 years
T =	1936·65	1969·82	1963·30
a =	7″·3265	5″·756	6″·467

According to the ephemeris, the position angle at the beginning of 1900 was 225°·72, and the distance was 5″·627; at the commencement of 1905 the corresponding figures will be 223°·58 and 5″·564.

In the same publication Prof. Doberck gives a set of elements, and a yearly ephemeris, for the orbit of ζ Sagittarii.

THE MEETING OF THE ASTRONOMISCHEN GESELLSCHAFT, 1904.—In No. 3970 of the *Astronomische Nachrichten* Herr Elis Strömgren gives a brief outline of the papers read at the meetings of the Astronomischen Gesellschaft, which took place at Lund on September 5–8 under the presidency of Prof. Seeliger. Numerous reports of the work suggested by the committee were given by the observers by whom it had been undertaken.

Among these there are reports by Herr Albrecht on the International Latitude Service, by Herr Müller on the catalogue of variable stars, and many others.

ENGINEERING AT THE BRITISH ASSOCIATION.

AT the conclusion of the president's address an interesting function took place. Dr. Schröter, on behalf of the German Society of Civil Engineers, presented to Mr. Parsons the society's gold medal. Dr. Schröter, in making the presentation, directed attention to the conspicuous part which had been played by the president in the advancement of science and its application to practical purposes, and he mentioned that the society which he represented consisted of no less than 19,000 members, and they were proud to think that they were the first engineering society to recognise by a public award the man to whose genius the success of the steam turbine was due.

The afternoon of this day of the meeting, Thursday, August 18, was devoted to a lecture by Mrs. Ayrton on the origin of sand ripples. The lecture drew a very large audience, and was illustrated by lantern slides, diagrams, and by a number of most interesting experiments. The experiments were carried out by means of tanks with glass sides, which were caused to reciprocate, and waves were thus set up; the actual formation of ripples could, therefore, be seen going on. Mrs. Ayrton was of opinion, and showed this fact by some of her experiments, that when water was flowing quite steadily in one direction, that is, without oscillation or wave motion, and without any disturbance, sand ripples could not be produced, and that such a flow of water over previously existing sand ripples would tend to obliterate them. It may be mentioned that on this point she disagrees with Prof. George Darwin, who gave one of the evening lectures, and dealt with the same subject.

The first three papers taken on the morning of Friday, August 19, were concerned with internal combustion motors, viz. flame temperature in internal combustion motors, by Mr. E. Dugald Clerk; the specific heat of gases at high temperature, by Prof. H. B. Dixon; and the calorimetry of exhaust gases, by Prof. B. Hopkinson. Mr. Clerk, in the introductory portion of his paper, stated that had we lived in a world of a much denser atmosphere, there was every probability that the internal combustion engine would have developed on somewhat different lines, that is to say, that the non-compression engine would have been much more successful. The author then described a method he had introduced by which it was possible to reduce the maximum temperature reached in the engine at the time of explosion and still maintain throughout the working stroke a high average pressure, the principle upon which he worked being to produce, as it were, an artificially increased atmospheric pressure. An additional charge of air, compressed by a pump, passed into the cylinder after the working charge had been completely drawn in, and Mr. Clerk showed that in one set of experiments he was able to increase the thermal efficiency from 28·7 per cent. to 34·4 per cent., reducing at the same time the maximum temperature from 1700° C. to 1200° C. The National Gas Engine Co. had constructed to his designs an engine of 300 h.p. to use producer gas, in which this system of air supercompression was used; the front end of the cylinder was arranged to act as the pump for compressing this additional air supply, and the pressure of the charge was raised by this means about 7 lb. per sq. inch above the atmospheric pressure. Mr. Clerk also utilised some of this compressed air for scavenging purposes.

Prof. Dixon in his paper dealt with the experiments he has been carrying out for many years on the specific heat of gases at high temperatures. He stated he had proved that it was impossible completely to burn carbonic oxide gas at very high temperatures. He had found as a general result of his experiments that in the case of carbonic oxide the specific heat rose with the increase of temperature up to a certain point, and then dissociation began. Prof. Dixon then described by means of blackboard diagrams some exceedingly beautiful methods of photographing actual explosions when taking place in glass tubes. Prof. Hopkinson's paper dealt with a method of measuring by means of a calorimeter the heat passing away from an internal combustion engine in the exhaust gases. The exhaust gases were cooled down in this calorimeter from the exhaust temperature to atmospheric temperature, and therefore the amount of heat they carried away from the engine could be accurately determined. He suggested that it might be possible with this method to carry out thermodynamic tests of large internal heat engines more accurately than by the method hitherto adopted, in which the heat given to the engine per unit of time was calculated by the aid of calorimeter experiments on the combustible gases employed in working the engine. The only item in the heat account which was not determined in his method was the small loss due to radiation. The indicator cards, or the brake, gave exactly the amount of heat converted into useful work, the amount of heat sent away in the jacket water was easily measured, and by this new calorimeter the amount of heat carried off in the exhaust gases could now be determined. It was pointed out in the discussion that this method of determining the heat required in a given time by a heat engine by measurement of the exhaust waste was analogous to that introduced by Hirn in the case of steam engines many years ago. Papers by Mr. J. W. Hayward on receiver drop in a compound engine, and by Mr. A. H. Peake on superheated steam, concluded the day's programme.

Monday, August 22, as usual, was devoted to the electrical papers, and the proceedings opened with a paper by Mr. A. A. Campbell Swinton on electricity from water power. The author stated that he had been able to obtain accurate statistics which showed that about 1,500,000 h.p. for electrical work was now generated by water power, nearly one-third of this huge total being in the United States, while the total for Great Britain was only about 12,000 h.p. He considered, therefore, that in all probability the real amount of water horse-power devoted to this purpose at the present time would be nearly 2,000,000, equivalent to a coal saving of nearly 12,000,000 tons a year. After giving some details of long distance transmissions abroad, he described two or three systems now at work in Great Britain, and then dealt with the water-power schemes with which he was officially connected, which had been undertaken by the Scotch Water Power Syndicate. In this scheme it is intended, first, to make use of Loch Sloy, which is about 757 feet above Loch Lomond; a dam will be built to raise the level of the loch by about 60 feet; the power-house is to be built on the shore of Loch Lomond at Inveruglas, and overhead wires will convey the electric current to the industrial districts of the Vale of Leven and the Clyde. The author estimated that about 50 per cent. to 58 per cent. of the total energy of the water would be delivered to the customers after making allowance for all the losses in the pipe lines, turbines, dynamos, transmission lines, &c. The company intends to employ from the start a pressure of 40,000 volts in view of the fact that it has powers for a considerable extension of its scheme in the future, when the demand for power justifies it. The total cost of the Loch Sloy scheme was estimated at 200,000*l*., and assuming 5000 h.p. delivered, this comes to about 40*l*. per h.p. everything included, a comparatively low figure.

The next paper, by Messrs. C. H. Merz and W. MacLellan, entitled "The Use of Electricity on the North-Eastern Railway and upon Tyneside," gave an account of the first important transformation of a steam locomotive-worked railway into an electric railway; the North-Eastern Railway Co. has adopted this latter method for the whole of the suburban passenger traffic on the north side of the Tyne. The company decided to use the third rail and continuous current system, the electricity being generated as a three-phase alternating current at a pressure of 6000 volts. At five substations this is converted into a continuous current of 600 volts. The service given on all the line will be practically quarter-hour trains, except on the riverside line. The electrical energy is obtained from the Newcastle-on-Tyne Electric Supply Co., and Parsons steam turbines, each of them having a normal capacity of 7000 electric horse-power, have been adopted by this company at their Carville power station; these are by far the largest steam turbines at present at work in this country. The authors stated that preliminary tests have shown that the steam consumption would not exceed about 12 lb. per electrical horse-power hour at any load between 4000 I.H.P. and 7000 I.H.P.

Messrs. W. M. Mordey and A. G. Hansard then read a paper on energy losses in magnetising iron, and described

the method they had adopted for measuring by a watt meter the total losses due both to hysteresis and eddy currents.

Dr. W. E. Sumpner and Mr. R. W. Weekes, in a paper on the Hopkinson test as applied to induction motors, stated that they had found Dr. Hopkinson's well known method, with certain modifications, so satisfactory in testing induction motors that they considered it was desirable to direct attention to the experimental details and to give particulars of the arrangements of the machines and the instruments needed for the test, and of their methods of determining the belt losses. In an appendix the results obtained in testing three-phase motors by this method were given.

Dr. W. M. Thornton contributed a paper on distribution of magnetic induction in multipolar armatures. The object of this paper was to discuss the best methods for determining the most suitable radial depth of an armature core for either continuous or alternating machines.

The last two papers dealt with on August 22 had reference to standards of light. Prof. J. A. Fleming, in his paper entitled "Large Bulb Incandescent Electric Lamps as Secondary Standards of Light," described a method he had devised of using as a secondary standard of light an incandescent filament fixed in a large bulb about 12 centimetres in diameter and about 20 centimetres long. The use of this large bulb diminished considerably the deposit of carbon upon the interior of the glass, and therefore the rapid falling off of candle-power with age of the lamp. He had found such lamps very suitable for photometric purposes. His method of employing them was equivalent to the well known system of double weighing. One of these standard lamps was balanced in the photometric gallery by an ordinary incandescent lamp, and then the standard lamp was removed and the lamp the candle-power of which it was desired to determine was substituted for it, and moved in or out towards the photometer disc until it also balanced the ordinary incandescent lamp previously used against the standard lamp. The second of the two papers was by Mr. Clifford Paterson, and was entiled "Some Investigations on the Ten Candle-power Harcourt Pentane Lamp made at the National Physical Laboratory." The author has been carrying out an investigation at the National Physical Laboratory on the effect of changes in the barometric pressure and of moisture in the atmosphere on the flame standard, and the work is still going on.

On Tuesday, August 23, the first business was the reading of the report of the Committee on the Mersey Tidal Regime. Briefly the committee has found that though extensive dredging has now been carried on in the Mersey for such a long period of time, the regime of the tides has hardly been altered.

