THURSDAY, APRIL 24, 1902.

PRACTICAL ZOOLOGY FOR BEGINNERS.

Leitfaden für das zoologische Praktikum. Von Dr. Willy Kükenthal. Zweite, umgearbeitete Auflage. Pp. viii+304; 169 illustrations. (Jena: Fischer, 1901.) Price 7 mk.

THE character of a work on practical zoology for beginners will differ fundamentally according to the particular point of view of the author. If the attainment of a thorough grasp of the organisation of a few animals be held to be the best means of developing the capabilities of a beginner, we are naturally led to the type-system of which Huxley was the pioneer, and his "Practical Biology," used conjointly with Prof. Howes' biological atlas, will remain a classic.

The German school, on the contrary, has developed another system; it gives the beginner at once a general outline of the animal kingdom, and concurrently a large number of animals are superficially examined.

There are arguments that can be advanced for either system. The broad outline of the animal kingdom provided by the German laboratories tends to arouse the interest of the student, and it is undoubtedly worth while to sacrifice much to accomplish this end; for without intelligent interest very little need be expected from the pupil. On the other hand, it must be admitted that such a system of instruction can too readily degenerate, and the result on the student's mind is likely to be but a confused assemblage of ill-digested facts. It may well be doubted whether a cursory glance over the whole animal kingdom constitutes as valuable a training for the future investigator as a thorough study of a few well-selected types.

In our universities we have to satisfy the needs of three classes of students:—(1) those seeking a general scientific education, (2) the future investigator and specialist in zoology, (3) the future medical man. The endeavour to deal with all three classes of students in the same manner cannot be wholly satisfactory; but a student beginning the study of zoology will probably not at first have the intention of becoming an investigator, and it would in practice be very difficult, or impossible, to separate the first two classes of students. Accordingly we must be content with arranging separate courses for the general student and the medical student.

The work by Dr. Kükenthal is primarily intended as a practical aid in the laboratory for the general student beginning his subject. The opinion as to how far the author has succeeded in his difficult task will greatly depend on the particular bias of the individual teacher. That the book has had a certain measure of success in Germany is evinced by the fact that the first edition appeared only three years ago.

The book begins with a rather meagre account of the apparatus required and of the general manipulation of the microscope. The body of the work consists of twenty chapters, each of which is divided into three parts:—(1) practical instruction in manipulation and the material required, (2) an outline sketch on the subject of the chapter, (3) a special description of one or more types.

The first chapter deals with the elements of histology. In the outline sketch, the nature of a cell and the general characters of tissues are shortly described. In the special description an amœba, white blood-corpuscle of the frog, egg of mussel and examples of the various tissues are very briefly introduced. The fact that a nucleus is capable of dividing is only just mentioned, although surely even a beginner ought to be shown preparations illustrating karyokinesis.

Each of the remaining chapters deals with one group or several allied groups of animals, and at the beginning of every phylum there is given a descriptive classification. The chapter on the Protozoa begins with an excellent account of events taking place in a hay-infusion, then in a single page the general characters of the group are summarised, while in the special description of types we find representatives of most of the more important classes of Protozoa; but the Foraminifera and Sporozoa are omitted. The Hydrozoa are also dealt with satisfactorily; the special descriptions include the following instructive series:—Hydra, Tubularia, Cordylophora, Clava, Tiara, Obelia, Liriope, Aurelia and Nausithoë.

The difficulty of such comparative treatment increases greatly as we pass to the more complicated Metazoa, and the author's accounts of the various groups tend to be decidedly unequal. Thus there is a brief description of the groups Bryozoa and Chætognatha, and among the Mollusca the genera Chiton and Sepia are included; yet of the Crustacea there is only Daphnia and a rather inadequate account of the crayfish. Also, in a book of this character the student might surely be somewhat further introduced to such larval forms as Trochosphere, Nauplius and Pluteus than by the mere mention of their names.

The chapters on the Vertebrata are the least satisfactory of the book. In some seventy pages we find Amphioxus, perch, frog, lizard, pigeon and rabbit. It may be doubted whether such an abridged account could be of much use to the beginner, and the descriptions take more after the method of a text-book than of a practical guide for the student in the laboratory. Inserted here and there are a few directions as to dissection, but without the constant aid of a demonstrator it is certain that an ordinary student could make but little of them. There are practically no figures of the vertebrate skeleton, blood-systems or nerves.

With the exception of the vertebrate section, the book is well illustrated with good figures, which appear in most cases to have been selected with much care. The appearance of one incorrect figure may be noticed. The series of diagrams after Boas (Fig. 38) showing the supposed stages in the degeneration of the medusa into a sporosac do not correspond to facts. The sporosac represents the degeneration of the whole of the medusa, and is not simply the persistent manubrium. There are a considerable number of original sketches which bear the impress of being drawn directly from dissected specimen, and are consequently especially useful to the student. The original drawings of the starfish and sea-urchin deserve particular mention.

In the opinion of the reviewer, we are in need of a compromise between the English and German methods of dealing with the beginner, in fact, a work intermediate in character between Huxley's "Practical Biology" and the present book. Such a work need not necessarily greatly exceed the "Leitfaden" in bulk, for the classifications, excellent though they are, and the general summary of the different groups might safely be left to the lecturer or text-book. This, together with the omission of some of the less important groups, would allow space for more practical instruction in manipulation and for a somewhat fuller treatment of most of the different types described, more especially of those of the vertebrates.

On the whole, it may be said that the present work bears the stamp of originality; the style is clear and the descriptions are terse and generally accurate, and if in a future edition Dr. Kükenthal should see fit to remodel his book in such a manner as suggested, it would be welcomed in our colleges as a valuable and much-needed aid to the beginner in the laboratory. E. W.

FERMENTS AND FERMENTATION.

Ferments and their Actions. By Carl Oppenheimer, M.D., Ph.D., and translated and amended by C. Ainsworth Mitchell, B.A., F.I.C. Pp. xii + 343. (London: C. Griffin and Co., Ltd., 1901.) Price 7*s.* 6*d.* net.

THERE are few subjects more interesting and at the same time more difficult than the study of ferments and their actions. But many students, and not a few original workers, shrink from the study of ferments owing to the great complexity of the subject. A book, therefore, which aims at treating the subject in a concise and intelligible manner must inevitably attract a wide class of readers.

The author very properly points out that it is impossible to understand any of the problems relating to fermentation unless there be formulated some definition of a ferment *per se* and some simple conception of the process of fermentation. With this object, in the second chapter the writer gives us what he considers a simple definition of the notion ferment:—

"A ferment is the material substratum of a peculiar form of energy, which is produced by living cells and adheres more or less firmly to them without having its activity bound up with the vital process as such; this energy is in a condition to bring about the liberation of latent (potential) energy of chemical substances and its conversion into kinetic energy (heat, light), in such manner that the chemical substance is so changed in the process that the new substance or the sum of the new substances produced possesses a smaller potential energy (*i.e.* a smaller heat of combustion) than the original substance."

It must be confessed that, however scientifically perfect this definition may seem to be, it will not impress the average reader with the idea of its simplicity. But the distinguished author goes on to elucidate the different heads of this definition, and in so doing makes clear even to the lay reader many vital points bearing on this difficult subject.

The following frank acknowledgment of the ignorance which underlies all our conceptions of the ways and means by which fermentative processes develop their activity is worth quoting in full:—

"We must simply resolve to regard fermentative actions as special phenomena of the ominous 'catalytic' processes from which their differentiation is required by the fact that they are produced by living cells. Catalytic action is nothing more than a scheme of despair under which we may group chemical reactions which, while possessing a certain similarity in their course, cannot, without further knowledge, be explained by our simple chemical theories. With the advance of our knowledge, we have naturally been able to assign many phenomena which were formerly regarded as catalytic to simpler chemical laws, so that this useful idea has undergone a considerable limitation in its applicability. At the same time we must not forget that in its essence even the theory of simple chemical decompositions and of chemical affinity is, as regards our theoretical knowledge, only one vast enigma; that we have only been much longer accustomed to deal with these conceptions as indispensable fundamental axioms without being able to approach them otherwise than metaphysically, which also holds good in a still wider sense of the conceptions of matter and force in general."