Major Sir Hanbury Brown then read a most interesting communication on the control of the Nile, the paper being fully illustrated with lantern slides. The author described the whole of the engineering works which have been constructed for the purpose of increasing the area of irrigation in Egypt since the days of Arabi Pasha's abortive revolution. Two great schemes have now been completed, first, the reconstruction of the old delta barrage so that it now can be completely utilised for its original purpose and a head of 20 feet of water can be held up, and, secondly, the construction of the great Assuan dam and Assiut barrage. The wonderful increase in the industrial prosperity of Egypt which has been brought about by these great engineering works reads almost like a fairy-tale, and not the least important of the social advantages has been the abolition of forced labour or corvée. In the discussion, Sir Colin Scott-Moncrieff, who has been responsible for so much of this splendid work, told an amusing story of how, during the reconstruction of the great delta barrage, the last hole, which had almost baffled the engineer, was at length closed by the use of costly curtains taken from an unused Khedivial palace standing near the barrage.

Mr. J. H. Wicksteed's paper on a universal testing machine of 300 tons for full sized members of structures described the machine made for the French Government by his firm, Messrs. Buckton and Co., of Leeds, which was officially inaugurated at the Conservatoire Nationale des Arts et Métiers on June 16 of this year. This formidable machine will take in columns or tension bars 88 feet long by 3 feet 3 inches by 3 feet 3 inches, and it will admit beams 3 feet 3 inches broad by 6 feet 6 inches deep on a 20 feet span, and can be changed from one form of test to another with great rapidity. On the day of the inauguration, a steel tension bar was broken under a load of 228 tons, and immediately afterwards a thick slab of armoured concrete was broken on a span of 16 feet 6 inches.

Prof. J. O. Arnold then read a paper on the fracture of structural steel under alternating stresses, in which he described a method he had devised and the special machine he had invented for placing test specimens under severe alternating stresses slightly beyond the elastic limit; his method, as it were, carried out the Wöhler tests in two or three minutes. Though the investigation was still going on, the author stated that the results obtained so far convinced him that the micrographic methods of examining steel had in their turn failed to show the cause and prevention of sudden rupture under vibration and alternation of stress.

The last two papers on August 23 were contributed by Mr. R. A. Hadfield. The first was on the production of magnetic alloys from non-magnetic metals. In it he stated that Dr. Heusler had produced a magnetic alloy of copper, aluminium, and manganese, and that the magnetic properties of this alloy were to be attributed entirely to the presence of the manganese. Mr. Hadfield himself had made the alloy, and was still carrying on an investigation in reference to it. The alloy was very brittle, and could not be forged either cold or hot. The second paper, on experiments relating to the effect upon the mechanical properties of iron and alloys of iron produced at liquid air temperatures, gave a brief account of some interesting experiments on the effect upon pure iron of great cold. Much fuller details of this investigation are to be given at the forthcoming meeting of the Iron and Steel Institute.

On Wednesday, August 24, the last day of the meeting, several papers of interest were taken, the first being a paper by Mr. Horace Darwin and Mr. C. V. Burton on side-slip in motor cars. The results which had been obtained by the authors in their investigations into this question were illustrated by a small model car, which ran down an inclined plane. The authors were of opinion from these experiments that side-slip would be considerably reduced by steering with the hind wheels and driving with the front wheels, though this car would not be so convenient for steering as the ordinary car.

Prof. Ernest Wilson gave a further account of his experiments on the electrical conductivity of certain aluminium alloys as affected by exposure to London atmosphere. The author has recently been employing micrographic methods in his investigations. He was of opinion that the great difference which existed between the tensile strengths and the other qualities of these alloys was not due to variation in structure.

Mr. J. Casey then described the proposed barrage of the River Thames, and two brief papers, one on the testing of alternating current motors by continuous current, by Mr. Wm. Cramp, and the other on the action of lightning strokes on buildings, by Mr. Killingworth Hedges, brought the proceedings of this section to a close.

It is pleasant to record that the attendance at Section G at Cambridge was considerably above the average, and this was all the more gratifying inasmuch as several of the papers contributed were of unusual importance and of high scientific value. T. H. B.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE president, Prof. C. S. Sherrington, F.R.S., delivered an address on the morning of August 18, choosing for his subject the "Correlation of Reflexes and the Principle of the Common Path." This address has already appeared in NATURE (September 8).

Prof. J. A. MacWilliam read a paper on reflex and direct muscular response to galvanic currents in fishes. His experiments had proved that eels were remarkably responsive to electrical currents, a responsive fin movement of a reflex nature being readily elicited. The negative pole was usually the effective one. Frogs, newts, carp, &c., gave negative results. After death of the spinal cord much stronger

currents were necessary to evoke any movement, and these were of a different character, being direct responses of the muscles.

Prof. W. H. Thompson read a paper on the metabolism of arginine. If arginine, an important crystalline base obtained by the cleavage of proteids, is administered to animals either by injection or with the food, from 80 per cent. to 90 per cent. of its nitrogen is excreted as urea. In the laboratory only 50 per cent. of the nitrogen can be split off from arginine as urea, the remainder appearing as ornithin. Hence in the body the ornithin nitrogen is also converted into urea, largely or entirely.

Prof. A. Kossel (Heidelberg), referring to the structural formula of arginine, pointed out how half of its nitrogen could be split off as urea by a simple hydrolysis, while the remaining moiety required oxidation before it could be obtained in this form. Dakin and he had shown recently that the liver and some other tissues produced a ferment capable of effecting this hydrolysis. Moreover, they had also found another ferment which possessed the power of acting upon this base in an exactly similar manner while it was still combined within the molecule of certain of the simple proteids (the protamines). The significance of these facts is of great importance in view of the wide distribution of arginine throughout the cell proteids of the body.

Dr. F. G. Hopkins stated that he had some time previously himself taken by the mouth a mixture of the hexone bases, and subsequently watched the hourly elimination of urea. He found that the rate of excretion of urea showed two maxima, the first of which he had ascribed to that part of the N of these bodies which could be obtained in the laboratory as urea, and the second maximum to the remaining N (ornithin, &c.).

Prof. E. H. Starling read a paper on the relation of trypsinogen to trypsin. Pawlow and his pupils have shown that fresh pancreatic juice, obtained from a pancreatic fistula, possesses no power of digesting proteids, but that after it has been acted upon by intestinal juice it gains that power. He concluded that the intestinal juice contained a ferment (enterokinase) which acted upon the trypsinogen of the fresh pancreatic juice, converting it into trypsin. Against this view French observers have brought forward another, viz. that the interaction of the two secretions is analogous to that of the cytases, and that the trypsinogen can only act upon proteids in the presence of enterokinase. Bayliss and Starling have studied the action of enterokinase upon trypsinogen, and by observing the rate of its action have, by finding that it follows the usual laws of ferment action, brought strong evidence to prove that Pawlow's view is the correct one, and that enterokinase is a "ferment of ferments." They have now further evidence in the same direction. By injecting rabbits with solutions of enterokinase, they found that an antibody could be produced which, acting upon enterokinase, was able to inhibit its action upon trypsinogen. Although this in itself could not be regarded as definite proof because the facts might bear another interpretation, yet taken in conjunction with the former evidence it was confirmatory of their view.

Dr. F. A. Grünbaum pointed out that the last evidence brought forward by Prof. Starling did not disprove the view that enterokinase and trypsinogen acted in a complementary manner to one another, since the result might be readily explained on the assumption that the antibody possessed a relatively greater attraction to the enterokinase than to trypsinogen.

Dr. W. E. Dixon communicated the results of his experiments upon the action of alcohol upon the heart and circulation. He pointed out that much of the literature upon the subject was valueless because the experiments had been conducted upon animals already under the influence of anæsthetics. The previous administration of chloroform or ether entirely abolished the first effects of alcohol. The experiments must therefore be conducted upon unanæsthetised animals or upon surviving organs. He proved that the first effect of alcohol upon the pulse was a slight acceleration, which he thought was due to an irritative effect of peripheral origin. The first action upon the heart was distinctly a stimulating one, as proved by cardiometer experiments. The effect upon the peripheral blood-vessels was a dilatation of the limb vessels associated with a constriction of the vessels of the splanchnic area. The effect upon the blood-pressure was a preliminary rise which was only converted into a fall when considerable doses had been given. If larger doses were suddenly administered the effect upon the heart was usually marked inhibition, which he ascribed to a direct action of the drug upon the cardiac centre.

Prof. E. A. Schäfer remarked that in some recent experiments he had found that if a mixture of chloroform and alcohol was made to replace the chloroform with which the animal was being anæsthetised, the result was an acceleration of the heart-beat, together with an increase in its force. This was not due merely to the diminution in the amount of chloroform administered.

The morning of August 19 was devoted to a discussion upon the relation of oxidation to functional activity. A report of this discussion appears in another part of NATURE (p. 590). Mr. Hankin's remarks on the spread of plague will be printed separately in another issue.

Dr. W. H. R. Rivers communicated the results of some of his observations on the senses of the Todas. These were made by methods similar to those which had been employed in the work of the Cambridge Anthropological Expedition to the Torres Straits, and the results were in general confirmatory of those reached by that expedition. The observations on Papuan and Toda seem to show that there is no marked difference between uncivilised and civilised races in purely sensory powers. Any superiority in the sensory and perceptual feats of the savage is probably due to his powers of observation and of drawing inferences based on his familiarity with his surroundings. Where there are differences between Papuan, Toda, and European, the Toda occupies in general an intermediate position between the Papuan and European, just as he occupies an intermediate position between them in intellectual and cultural development.

The only striking feature which marks off the Toda from the others is the great frequency of colour-blindness. Whereas this condition is absent or very rare in some savage races, the proportion of colour-blind persons amounts to 12·8 per cent. in Toda males as compared with about 4 per cent. in European races.

Dr. C. S. Myers communicated a paper upon recent developments in Helmholtz's theory of hearing. He alluded in the first place to Ebbinghaus's conception of an internodal vibration of the basilar fibres, and showed its value in providing a theoretical basis for the degree of relationship between the various musical intervals. Next he referred to the discovery of intertones (Zwischentöne) by Stumpf, and to their importance in determining the number of adjacent basilar fibres thrown into vibration by any simple tone, and in modifying the principle of specific nervous energy as applied to the ear. Schäfer's theory of the origin of subjective combination-tones was then described, and the difference between objective and subjective combination-tones was discussed. Lastly, Dr. Myers showed the great value of Helmholtz's theory in best explaining the known pathological phenomena of hearing, and suggested that the hair-cells rather than the basilar fibres might be the sympathetically vibrating end-organs. Such a modification involved the application of altered physical considerations to the organ of Corti, but appeared more rational and less difficult on the whole.

In the morning of Monday, August 22, the work of the section was devoted to a discussion on conduction and structure in the nerve-arc and nerve cell.

Prof. J. N. Langley, in opening this discussion, said that he restricted himself to a consideration of the general scheme of structure and arrangement of the nervous system in vertebrates, and the broad relation of this scheme to nervous functions. At present there are two main ideas of structure, one often called the neurone theory, according to which the nervous system is made up of a multitude of neurones or cells which have no connection with one another, and the fibrillar theory, according to which the nervous conducting part consists of minute fibrils joined together here and there into a network. Prof. Langley argued that whatever view is taken of the structure of the nervous system, the facts of degeneration of nerves show that it is made up of a number of trophic units, and that the theory of trophic units held whether the unit consisted of one or

of a hundred cells, and whether the units were in continuity with one another or only in contiguity.

A second point which seemed certain was that the properties of the central nervous system required for their explanation some structure not present in the peripheral nerves. This structure might be, in part, the nerve-endings of the trophic units, but, in part, it must be referred to the nerve-cells, which, in fact, consisted of different protoplasm from that of either nerve fibres or nerve-endings.

If the fibrillar theory were true, there were facts which showed that the fibrils must be different in different parts of their course. This was illustrated by the action of nicotine and of other poisons on the different parts of the nervous system. With this modification, the fibrillar theory simply transferred to a part of the cell functions which were commonly supposed to belong to the whole. But it could not be regarded as certain that there were any fibrils at all in the nerve cell, for the microscopic appearances varied considerably according to the method of preparation.

A point which was much contested was the question whether the trophic units were continuous with one another or not. This point was not of great physiological importance, but the physiological facts were best explained on the assumption that the units were contiguous but not continuous.

The last point considered was whether the unit consisted of a single cell or of many cells. The study of the development of nerves had led different observers to entirely opposite conclusions. Experimentally, the question was of interest in connection with the regeneration of nerves. Numerous surgeons had found new nerve fibres in the peripheral ends of cut nerves, but their observations failed to show that some central connection had not been established. In some recent experiments made by Prof. Langley in conjunction with Dr. Anderson, it was found that without a single exception, the new fibres had become connected with the central nervous system. The balance of evidence was then against the occurrence of autogenic regeneration and in favour of the unit consisting of a single cell.

Dr. A. Hill stated that he was entirely prepared to give his approval to the neurone theory as defined by Prof. Langley, but he objected that this was merely a statement of the cell theory and did not require the special title given to it by Waldeyer. He was inclined to think that the more light we gained on this subject the more should we find that Bethe's view was correct. Apathy has shown a network of neuro-fibrillæ in nerve cells of invertebrates. This network is easily shown, and is beyond all doubt a structure existing during life. In the spinal ganglion cells of vertebrates a somewhat similar appearance is obtainable. It was easy to make preparations of vertebrate nerve cells in which fibrillæ were indisputably present, but how far this appearance was due to reagents it was impossible to say; but there was a strong probability that the net arranged itself about an existing system of fibrils. The connecting link appeared to him to be the "thorns," and it was a remarkable fact that the spacing of the thorns corresponded to the spacing of the pericellular network. Far as we were from being in a position to form a conclusion on this subject, it was not impossible that neuro-fibrillæ, Golgi's net, and thorns form a system of conducting fibrils of extreme tenuity and almost infinite complexity.

Prof. Graham Kerr gave an account of the results of his researches on the development of the nerves in Lepidosiren. His first studies on the mode of growth of the nerves in these animals seemed all in favour of His's view that the nerves developed as outgrowths from the spinal system, but more extended observations upon embryos in various stages of development led him to the conclusion that the fibres originated as strands of undifferentiated protoplasm extending between the neuroblasts of the spinal cord on the one hand and the developing myotonic cells on the other. At a somewhat later stage fibrillæ appeared in these strands, and still later a sheath was formed from mesoblastic tissue which surrounded and enclosed the group of fibrillæ. A more doubtful conclusion which might perhaps be drawn was that the original path was one along which impulses surged to and fro, and that consequent upon this use the fibrillary structure was developed as a more convenient substratum for the maintenance and extension of that function.

Dr. Mann pointed out that nerve cells might be theoretically in one of three states, viz. separate units, or continuous with one another, or at one time continuous and at another separate. In all embryos at a certain period the motor cells in the cord form a syncytium with scattered nuclei, an arrangement which later on becomes less and less marked until in most cases the cells form separate units. Cells not derived from a common mother cell are never in continuity. He pointed out that great care was needed in drawing conclusions from any preparations where such electrolytes as corrosive sublimate were used for purposes of fixation, inasmuch as all coagulation by electrolytes invariably leads to a very distinct fibrillar appearance. This is much less marked after the use of such non-electrolytes as osmium tetroxide or formaldehyde free from formic acid. At present, therefore, we are not in a position to make any assertions as to the existence or non-existence of fibrils in nerve cells or in tissues.

Dr. W. B. Hardy also directed attention to the treacherous nature of the evidence of fibres and networks in cells. A fibrillar structure can be produced from a perfectly homogeneous solution of egg-white by fixing it with the ordinary reagents and staining it in the usual way. Again, if a concentrated viscous solution of egg-white be stretched between two points and then treated with the ordinary fixing reagents, it can be shown that the fibrils produced in it run longitudinally, and are connected by less prominent ones which run transversely. These fibrils must, of course, be purely artificial.

Dr. H. K. Anderson emphasised the point that though the neurones might be physically continuous, yet on the whole they must be trophically discontinuous. Experimenting upon very young animals, he had found that section of a post-ganglionic segment led to degenerative changes in the corresponding preganglionic segment. On the other hand, the converse was not true. As a further point against the view that the fibrillæ of a preganglionic segment were continued down into the postganglionic fibres, he pointed out that Langley had shown that the mode of termination of the preganglionic fibres in the sympathetic ganglia was not specific, since an ordinary motor nerve can be made to grow down to a sympathetic ganglion, and terminating there in its own specific manner could yet establish physiological continuity.

Dr. E. Overton pointed out that it had been proved that the presence of sodium ions was an essential condition for the physiological activity of both muscular and nervous tissues, and, in the second place, it had been shown that both sodium and calcium ions were essential for the proper action of nervous interconnections, thus tending to prove that some third substance intervened between the two units, *i.e.* that there was discontinuity.

Dr. W. MacDougall argued that the fact that motor neurones could not conduct backwards was the best evidence of discontinuity. Upon the same hypothesis depended also the simplest explanation of another typical characteristic of nervous activity—the effect of summation of weak stimuli. Moreover, the "law of nerve habit" was most difficult to explain except on the assumption that there is some intermediate structure between successive nerve elements which offers a resistance to the transmission of impulses, a block, however, which can be overcome by the action of appropriate stimuli.

Prof. Langley, in replying on the whole discussion, suggested among other points that the strands of material described by Dr. Kerr in the development of nerve fibres might be simply connecting structures along which the nerve fibrillæ, *i.e.* the true nerve element, grew down from the developing neuroblast.

Prof. E. A. Schäfer demonstrated a method of artificial respiration which is a modification of one first suggested by Dr. B. Howard in 1869. In Howard's method the patient in a case of drowning is first turned downwards and the back is pressed on two or three times to force out water from the lungs, after which he is turned face upwards. The operator is then directed to grasp the lower part of the chest and to press gradually forward with all his weight for three seconds, then with a push to jerk himself back and wait three seconds, repeating this eight to ten times a minute.

This method is simple, can be performed by one person,

and is fairly efficient so far as air exchange is concerned. The drawbacks are that the tongue in the face-up position tends to fall back and block the passage of air through the pharynx; that there is risk of rupturing the liver; and that there is risk of breaking the ribs if the operator is heavy and powerful and if the patient is advanced in years.

These drawbacks are avoided if the patient be turned into the prone position during the whole procedure. Greater efficiency is thereby attained, and the risk of injury to ribs or viscera is reduced to a minimum. The muscular exertion required is only that needed to swing the upper part of the body backwards and forwards on the hands about twelve or thirteen times a minute, the operator kneeling by the side of or across the patient. The pressure is gradually applied and gradually released. The amount of air exchanged by this method per minute is greater than that yielded by any other which has been tried, and may even exceed the ordinary rate of exchange of the individual.

Tables showing the amount of air exchanged in the various methods which have been recommended for artificial respiration were shown, from which it was seen that only in Howard's method and in Schäfer's modification of that method did the amount reach that attained in normal respiration. Schäfer's method is easy to carry out, even for prolonged periods, and is sufficient for the needs of a normal individual who submits himself to be respired in this manner. On the other hand, in both the Sylvester and Marshall Ward methods, a normal individual is unable to refrain from himself actively respiring on account of the air-exchange being insufficient.

Dr. F. W. Edridge-Green read a paper on the necessity of a lantern test as the official test for colour blindness. Dr. Edridge-Green described two cases, both naval lieutenants, which he had examined, in both of which the men passed the wool test but failed when examined by the lantern test. These were selected because both had daily experience with coloured lights and not with wools. He concluded, then, that because a man can sort wools correctly it does not follow that he can distinguish between coloured lights. In his opinion many varieties of colour blindness may escape detection by the wool test.

On Tuesday, August 23, Prof. A. Kossel (Heidelberg) communicated the main results obtained in work conducted in conjunction with Mr. H. D. Dakin on the protamines. These are the simplest type of proteids. One of them, salmin, when treated with boiling dilute mineral acid yields only five atomic groupings, viz. urea, diamido-valerianic acid, serine, monoamido-valerianic acid, and pyrollidin-carboxylic acid. They had investigated the relative proportions in which these five substances were present in salmin, and had found them approximately as follows:—ten molecules of diamido-valerianic acid, ten of urea, two of serine, one molecule of monoamido-valerianic acid, and two molecules of pyrollidincarboxylic acid. The composition of clupein was found to be complicated by the presence of alanine in addition. On the other hand, scrombine possesses an even simpler constitution, for, in addition to urea and diamido-valerianic acid, only alanine and pyrollidincarboxylic acid were found. Sturin obtained from the testes of the sturgeon presents a different constitution. Two diamido-acids are present, diamido-valerianic acid and diamido-caproic acid, the former being combined with urea. To this complex a heterocyclic group, histidine, remains to be added.