Chapter iii., on the chemical nature of ferments, is well worth the most careful perusal. It is the fault of the subject, not of the writer, that it makes stiff reading. In this chapter the author points out the uselessness of such vague expressions, which lead nowhere, as that there are in ferments "fragments of protoplasm" endowed with "residues of vital force." Gautier's dissolved cell hypothesis is very ably discussed.

The influence of external factors on the action of ferments is concisely dealt with in chapter iv., and chapter v., on the mode of action of ferments, is perhaps the most interesting in a book all of which is full of matter of absorbing interest and importance.

But it is impossible within the scope of this short review to touch on more than a fraction of the points in the work, which will repay study by both the layman and the expert in this subject.

A. C. HOUSTON.

OUR BOOK SHELF.

Civil Engineering as applied in Construction. By Leveson F. Vernon Harcourt. "Longmans' Engineering Series." Pp. xv + 624; with 368 illustrations. (London, New York and Bombay: Longmans, Green and Co., 1902.) Price 14*s.* net.

THIS book, as the author states in the preface, consists of a concise grouping together of the various branches of constructive civil engineering.

A book that attempts to deal in a single volume with the vast range of subjects embraced in civil engineering must necessarily be more in the nature of an encyclopædia than a series of treatises on the subjects dealt with; and the descriptions of the works selected as examples are, therefore, necessarily limited to as small a space as is possible for the elucidation of the various subjects, and for indicating the practice followed in the execution of constructive works; but what is given is of a thoroughly practical character, and the subjects are very fully illustrated. The author has not taken up space by dealing with theories, or by giving elaborate formulæ.

The information given has been derived to a very large extent from *Proceedings* of the Institution of Civil Engineers, of which the author gives full acknowledgment.

The book should be of great use to an engineer when called upon to deal with constructive works of a character that he has not had previous experience of, as indicating the various ways in which constructive requirements have been treated. To students of engineering it will be of value in directing attention to the principles forming the basis of design and construction, and by indicating the different ways in which these principles have been applied in practice.

The volume may, in fact, be regarded as a guide-book to what has been done, but its usefulness would have been enhanced if more frequent references had been made to the sources from which complete information on the different subjects could be obtained, or if a list of the works in which the subjects have been treated had been given at the end of each chapter. It is true that in such matters as harbours, docks and canals, with which the author is most conversant, the references from which the information is taken are plentifully given; but these are principally to the author's own works, and no mention is even made of the works on these subjects that have been published within the last few years in "Longmans' Engineering Series," of which this book forms part.

Besides a general introduction, the subjects are dealt with under five heads, and include (1) materials employed in construction; preliminary arrangements for carrying out work; excavation; dredging; pile-driving; cofferdams; foundations; piers of bridges; roads and street-paving. (2) Laying out and formation of railways; bridges; viaducts; tunnels; permanent way; light railways and tramways. (3) Control and regulation of rivers; canals and canalised rivers; ship canals; and irrigation works. (4) Docks, river quays, harbour works; lighting coasts and channels; land reclamation and coast protection. (5) Sanitary engineering, including water supply and sewerage works.

Rural Reader—Senior. By V. T. Murché. Pp. 292. Price 1*s.* 9*d.*

The Teacher's Manual of Object Lessons for Rural Schools—Senior. By V. T. Murché. Pp. xxiii+396. (London: Macmillan and Co., Ltd., 1902.) Price 2*s.* 6*d.*

The schoolmaster in the country is just now very much in want of a text-book to guide him in giving that kind of instruction which is variously termed "nature knowledge" or "rural economy"; such elementary observation and reasoning applied to common things, as will stimulate the child's mind and yet serve as an introduction to agriculture or horticulture later. Mr. Murché was ready with two text-books very soon after the circular from the Board of Education in 1900, and now comes forward with two more for senior children, a reading book for school use and a parallel series of object lessons set out for the teacher's benefit.