The ordinary proteids differ mainly from the protamines in an increased proportion of monoamido-acids, so that the complexity of molecule is extraordinarily great. This complexity is further increased by the addition of other groups, *e.g.* dibasic acids such as aspartic and glutamic acids, which are not present in the protamines.

Prof. J. E. Johansson (Stockholm) gave an account of his experiments upon the immediate effect of carbohydrates upon metabolism. These experiments dealt with the rate of excretion of carbonic acid following the administration of various carbohydrates, and were conducted upon man in a respiration chamber. He first showed that for a particular individual the rate of excretion was practically constant if taken some hours after a meal, and that this rate did not vary with differences in the previous diet nor at different periods of the year. If, then, an individual is given a quantity of a particular carbohydrate about eight hours after a meal, the amount of increase in CO_2 excreted is to be assigned to the food given. He showed in this way that an increase of CO_2 followed the administration of glucose, saccharose, or levulose, and that this increase, which amounted on the whole to from 8 per cent. to 20 per cent. of the total carbon given, began within the first half hour and lasted from two to three hours. The increase persisted longer after saccharose or levulose than after dextrose, and the total amount was greater. He further showed that the amount of the CO_2 surplus was in proportion to the amount of carbohydrate given if this did not exceed 150 grams. The effect of a dose of sugar was greatly influenced by the previous state of nutrition of the person experimented upon. Thus, after a fasting period of forty hours, the amount of carbon retained was much greater than after a ten hours' period. A further point of interest was that the amount and rate of destruction of the various sugars were not influenced by the performance of work. The two effects were additive, and did not interfere with one another.

Mr. P. P. Laidlaw gave the results of some observations on blood pigments. The iron in hæmochromogen is unstable to dilute acids, a fact which shows that hæmatoporphyrin is present in the hæmatin molecule. This was absolutely proved by the artificial formation of hæmochromogen by warming iron free hæmatoporphyrin in an ammoniacal solution to which Stokes's fluid was added from time to time, when on repeatedly reducing the mixture for an hour or so hæmochromogen was formed. The method of synthesis renders it probable that hæmatin is a combination of two hæmatoporphyrin groups with one of iron. Turacin also may be synthesised from hæmatoporphyrin by boiling with cuprammonium solutions.

Dr. F. G. Hopkins wished to lay stress on a further point which had not, perhaps, been brought out very clearly in Mr. Laidlaw's paper. It had been found that if reduced hæmoglobin was treated with a mineral acid, the decomposition went as far as the production of hæmatoporphyrin, whereas, when the same hæmoglobin was converted into oxyhæmoglobin and then treated with acid, hæmatin only was produced. From this it was clear that a very fundamental part was played by the iron in the conversion of hæmoglobin into oxyhæmoglobin.

Prof. A. B. Macallum (Toronto) read a paper on the distribution of potassium in animal and vegetable cells. A solution of the double nitrite of sodium and cobalt gives a yellow precipitate with a potassium salt. If, therefore, thin pieces of the tissue to be examined be treated with this solution, and the excess of the reagent be washed away with ice-cold water, the position of the potassium in the cells is indicated by the presence of the yellow precipitate. Its localisation may be rendered more obvious by converting the yellow precipitate into a black one by further treatment with ammonium sulphide, which precipitates the cobalt as a black sulphide. In this way is was found that potassium is never diffused through the cell. It is more abundant in vegetable than in animal protoplasm, and the nucleus is always absolutely free from it. Only one tissue element was found absolutely free from it, viz. the nerve cell and the axis cylinder. All dead and inert material in a living tissue becomes charged with potassium. This is especially the case with intercellular material.

Dr. W. B. Hardy remarked on the difficulties of determining the distribution of a soluble substance in so small a structure as a cell, for diffusion may be relatively rapid, and thus the results obtained might be very misleading.

Prof. Brodie suggested that the reason why the nucleus never contained any of the precipitate could be readily explained on the assumption that the nuclear membrane was impermeable to the cobalt salt. This, too, would explain the fact pointed out by Prof. Macallum that in many instances the precipitate was found accumulated immediately around the nucleus, for if the nuclear membrane were impermeable to the cobalt salt but permeable to a potassium salt, the latter as it diffused out would be precipitated at once by the excess of cobalt salt present in the surrounding protoplasm.

Prof. W. O. Atwater described his investigations on the nutrition of man at a joint meeting with the section of economics. An abstract of the paper will appear in another issue of NATURE.

Dr. W. Page May brought forward a communication by Prof. Elliot Smith and himself on the motor localisation in the lemur. He showed the area stimulation of which produced movements on the opposite side of the body, and demonstrated that the sequence of representation of movement was in agreement with that of Sherrington and Grünbaum on the ape. It also cleared up the discussion on the homologies of a small sulcus which had previously been described as postcentral and precentral, but which is really central, as Elliot Smith, arguing merely from morphology, pointed out two years ago.

He also described the results of localisation in the dog obtained by Elliot Smith and Wilson, who have shown that the excitable area is limited anteriorly by the crucial sulcus. This result was in harmony with the histological results of Cushing.

In a second communication Dr. Page May discussed the results of previous workers on the optic thalamus, and described some experiments he had made on this subject. He showed that following lesions in the thalamus certain motor disturbances were produced, and that descending paths could be traced from the thalamus into the anterior and lateral columns of the spinal cord. He also showed photographs and specimens of a descending tract hitherto undescribed in the posterior columns of the cervical and dorsal cord. This extended downwards from the thalamic region, and occupied a position near the middle line at the anterior end of Goll's column. In rare cases fibres could be traced into the lowest portions of the spinal cord.

Prof. G. S. Woodhead communicated the results of an investigation on joint-ill in the foal. This is an affection of especial importance to horse-breeders, in which, in addition to certain constitutional symptoms, marked stiffness and swelling makes its appearance in the joints, while at a later stage abscesses form. Investigation of the cause of this disease proved it to be due to a microorganism which gained admittance into the young animal through the cut end of the umbilical cord. From the practical point of view it was therefore evident that such precautions as are taken against septic infection in the case of the child at birth should also be taken in the case of the foal.

Dr. T. S. P. Strangeways gave an account of a committee of pathological research which is being founded with the object of investigating some of the more important diseases the pathology of which is as yet undetermined. The proposed lines on which the committee intends to act is to select some special disease and make an exhaustive study of it from all sides, a study which will last for two to three years. It is proposed to found a small hospital which shall be devoted entirely to cases of that disease during its period of study. The committee is to be a comprehensive one, and include all who will watch the course of the disease or who will undertake research work on the subject. These will report to a central body, which will also be responsible for the distribution of the collected facts and literature of the subject to those actively engaged in working upon it.

Prof. C. S. Sherrington and Miss S. C. M. Sowton communicated the results of an investigation into the amount of chloroform which, when administered to the heart, can dangerously embarrass its action. For this inquiry they had adopted the method, gradually evolved of recent years, of keeping the excised heart of a mammal alive by perfusing its blood-vessels with warm nutrient solutions. The heart used by them was that of the cat. The beating of auricle and ventricle was recorded graphically. The effect of chloroform was examined by allowing the perfusing fluid, pure saline, serum, or blood, as the case might be, to be replaced by a similar fluid to which chloroform in known quantity had been added. When this was done the chloroform showed its effect, practically at once, by diminishing the amplitude of the beat without altering its rate. The amount of the diminution was proportionate, within limits, to the concentration of the solution of chloroform. When exhibited in saline solution, chloroform showed a depressant action even in a dilution of 1 part in 150,000 of the saline solution. The full amount of the depression caused by a given solution was rapidly reached, *e.g.* in a minute, and then the continued administration of that solution caused no further depression—even if continued for half an hour at a time. That is to say, there is no cumulative action of the drug detectable in the isolated heart so perfused for a period of half an hour. On the contrary, there was generally evidence of a slight waning of the depression as the exhibition of the drug was uninterruptedly maintained. This tolerance was, however, quite evanescent, for on interrupting the perfusion with the chloroform solution and then returning to it, the depression recurred in its original depth. On discontinuing the perfusion with chloroform solution and reverting to the chloroform-free fluid, the depression caused by the chloroform—unless the chloroform solution has been of great concentration—is extremely rapidly removed, even when the beat of the heart has been for many minutes practically abolished. This suggests the view that the effect of chloroform on the cardiac muscle is due to the formation of some easily dissociable compound between the chloroform and some active constituent of the tissue. It has been recently urged by Moore and Roaf that this constituent is a proteid, and in favour of this view is a further fact elicited in the present inquiry. On comparing the amount of depression of a chloroform solution of given concentration, in salt solution on the one hand and in blood on the other, it is found that the effect of that concentration in blood is much less than it is in salt solution. In other words, the effect of a chloroform solution of given concentration in blood is only equivalent to that of a solution barely one-twelfth as concentrated in salt solution. This can be explained by supposing that the salt solution, though it supports the beat of the heart, supports it less well than does blood; but the more important part of the explanation seems to be that the tension of the chloroform in the blood is much less than in the salt solution. In other words, the difference seems referable to some constituent of the blood taking up and holding, in a relatively inactive form, a considerable fraction of the chloroform added to it. The chloroform added distributes itself in that complex fluid according to a coefficient of partition. It is only what is left over freely dissolved in it which is available for acting on the heart tissue. Comparative estimations of the depressant effect in blood, serum, and saline solution show that serum is intermediate between the other two, so that evidently the corpuscles contain, in large measure, a substance that combines with the chloroform.

THE RELATION OF OXIDATION TO FUNCTIONAL ACTIVITY.[1]

IN opening this discussion, Sir John Burdon-Sanderson said:—

In undertaking to open this discussion, I do not claim to contribute any results of my own researches or to speak on any subject *ex cathedra*, or with any degree of finality. I propose to state very shortly what seem to me the discussable questions, *i.e.* those respecting which we have experimental data, and to submit to the section those on which we need enlightenment.

The title is "Oxidation and Functional Activity." May I say that, without criticising it, I would ask for some latitude as regards the word oxidation. By oxidation is meant the formation of an oxide. Now we know that in the living organism oxygen may and does act without this happening, *e.g.* in those processes of which the oxygenating of the colouring matter of the blood is the type.

This is so important a distinction that I would suggest to substitute in these cases the term "oxygenation." The subject of our discussion would then be rightly stated as follows:—"The Relation between Oxygen and the Chemical Processes which Constitute Animal and Plant Life." The older notion of the part played by oxygen in the chemical processes of life was that it was a destroyer and not a maintainer of the chemical energies of the cell. We now recognise that oxygen may have a double function to perform, first as an element the presence of which is essential to the anabolic process by which living matter is built up, and secondly as equally essential to the disintegrative process which, taking muscular activity as the type of others, is associated with the performance of function. Of these two actions, in each of which oxygen is concerned—the *con*structive and the *de*structive—the second is better under-

[1] Report of a discussion before the Section of Physiology at the Cambridge meeting of the British Association, August 19.

stood than the first. It can be proved experimentally that in the living organism muscular work is accomplished by the transformation of a corresponding amount of chemical energy, however imperfectly we may understand how this transformation can occur at the temperature of the body. But as regards the participation of oxygen in the process of *restitution*, we are obliged to frame for ourselves a hypothesis and to clothe it in chemical language, according to which each elementary function is represented by a specific kind of living matter, *i.e.* by an aggregate of *living molecules* each of which is endowed in equal degree with the capacity of discharging the function which it represents. The difficulty lies in this, that the physiologist finds himself compelled to use chemical language in a sense which the chemist does not recognise. What we mean thereby is that the hypothetical living molecule consists of a permanent part which is not concerned in the performance of function, and of a collateral part which is used, *i.e.* disintegrated in every transition of the molecule from the inactive to the active state, to be immediately re-constituted when action ceases. This notion of *restitution* is the nutshell in which the difficulty lies. All that we know about it is that the access of oxygen is an essential condition for its accomplishment—oxygen not as an oxidiser, but as a restorer of functional capacity.

I now propose to pass from the general to the particular, *i.e.* to the consideration of the chemical process of life as it presents itself in particular organs, namely, first in muscle and in nerve centre, and secondly in such glands as have up to this time been investigated—two groups of structures representing what Bichat called respectively animal life and organic life. On the general principle that in all our investigations we should proceed from the known to the unknown, muscle must be taken first, for its metabolism is more within reach of investigation and is better understood than that of any other organ.

When oxygen enters the living substance of muscle it is not as an oxidiser, but as a preparer and builder up of material ready for explosion. For the muscle molecule receives two things from the blood, oxygen and oxidisable material, but these two do not combine as a mere result of juxtaposition or of encountering one another. As Ostwald says, "Der freie Sauerstoff ist ein sehr träger Stoff," at the temperature of the body. It cannot be brought into action in the living organism by a stimulus so long as it is in its free state. It must first become what Pflüger calls "intramolecular," and thereby change its Trägheit for mobility. The immediate effect of the access of oxygen is that the living substance of which it becomes a part becomes more susceptible to mechanical and electrical disturbance, *i.e.* more excitable than it was before. It requires, so to speak, to be wound up so as to become capable of discharging its oxidising function when awakened by a stimulus. Dr. Fletcher's experiments, to which I will return later, show that the more perfect this preliminary anabolic process is the more complete will be the catalysis.

You will, I think, agree with me that in different stages of the metabolic process which is associated with muscular function oxygen acts in different ways, at one time taking part in an integrating process for which we might, perhaps, employ the word oxygenation, at another in a process of oxidation, the molecule in which this occurs retaining its existence notwithstanding the disintegration of its oxidisable part.

We have now to pass on to the question how oxygen takes part in the functional activity of the central nervous system. The only part of that system which is within reach of experimental investigation is the spinal cord. We have to consider in how far the results of investigations in the cord and in muscle agree or differ.

Let me say on the threshold that our knowledge is largely due to work recently done at Jena and Göttingen under the direction of (or in cooperation with) Prof. Verworn. I must first ask your attention to the method.

More than thirty years ago Cohnheim taught us the use of a preparation which we used to call "the salt frog," in which the blood was replaced by physiological salt solution. He discovered that notwithstanding the defect of hæmoglobin, and consequently of oxygen, the chief functions of life could be carried on. With much more perfect methods Verworn has followed Cohnheim. The improvement consists in this, that the circulation is maintained by mechanical means, so that by varying the rate of flow and the percentage of oxygen in the liquid the supply of oxygen to the cord can be increased or diminished at will. The effect produced is judged by the mechanical responses to reflex excitation, the indications given by which are rendered more delicate by the previous administration of a trace of strychnine. The first step in the experiment is to establish a normal state of things by the circulation of salt solution which has been freely exposed to air or oxygen. Under these conditions the response to stimulation of the surface consists of a succession of brief tetani, each lasting two or three hundredths of a second. The next step is to substitute salt solution which has been deprived of oxygen, and to observe that the reflex centre is gradually paralysed, as indicated by the fact that single tetani have taken the place of the serial responses, that on renewing the supply of oxygen the former state of things is restored, and, finally, that these changes may be repeated over and over again with the same result.

All these facts come under the general statement that while oxygen has no power of acting as a stimulus it increases the excitability of the centre, enabling it when excited to discharge itself so completely that after the discharge it is wholly incapable of responding. It further shows that oxygen shortens the time required for restitution to the normal—reintegration following disintegration—anabolism following katabolism so immediately that they may almost be considered as simultaneous.

If we compare the behaviour of oxygen in the centre with its behaviour in the muscle, we shall find that they differ chiefly in one particular, namely, in their time-relations. In both cases oxygen acts as a predisposing, not as an exciting cause of functional activity. In both cases a *tertium quid* is wanted—a liberating or letting off mechanism; but in the muscle the functional cycle is accomplished in scarcely more than 1/100 sec., whereas in the centre the effect occupies a few hundredths of a second, and the preparation for it a much longer period. There is therefore no difficulty in understanding why the so-called refractory period can be so easily observed and measured in the centre (while in the muscle its presence can only be inferred), a circumstance which is helpful as affording an additional evidence of the anabolic action of oxygen; for it is easy to show that the period in question is shortened by supply of oxygen, protracted by its absence.

We now come to the last point which I am anxious to submit to you—that of the relation of oxygen to the function of glands. I must begin by saying that it is in this part of our subject that the crux lies, for the investigation of the intimate metabolism of glands is beset with difficulties even greater than those of muscle and spinal cord.

Mr. Barcroft, to whose admirable researches we shall have occasion to refer repeatedly to-day, found as the result of his estimate of the oxygen and carbonic acid yielded by the blood circulating through the submaxillary gland under different conditions that this gland takes from the blood much more oxygen when excited by the chorda tympani than when at rest, no such effect occurring when the excitation had been rendered ineffectual by the previous administration of atropine. These observations gave good reason for believing that oxygen promotes the action of the cells, but afforded no evidence that this action is attended by a corresponding discharge of carbon dioxide. Similarly Prof. Starling, whose experiments were made with Mr. Barcroft's cooperation, found that when the pancreas is made to act by the injection of secretin a similar want of relation presented itself between the quantity of oxygen taken in and of carbon dioxide discharged. Finally, the comparison which has been recently made by Dr. Brodie (who will, I hope, explain to us his very admirable method) of the state of activity of the kidneys with the state of rest, points to the same conclusion as regards that organ. When diuresis was produced by the injection of urea, the clearest evidence was given of the increased demand for oxygen, the intake of which was very largely increased, but there was no indication that the ultimate products of oxidation found their way into the blood in quantities proportionate to the oxygen supplied.

Taking these data as our point of departure, what can we infer from them as regards the resemblances and differences between the two processes we have been considering,

viz. the functional activity of muscle and nerve centre on the one hand, that of gland on the other? The *obvious* contrasts which exist between secretion, muscular contraction, and reflex innervation need not be dwelt upon; the one thing with which we have to do is the nature of the chemical processes which are associated with these three forms of activity. If analogies are to be sought for it is here they will be found.

I submit to the section, and particularly to those members of it who are engaged in experimental researches on the subject, that the most important contrast between the concomitant chemical processes of gland function and muscle function consists in this, that whereas the former is not in any marked degree katabolic, the dominant process in the oxidation which is inseparably associated with the performance of muscular function *is* katabolic. We can readily account for this by reference to the fact that whereas the processes in muscle and in reflex centre are excitatory, those in glands are for the most part determined by stimuli of a very different kind from those that evoke nervous or muscular action, which last act exclusively as liberators of katabolic processes which are waiting to be discharged.

We have long been accustomed to regard the process by which, in muscle, chemical is translated into mechanical energy as explosive and instantaneous, and to take the end-result—the discharge of carbon dioxide—as the necessary concomitant of the production of heat and work; but as I remarked before, Dr. Fletcher recently published experiments which seem to show that for the attainment of this ultimate result it is essential that the muscle should be abundantly supplied with oxygen, in failure of which the oxidation process may stop short before its completion. I trust that we shall have the advantage of hearing to-day the further results of his researches, and particularly that he will give us information as to the relation between efficiency of contraction and the degree of completeness of the oxidation process.

In conclusion, the questions which present themselves are:—

(1) Whether it may be generally stated that the oxygen which is conveyed to the living matter of the tissues by the blood *is stored as "intramolecular oxygen" until it is required for the performance of katabolic functions*, and, if so, what is the *chemical relation* between the stored oxygen and the living molecules by which it is held? In submitting this question, I must again ask that the use of the term "living molecule" may be condoned.

(2) Whether it may be assumed that every *disintegrative process conditionates a subsequent integrative process* by which the *status quo* is restored in the same living molecule; if so, does the anabolic effect which in muscle *follows* the change of form constitute as much a part of the response to stimulation as the catabolic effect which *precedes* the change of form? Can this be said of the chemical process which is associated with functional activity in gland?