The scope of the books is extensive enough—a little chemistry and botany, a few discourses on farming, then comes a considerable section on insect life, with chapters on fishes, reptiles, trees and ferns to the end. The get-up is excellent, nice type and plenty of pictures, so that any child will enjoy the varied course of the reader, and the teacher may get many excellent hints from the object lessons. But how fatally does the author miss the whole spirit of the work, which is to make the child see and think and find out things for himself. From beginning to end of the book the child is being told in dogmatic fashion scraps of information about natural objects of the most unequal degree of importance. The book is a typical compilation; in each subject the man who knows will detect, if not mistakes, yet that want of proportion, that emphasis in the wrong place, which mark the writer at second hand.

For example, on p. 63 the children are made to compare the flower of the Deadly Nightshade, *Atropa*, with the potato flower, to show them how a garden plant may have wild relations. In the first place, there is little superficial resemblance between the flowers, and *Atropa* is a really rare and casual plant in England, whereas every hedgerow contains the "Woody Nightshade," poisonous enough and with flowers that are unmistakably the fellows of the potato flower. Again, we notice on p. 127 an account of the mole cricket, with a picture; how many collectors, not to speak of children, have ever found a mole cricket? And so the book goes on through the whole gamut of animated nature; our feeling in the end is one well known to examiners, "I suppose I must allow some marks for this, but——" We have not yet found the text-book for country schools, and we are afraid that Mr. Murché's is just a sufficiently middling substitute to block the way of the real article when it comes.

A. D. H.

Poultry Management on a Farm. By Walter Palmer, M.P. Pp. 94. (Westminster: Archibald Constable and Co., Ltd., 1902.) Price 1*s.*

The object of this work is to show that poultry in considerable numbers can be kept on an ordinary farm with profit. Mr. W. Palmer, M.P., on land of about 200 acres, has established a poultry department. 350*l.* have been expended in buildings and the necessary appliances, a skilled manager with three assistants have been appointed, and the results of three years' work are very fairly given in this well-printed and well-illustrated, but very cheap, volume. Whether the results are such as will induce many other agriculturists to go into the pursuit or not may be regarded as doubtful, but the volume is well worthy the attention of those who are interested in the matter. Poultry farms pure and simple have long been known to be visionary, those institutions at present going under that name not being utility poultry farms, but places for the rearing and sale of fancy stock at fancy prices. Mr. Palmer is an enthusiast in his subject, and it is needless to say that his work presents the results of his experiments in the most favourable light, but this is obviously done with a good motive and in an exceedingly truthful manner. Many practical farmers would, however, object to his figures. Nothing is charged for the annual depreciation and wear and tear of the plant. The annual value of the manure of the two thousand birds is estimated at 100*l.* Moreover, the author states that if the ninety thousand farms in England were all to keep poultry on the plan recommended by himself, the profit arising from this source would be no less than four and a half millions a year to the British farmer. These statements will be differently estimated by different readers.

Lectures on the Lunar Theory. By John Couch Adams M.A., F.R.S. Edited by R. A. Sampson, M.A Pp. 88. (Cambridge University Press, 1900.) Price 5*s.*

We are glad to see that the famous lectures of Adams on the lunar theory have been published so as to be readily accessible to all. They have been well edited and most lucidly presented to the reader. Prof. Sampson naturally, however, did not feel at liberty to extend the subject-matter of the lectures, so that the work remains in a slighter form than Prof. Adams would, perhaps, himself have cared to publish it.