Continuing the discussion, Dr. W. M. Fletcher pointed out that in the muscle cell only the katabolic processes had been effectively studied, and that these are characteristic of the special material giving energy for contraction—a material probably without analogue in the gland cell. The classical conceptions, due to Pflüger and to Hermann, of this material as a highly oxygenated substance breaking down, whether rapidly as in contraction or slowly as in survival periods, by inevitable stages to the ultimate stages of carbonic acid and water, irrespective of a contemporary supply of oxygen, were discussed and compared with the views of Verworn. It was urged that while a preliminary oxygenation of the living molecule may be admitted on wide grounds as the condition of irritability, such a conception by no means precludes the idea of additional oxidative processes occurring at some stage or stages of the katabolic disintegration. Disintegration effected under anaërobic conditions might, on this view, stop short of its normal end-products, these being replaced by representatives of earlier stages in the breakdown. Evidence in this direction has been got from three main classes of experiment. In the case of excised muscle, Dr. Fletcher's observations of the relation of oxygen supply to the yield of carbonic acid in rest and in activity, and to the onset of fatigue and of rigour, were described and held to be incompatible with the view that the entrance of oxygen conditioned the lability of the molecule without further influence upon the subsequent course of katabolism. A second class of evidence was derived from the work of Chauveau and Kauffman, Ludwig and his pupils, Minot and others, upon the respiration of muscles with artificial circulation. An increased yield of carbonic acid due to activity was claimed or denied by these observers strikingly in proportion to the success with which the artificial circulation had been made to reproduce the normal. A third and large body of evidence is supplied by observers like Araki, Geppert, Meyer, and others, who have studied the results of muscular contraction with normal circulation, but under conditions of deficient oxidation. Anaërobic conditions always appear to diminish the amount of carbonic acid expired, while increasing the amount of acid products in the tissues, the blood, or the excreta.

Prof. N. Zuntz (Berlin), in a letter addressed to the section, referred to some of the points which it had been suggested should be dealt with in the discussion, in the following terms:—"Is one justified in drawing a hard and fast line between the anabolic and the katabolic processes on theoretical grounds? Would it not be more correct to take Pflüger's view and regard that process as the normal one in which every katabolically decomposed molecule is at the very moment of decomposition anabolically regenerated by taking up oxygen and oxidisable groups? In this case one would regard the katabolic processes, which render the molecular structure less stable and give rise to free affinities, as the factor which inaugurates and makes possible normal anabolism. In this connection, however, the fact remains that anabolism can also take place later on, if an element such as oxygen, necessary to the building up of the molecule, should be wanting at the time that the katabolic processes occur. It is accordingly a subject for investigation to decide whether subsequent regenerative processes occurring in the above manner take place as easily as normal assimilation occurring at the same time as the breaking down of the molecule, or whether they use up more energy if they occur later. I have already some data which tend to show that anabolism demands more energy if it has to take place at a period after the katabolic processes, but I dare not yet give any definite verdict on the question.

In regard to the question as to how far the metabolic processes may be the work of an oxidase, I should like to lay stress on the fact that the fundamental importance of innervation for katabolic processes in muscle is not easy to reconcile with the assumption that these processes are much affected by ferments. Neither does the great influence which the tension of a muscle has on oxidation processes in it harmonise with our knowledge of the action of enzymes.

Prof. T. G. Brodie described the results obtained in experiments, conducted in conjunction with Mr. Barcroft, upon the gaseous exchanges in the kidneys under the different conditions of rest and activity. In all cases they had found that the amount of oxygen taken in by a kidney which was made to secrete urine actively was greatly in excess of that absorbed by a resting kidney, while on the other hand the quantity of carbonic acid eliminated showed far slighter variations. In the greater number of their experiments they had found that the kidney at rest eliminated a greater volume of carbonic acid than it absorbed of oxygen. Their results thus indicated that the performance of work by the kidney was accompanied by an approximately proportional increase in the intake of oxygen, while the output of carbonic acid, although increased, was usually much less in amount. From the fact that the carbonic acid output was often in excess of the oxygen intake, it would seem that the final metabolic changes, as evidenced by the carbonic acid output, was a more gradual process, though the results they had obtained, up to the present, did not warrant the conclusion that the carbonaceous waste products resulting from the activity of the tissue were confined to carbonic acid only.

Mr. J. Barcroft, in discussing the metabolism of glands generally, pointed out that there were three methods which had been used for the investigation of their gaseous metabolism. In the first, an excised organ was kept in an enclosed space, and the surrounding air analysed. This method had been dealt with by Mr. Fletcher, who had pointed out that the method shed light on the katabolic

phase of activity only. In the second method the general gaseous exchanges of the body were watched during states of rest and activity of the organ to be investigated. This, however, was inapplicable to the glands of the body on account of their small size. The third method was that of measuring the blood gases, combined with an estimation of the rate of flow of blood through the gland.

Three glands have been studied by this method up to the present, the submaxillary, the pancreas, and the kidney. In the submaxillary gland the problem was very complicated, since the blood became concentrated, losing a tenth of its water or even more, and a considerable quantity of the carbonic acid left the gland in the secretion. After due allowance had been made for these disturbing factors, it appeared that the O intake and the CO_2 output were increased from three- to four-fold during stimulation of the chorda tympani nerve. As to how far these changes might be due to concomitant vascular changes was studied by examining the gaseous exchanges of an atropinised gland during stimulation of the chorda. It was found that this led to no increase in the amounts of O withdrawn, though an increased output of CO_2 was observed.

In the pancreas, which had been studied in conjunction with Prof. Starling, there was often no increased flow of blood synchronously with a secretion following an injection of secretin. They invariably found an increased absorption of O. Usually this increase was considerable; thus from eight comparisons the mean quantity of O taken up by the resting gland was 1·5 c.c. per minute, and by the active gland 5·5 c.c. per minute. These results were entirely in harmony with those brought forward by Prof. Brodie for the kidney.

It seemed, then, that glandular activity was accompanied by a large and instantaneous consumption of O, but that it was not necessarily accompanied by an increased CO_2 output.

Another point indicated was the magnitude of the gaseous metabolism of glands. In the submaxillary and in the pancreas, when at rest, about 0·025 c.c. to 0·035 c.c. of O per minute per gram of gland substance was absorbed. In the kidney Prof. Brodie had given one instance in which the organ was using as much as one-fifth of the total quantity of O taken in by the lungs, and it was common to find the O consumption of the kidney during diuresis to amount to one-tenth of the total taken by the whole body.

Prof. T. Clifford Allbutt suggested that the theories advanced as to the part played by oxygen offered some explanation of the fact, often experienced clinically, that the administration of oxygen gave relief to patients not only in cases where the heart and lungs were affected, but in many others also. He had long since given up the idea that oxygen was effective in these cases simply on account of the more favourable conditions under which the respiratory functions were placed. This was evidenced, for instance, by the tenacity with which the patients adhered to the treatment; for example, in cases of the vomiting of pregnancy, where its administration was often of great service.

Sir John Burdon-Sanderson, in bringing the discussion to a close, remarked that it had been an exceedingly fruitful one, and none the less so because the points under discussion had not been settled, but were still under investigation. It seemed clear to him that oxygen played two parts in metabolic processes, one of which was prominent in muscle, and was responsible for the final oxidation of explosive material, while the other, which was more accentuated in glands, was akin to a building up process, as it was involved in the elaboration of new material.

GEOLOGICAL NOTES.

THE puzzling and commonly fragmental remains styled by von Gümbel Lithiotis are the subject of an elaborate monograph by Dr. Otto Reis (*Abhandlungen der k.k. geol. Reichsanstalt*, Bd. xvii., Heft 6, 1903). After being considered as plants, from algæ to palms, for some twenty years, they settled down in 1890 as bivalve molluscs allied to oysters. Von Gümbel's revision, to this effect, is now revised by Dr. Reis, who points out that certain long ridges in the hinge-area represent teeth. Two genera, Cochlearites and Lithiotis, are established, forming the Lithiotidæ, a subfamily of the Spondylidæ. The minute structure of the shells is carefully described.

The interest aroused by the publication of "Bau und Bild Österreichs," recently reviewed in these columns, has called from Dr. Friedrich Katzer a series of papers (*Verhandlungen der k.k. geol. Reichsanstalt*, 1904, pp. 123, 150, 177, and 193), in which he hopes to fill some of the gaps still remaining in our knowledge of Bohemian geology. His work covers such widely diverse subjects as the zoning of the north-eastern coalfield under the Riesengebirge, and the magnetite-ores, occurring as separation-products in garnet-amphibolite, in the neighbourhood of Kutna Hora.

In the *Verhandlungen der k.k. geol. Reichsanstalt* for 1904 Herr R. Zuber (p. 200) explains his views as to the analogy of the Flysch deposits of Europe and those forming in tropical climates, with a heavy rainfall, in the neighbourhood of the mouths of rivers, whether these flow from continental land or from the members of an archipelago. Dr. H. Vetters (p. 134) interestingly connects the structure of the Little Karpathians with that of the eastern Alps on the one hand, and of the true Karpathians on the other. The Flysch of the north side of the Alps thus reappears from under the Vienna basin, and passes into the Karpathian Sandstone series; while the characteristic Karpathian "Klippen" are also traceable in this connecting range. The author regards the so-called Silurian grauwacke of Hainburg, down against the Danube, and similar rocks of the Leitha range, as in reality the equivalents of the Liassic beds in the Little Karpathians.

The *Jahrbuch der k.k. geol. Reichsanstalt* of Vienna usually contains more massive papers than the *Verhandlungen*, though it is difficult to discriminate between the two in scientific value. In vol. liii. of the former (1903), pp. 169–252, Dr. O. Ampferer describes, with numerous sections, the Triassic and Jurassic mountains that form the impressive broken country of crag and forest between Innsbruck and the Achensee. He illustrates his view of their structure (plate x.) by a skilful drawing of a relief-model, much in the American manner, thus emphasising the simpler anticlinal and synclinal structure in the south, and the great overfold of Trias upon a recumbent Jurassic synclinal in the Gamsjoch area. It seems possible, as the author points out, that the whole highland of Triassic rocks rests upon an underfolded and underthrust knot of younger strata. Dr. Ampferer modestly regards his own researches as supplementing, and correcting at certain points, those of Prof. Rothpletz and his Bavarian colleagues. He adds, moreover, details as to the glacial phenomena throughout the district. Herr E. Fugger's paper in the same volume (p. 295) describes the foothills of the Alps in the famous Salzkammergut area, where the Flysch, with its dubious fossils, forms the oldest series, and is confidently ascribed to the Upper Cretaceous epoch. Dr. F. Ryba (p. 351) revises and amplifies the list of fossil plants from the Cannel Coal of Nýřan in Bohemia, and Dr. Waagen (p. 443) adds to our knowledge of the small brachiopods characteristic of the Tyrolese Trias.

We have received the August number of the *Quarterly Journal* of the Geological Society, which contains a well illustrated article on the history of volcanic action in the Phlegræan Fields by Prof. Giuseppe de Lorenzo; an account of the discovery of a human skeleton in Gough's Cavern, at Cheddar, by Mr. H. N. Davies, who regards the remains as of late Palæolithic age, although in the discussion which followed the reading of the paper this antiquity was questioned; and among other papers there is an important one on the age of the Llyn-Padarn dykes in Carnarvonshire by Mr. J. Vincent Elsden, who regards these deep-seated intrusions as having taken place during the latest stage of the Bala eruptions.

The summary report of the Geological Survey Department of Canada for 1903 has been issued by Dr. Robert Bell, the acting deputy head and director. As usual, the energies of the staff have been given mainly to investigating and aiding the development of the mineral resources of the country. Field work has been carried on in Yukon territory, in British Columbia, in the Keewatin district, in Ontario, Quebec, New Brunswick, and Nova Scotia. In connection with the large output of coal which is now going on in

both Nova Scotia and Vancouver Island, it is mentioned that the only coal known to occur in North America on the immediate seaboard of either the Atlantic or Pacific belongs to Canada.

Some new genera of Carboniferous Mollusca from the United States have been described by Mr. G. H. Girty (*Proc.* U.S. National Mus., vol. xxvii., No. 1372). They include Limipecten, a form considered to be near to Aviculipecten (*sic*), and with that genus to have affinities with the Pectinidæ rather than with Aviculidæ. Other new genera are Pleurophorella, allied to Allerisma, and Clavulites, having some resemblances to Dentalium.

The Miocene diabase of the Santa Cruz Mountains in San Mateo County, California, is described in some detail by Messrs. H. L. Haehl and R. Arnold (*Proc.* Amer. Phil. Soc., vol. xliii., No. 175). The diabase, in the form of tuffs, dykes, and intrusive sheets, occupies about 35 square miles in an area of 300 square miles. It is remarked that the tuffs are interbedded with Miocene limestones, sandstones, and shales, and that intrusions of limestone derived from the interbedded limy layers have been forced into fissures in the tuff. In the intrusive diabase the percentages of soda and titanium are large, and it presents the characters of augite-teschenite.

An essay on the palæontology of the Lancashire Coal-measures, part i., contributed by Mr. H. Bolton to the *Transactions* of the Manchester Geological and Mining Society (vol. xxviii., part xiv.), has been reprinted as one of the "Museum Handbooks" of the Manchester Museum, Owens College (price 1*s*.). In this work the author deals with the lower Coal-measures, and his object has been to record the horizon and geographical occurrence of each species so far as possible by reference to known specimens.

Prof. G. A. J. Cole and Mr. T. Crook have reported on rock specimens dredged from the floor of the Atlantic off the west coast of Ireland in 1901 (Dept. of Agric. and Techn. Instruction for Ireland, App. to part ii. of Rep. on Sea and Inland Fisheries). The rocks which were obtained off the west coast of Mayo and Galway appear to have been derived from submerged masses of rocks familiar in western Ireland. They include also an olivine-gabbro which is regarded as probably of Carboniferous age.

In an article published in the *Land Agents' Record* (August 20) Mr. F. J. Bennett directs attention to the important uses to which the Ordnance Survey maps, on the scale of 25 inches to a mile, might be put for estate and agricultural purposes. As he points out, much valuable information is lost, both to the landowner and farmer, to say nothing of the geologist, for want of recording it at the time. He instances the nature of the soil and subsoil as proved in draining the land and in various temporary excavations, as well as information with regard to wells, springs, stone quarries, or clay pits. The courses of the drains have rarely been laid down on estate maps. In addition to records of these matters, he suggests that the maps be used also for statistics with reference to cultivation. Thus the amount of seed sown, the kind and quantity of manure used, the weather, and, finally, the result of each field crop might be notified. If these particulars were tabulated, say for seven years, the reasons for success or failure might be judged. In the transfer of property or of leases such information would be of the utmost value to the incoming owner or tenant, and the records, which would be the private property of the occupier, should be of sale value.

We have received a number of important geological publications from South Africa. In the *Transactions* of the South African Philosophical Society (vol. xv., part ii.) Mr. E. H. L. Schwarz describes the high-level gravels which cap the flat-topped hills all over the southern coast regions of Cape Colony. The evidence shows that the gravels were river-borne, and in the Karroo district they yield gold. No gold-bearing reef has, however, been detected in that area, and the author is strongly of opinion that the gold came from the Zwartebergen, where it occurs in the Table Mountain Sandstone. Messrs. A. W. Rogers and A. L. du Toit describe the Sutherland volcanic pipes and their relationship to other vents, notably those of Kimberley. In the *Transactions* of the Geological Society of South Africa (vol. vii., part i.) there are various papers of local interest on the geology of the Transvaal, and on the Witwatersrand series in particular. In the annual report of the Geological Commission of the Cape of Good Hope for 1903 we have a record of the careful detailed work carried on by the director, Mr. A. W. Rogers, and his staff. The survey of the south-western portion of the Karroo has been completed, and much information has been gathered with reference to the sedimentary and volcanic formations. The recognition, in the Verloren Valley, of a group of rocks (the Ibiquas series) between the Table Mountain Sandstone and the Malmesbury series is of considerable interest.

"The Geology of the Country around Merthyr Tydfil" (being the fifth part of the "Geology of the South Wales Coal-field") has just been issued by the Geological Survey, price 1*s*. 6*d*. It is the work of Messrs. A. Strahan, Walcot Gibson, and T. C. Cantrill, and is an explanation of the geological map sheet 231. The area includes the North Crop of the Coal-field from Dowlais to the Tawe Valley, with a considerable tract of Old Red Sandstone in the mountainous land of Fforest Fawr, and also of Lower Carboniferous rocks. The great scarp of the Pennant Sandstone stretches across the country on the south. The stratigraphical features, the lithology, the faults and disturbances of this important coal-region are dealt with very fully; the Glacial drifts and other superficial deposits are duly described, and a short chapter is given on the economic products.

We have received an official report by Signor A. F. Umlauff on the Cinnabar of Huancavelica, issued as a *Boletin* of the Corps of Mining Engineers of Peru. The ore occurs in irregular deposits in sandstones and limestones, which have yielded Cretaceous fossils, and sections are added showing its mode of occurrence. A description is also given of the aludel furnaces, which are used in extracting the mercury, and have remained practically unchanged for more than two centuries.

From the United States Geological Survey we have received *Bulletin* No. 228, dealing with analyses of rocks from the laboratory, 1880 to 1903, by Mr. F. W. Clarke; also *Professional Paper* No. 28, giving the superior analyses of igneous rocks from Roth's Tabellen, 1869 to 1884, arranged according to the quantitative system of classification.

The occurrence of a "calcareous coal" in the Lanarkshire Coal-field is described by Mr. R. W. Dron (*Trans.* Inst. Mining Engineers, vol. xvii.), and shown by analysis to contain carbonates of lime and magnesia. The author seems to have been unaware that Mr. A. Strahan, in 1901, brought before the Geological Society an account of the passage of a seam of coal into dolomite, as observed at the Wirral Colliery in the small Parkgate Coal-field.

The glaciation of Mount Ktaadn, in northern Maine, forms the subject of an essay by Mr. R. S. Tarr (*Bull.* Geol. Soc. Amer., vol. xi.). The mountain, which is composed of granite, rises to a height of 5150 feet, and has hitherto been regarded as bearing no proof of ice-covering during the Glacial period. The author brings forward evidence to show that the ice did overtop the mountain, and that glaciers subsequently occupied the valleys on its eastern side, leaving well defined moraines some of which enclose lakes.

In the *Brazilian Mining Review* (for April and May) Mr. H. Kilburn Scott gives some account of the mineral resources of Rio Grande do Sul, which is the southernmost of the States of Brazil. The village of Lavras is at present the centre of the gold-mining industry, the gold occurring in quartz-veins or as impregnations in decomposed syenite-rock. The principal copper deposit is that of Camaquam, and the ores comprise copper glance, copper pyrites, and bornite (erubescite). Lodes occur in hard conglomerates and sandstones which have been invaded by melaphyre, and there seems to be a close connection between these metalliferous deposits and the eruptive rock.

A useful index to the mineral resources of Alabama, compiled by Messrs. E. A. Smith (State geologist) and H. McCalley, has been issued by the Geological Survey of Alabama. It includes an account of iron and manganese ores, bauxite, coal, clays, building stones, mineral paints, mineral waters, &c., and is illustrated by a small geological map and pictorial views.

The tin deposits of the York Region, Alaska, are briefly described by Mr. A. J. Collier (*Bulletin* No. 229, U.S. Geol. Survey). Stream tin was discovered in 1900, and since then

prospecting has been going on to determine its extent and to locate its source in the bed-rock. The ore is mostly cassiterite, but stannite also occurs. Pebbles of slate containing small tin-bearing quartz veins have been found in the gravels, while elsewhere the ore has been found disseminated through more or less altered granitic dykes.

PRIZE SUBJECTS OF THE INDUSTRIAL SOCIETY OF MULHOUSE.

THE Industrial Society of Mulhouse has issued a programme of the prizes to be awarded by the society in 1905; excluding the subjects which are of a purely local or technical character, the following are the principal prizes open to competition to all nationalities:—

In the section of chemistry, medals of honour will be given for experimental investigations of the alizarine reds, of the colouring matter of raw cotton, of the transformation of cotton into oxycellulose, and of cochineal carmine; for the synthesis of the colouring matter of cochineal or of some other dye used in industry; and for the production of fast dyes of a specified nature. Several medals will also be awarded for studies of special mordants and for the synthesis of some naturally occurring substance. A sum of 500 francs to 1000 francs is to be allotted to the best compilation of densities of mineral and organic substances in the solid state and in cold saturated solution. Many practical chemical problems in the bleaching and dyeing of cotton, wool, and silk are also suggested as subjects for competition.

In the section of mechanical arts, a prize of 500 francs and a silver medal is offered for a new method of construction of buildings suitable for cotton spinning, wool combing, or calico printing. The following subjects will receive medals:—a new non-tubular type of boiler; an indicator of the total work done in a steam engine; a new system for heating steam boilers; various machines for combing, carding, and weaving the textile fibres; a comparative study of electric and gas lighting in factories; a system of automatic lighting by conductors of the second class.

The following subjects deal with natural history and agriculture:—a catalogue of the plants in the neighbourhood of Mulhouse, Thann, Altkirch, and Guebwiller; an account of the fauna of Alsace; a mineralogical or geological description of part of Alsace; a study of the plants or insects inimical to agriculture in the same province. A medal is also offered for an investigation of the character of Alsace in prehistoric times.

In the sections of commerce and statistics the subjects are:—a consideration of the questions of insurance against risks of transport and fire; the influence of taxation on industry; and the effect of trusts and like organisations on commerce.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. J. J. Lister, F.R.S., of St. John's College, has been appointed demonstrator of comparative anatomy.

The Board of Geographical Studies has arranged for a course of instruction in geographical surveying, to be given by Mr. Hinks at the observatory.

The council of the Senate proposes an important scheme whereby the matriculation and senior local examinations of the Universities of London, Oxford, and Cambridge shall be mutually recognised. The object is to diminish the number of distinct examinations for which schoolmasters have to prepare their pupils. The proposed conditions are set forth in the *University Reporter* for October 11.

Mr. R. R. Webb, St. John's, Mr. G. H. A. Wilson, Clare, Mr. J. M. Dodds, Peterhouse, and Mr. E. W. Barnes, Trinity, will be the examiners for the mathematical tripos, part i., in 1905.

SIR ISAMBARD OWEN has been appointed principal of the Durham College of Science in place of the late Dr. Gurney.

DR. ARTURRO MARCACCI, of the University of Palermo, has been appointed professor of physiology in the University of Pavia.

DR. HERMANN KOSSEL, of the Imperial Board of Health at Berlin, has been appointed to the chair of hygiene at the University of Giessen in succession to Dr. Georg Gaffky.

THE first congregation to inaugurate the University of Leeds was held on October 6, and the honorary degrees announced in our issue of September 29 (p. 547) were conferred. The Chancellor of the university, Lord Ripon, presided.

WE learn from the *Athenaeum* that Dr. Hans Batterman, of the Berlin Observatory, has been appointed director of the observatory at Königsberg, and professor of astronomy at the University of Königsberg, in succession to Prof. Hermann Struve, lately appointed to the vacancy at Berlin caused by the retirement of Prof. Förster.

THE Board of Education has issued its "Syllabuses and Lists of Apparatus" applicable to schools and classes other than elementary from August 1, 1904, to July 31, 1905. A new subject, under the title "Elementary Science of Common Life (Chemistry)," number twenty-six, has been added to the list of branches of science in which the board holds examinations. The list of subjects in which no examinations are held, though the subjects are recognised by the Board, has been extended, and now includes many subjects introductory to more advanced work in technology.

THE anonymous gift of 1000*l.* to the University College of Bristol announced a few days ago is, it may be hoped, an indication that the work of this institution is being appreciated in Bristol and the surrounding district. In addition to the usual courses, appropriate and systematic instruction is given at the college in those branches of applied science which are most nearly connected with the arts and manufactures. We notice that the total number of individuals, excluding medical students, attending the college during the session 1903–4 was 1084, of whom 596 were day students.

THE new calendar of University College, London, that for the session 1904–5, gives full particulars of several interesting new developments in the work of the college. The university courses of study, especially those in economics, have been extended, and further arrangements have been made for post-graduate courses, lectures, and research—this post-graduate work is explained fully in ten pages of the calendar. The list of papers and other publications from the scientific departments of the college, since the Dean's report of last year, runs to eight full pages, and shows that the work now being accomplished in the college is of the same high order as in previous years.

IT is reported that there is apparently a deficiency of about 2000*l.* for the annual working expenses of the Tata Research Institute, and on account of this the scheme for the institute is at a standstill. Referring to this, *Capital* remarks:—"The question now is whether for the sake of two or three thousand pounds India should go without a Research Institute. Is the object good or not? If it was not good, why did the Government of India promise to help it? If it is good, why should there be any stinginess on their part about it? Should a great Government refuse its support and countenance to a scheme, the expenditure on which will be repaid not only to the people of India, but also to the Government itself a hundredfold?"

THE buildings of the new technical college at Danzig were opened on October 6 in the presence of the German Emperor. The college, which has been established on a modern basis, is intended to develop the industries of West Prussia and of the city of Danzig. Shipbuilding is to receive special attention. In a speech which he made, the Emperor referred to the importance of technical education for the maintenance of Germany's position among the nations, and described the special characteristic of the German technical colleges as being their "comprehensive many-sidedness." It is, he continued, for this reason that these colleges constitute a scientific "Universitas" which may be compared justly with the old universities, and explains why the endeavour has been made to place the two kinds of institutions on an equal footing by bestowing upon the technical colleges the right to confer degrees. "May the new college," the Emperor concluded, "prosper and flourish to the glory of German learning, to the blessing of these old Prussian provinces, and to the honour of the German name!"

A RESOLUTION adopted by the manufacturers' section of the London Chamber of Commerce, and approved by the council of the chamber, was recently forwarded to the Board of Education together with a letter from the secretary of the chamber expressing the views of the manufacturers more explicitly. The resolution states that, in order to retain our industrial position and to introduce into this country such further industries as may be profitably developed, the manufacturers' section is of opinion that it is absolutely necessary to raise the standard, and, if possible, cheapen the cost of technical and higher technical education, and that representations should be made to the Board of Education in this sense. The letter to the Board of Education points out that up to the present time manufacturers in this country have not realised that there is a scientific aspect to every branch of manufacture, requiring study to attain the highest results, and that there is hardly an industry that would not benefit from the more general employment of specially qualified scientific assistants. At present such qualified assistants as are available are mostly foreigners, the letter continues, and there is urgent necessity for providing greater facilities for obtaining a thorough training in applied science in this country. There would seem to be urgent need for technical colleges of university type in connection with each industry, where students could have opportunities of carrying out specialised study and research work under competent teachers. The fees charged should not be greater than those charged by similar Continental institutions, and poorer students of ability should be assisted by a liberal system of scholarships. Mr. Morant, replying on behalf of the Board of Education, says the board is keenly alive to the importance of encouraging a better provision of higher technical education than at present exists, and will take every step in its power towards its promotion. But these efforts will be largely in vain unless British manufacturers give every encouragement in their power to promote the employment of students at home thoroughly trained for the needs in question. Mr. Morant rightly points out, with reference to the considerations submitted, that the want of properly qualified English assistants referred to may be attributed partly to the fact that the salaries offered are frequently too low to tempt natives of this country, partly to the shortsightedness of many English parents in refusing to continue their sons' education to a sufficiently advanced point, partly to the fact that there is no adequate provision at present in Great Britain for enabling persons to acquire the manipulative skill necessary in certain branches of industry, and partly also to the inadequate endowment and the insufficient encouragement of research.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 3.—M. Mascart in the chair.—A comparison of the expenditure of the flexor and extensor muscles of the forearm, applied, each group separately, to the production of the same continuous external work: A. **Chauveau.** The energy expended was measured by means of the respiratory coefficient. It was found that the external work effected by the flexor muscles of the forearm was less than that of the extensors, the proportion being about 0·4 for the former and 0·6 for the latter. This difference appears to be due exclusively to the less favourable conditions under which the extensor muscles work.—On the loss of electricity in air in the neighbourhood of thermal springs: A. B. **Chauveau.** In the thermal springs at Cauterets, the radio-activity of the air near the spring was clearly marked, the loss observed in the neighbourhood of the reservoir being three times as fast as in the open air.—The colorations produced by the Becquerel rays; its application to crystallography and to the calorimetric determination of radio-activity: C. J. **Salomonsen** and G. **Dreyer.** The coloration produced by radium on certain crystals demonstrates the zonal structure of the crystal, and thus throws light upon the manner in which it has been built up. In the case of quartz, this zonal structure has not hitherto been demonstrated.—On a vacuum effect produced by a waterspout: Léon **Pigeon.**—On actinium: A. **Debierne.** The substance previously described by the author under the name of actinium presents many similarities with the emanium of Giesel. The opportunity has recently arisen of directly comparing the two substances, and the observations of M. and Madame Curie, M. Giesel, and the author on the characteristic phenomena of phosphorescence provoked by the two products shows that they are identical. The name emanium should therefore be dropped in favour of the earlier actinium.—The properties and constitution of the molybdenum steels: Léon **Guillet.** The series of steels studied contained only 0·2 per cent. of carbon, with molybdenum increasing from 0 per cent. to 15 per cent. A second series contained about 0·85 per cent. of carbon. In small quantity, molybdenum increases the breaking load without causing extra fragility. The general properties of the molybdenum steels resemble those of tungsten steels, but four times as much molybdenum as tungsten is required to produce the same results.—A thermochemical comparison between rosanilines and leucanilines: Jules **Schmidlin.**—On the morphology of the Chetoptera: Ch. **Gravier.**—The archaic form of the Thecosome Pteropods: Paul **Pelseneer.**—On the structure of the muscles of *Anomia ephippium*: F. **Marceau.**—On acarophytism in Monocotyledons: E. **de Wildman.**—Semeiology of the prostatic secretion: A. **Guépin.**—On a new treatment of seeds: E. **Bréal** and E. **Giustiniani.**

NEW SOUTH WALES.

Linnean Society, August 31.—Dr. T. Storie Dixson, president, in the chair.—Revision of the Australian species of Bolboceras (Coleoptera, fam. Scarabæidæ), with descriptions of new species: Rev. T. **Blackburn.**—Studies in Australian entomology, No. 14, new species of geodephagous Coleoptera from Queensland and North-West Australia: T. G. **Sloane.** Three additions to the Cicindelidæ and five to the Carabidæ are proposed as new.—The botany of Funafuti, Ellice group: J. H. **Maiden.** The author gives a list, with critical notes, of thirty-eight dicotyledons, eleven monocotyledons, five vascular cryptogams, and one lichen. All the species are more or less widely distributed in the Pacific Islands as denizens of other coral islands or of the coastal tracts of the larger islands.

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