This being so, we are led to ask—What class of readers does this book specially cater for? We do not think the students, for the book cannot compete with Dr. E. W. Brown's treatise, nor would it be of any great value to the calculator who should wish to develop afresh correct expressions for the moon's coordinates, for the chief difficulties here consist in the correction of approximate solutions, a section to which only four pages (pp. 30–33) is devoted in the present work, and, moreover, the action of the planets is not considered. Perhaps, then, the class that will find this book most interesting are the astronomers, who from time to time want to refer to small portions of the theory and obtain numerical values for some of the quantities that occur. This was, perhaps, not the design of the work, but we can recommend it as serving this purpose thoroughly.

Lectures and Essays by the late William Kingdon Clifford, F.R.S. Edited by Leslie Stephen and Sir Frederick Pollock. 2 vols. Pp. 410, 342. (London: Macmillan and Co., Ltd., 1901.) Price 10s.

It is neither upon his popular lectures nor upon his crude essays in metaphysics that Clifford's permanent reputation is based. But it is not surprising that they still find numerous readers; they are so free from pedantry, so engagingly frank, so evidently the work of a man who sought truth with a really passionate desire. We may smile at Clifford's theory of "brain-stuff," which is easily demolished by the very same kind of criticism which he himself applied to "The Unseen Universe"; we may feel justly astonished that a mind so penetrating in many ways should believe that consciousness is a complex of elementary feelings, which can separately exist as things in themselves; we may regret the occasional bitterness of his invectives, even while we remember that they were inspired by a hatred of priestcraft and superstition. But with all this, when we turn again to these fresh and stimulating pages, and when we read once more Sir Frederick Pollock's graceful and generous introduction, we can understand how Clifford charmed and impressed his contemporaries, and how keen was their sorrow at his premature death. It is, perhaps, not altogether fanciful to compare Clifford's fate with that of Robert Louis Stevenson; in each case a reaction has followed the too partial praise of admiring friends, and this disparagement is again being corrected by a more dispassionate criticism.

Teoria delle Funzioni Analitiche. By Giulio Vivanti. Pp. 432. (Milan: Ulrico Hoepli, 1901.) Price 3 lire.

"A pocket guide to the Theory of Functions," may strike many pure mathematicians as being a rather startling innovation. But the rate at which mathematical knowledge is added to every year makes it increasingly difficult for a mathematician to acquire a thorough acquaintance of more than a very limited range of study, and if the physicist, for example, has to derive his information on the theory of functions from large treatises and scattered literature, "life is too short" and the work is crowded out by other matters.

The book is divided into three parts, the first containing the elements of the theory of groups, the second the general theory of analytical functions, while the third contains a sketch of certain recent developments of the theory of functions. Prof. Vivanti bases his treatment on Weierstrass's methods. At the end is a list of 218 books and papers dealing with the subject, all for the very small price of half-a-crown.

It is much to be wished that a reaction may be set on foot in this country against the over-elaboration and specialisation of mathematical text-books by the publication of a series of small handbooks similar to this little Italian treatise. The need for a change of this kind is well illustrated by a copy of the 1860 edition of Routh's "Rigid Dynamics," which the present writer has just acquired. It bids fair to be much more useful in teaching a certain class of student than the modern large two-volume editions.

Graduated Exercises in Elementary Practical Physics. By C. J. Leaper. Pp. iii + 264. (London: Biggs and Co., 1901.) Price 2s. 6d.

This contains the usual elementary exercises in physics, and it is not obvious what special advantages it offers. Many of the diagrams are very bad, and the printing is poor. Examples are given for the students to follow; thus we find the product in Boyle's law carried to six significant figures, and the latent heat of fusion of ice to five figures. How often are we to cry out against this?

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 Education Bill.

The suggestion in your editorial memorandum last week on this subject is one for which there is a remarkable precedent in the history of educational controversy. That suggestion is to the effect that, having regard to the complexity of the subject, to the fact that the urgent need of our time is the organisation of secondary and higher instruction, while the condition of our primary instruction is, on the whole, satisfactory and but for the demands of the voluntary schools would not require any material change at all, it would be well to divide the Bill into two parts and to press forward during the present session the enactment, with due modifications, of that part which affects intermediate and scientific education, and so to leave the part relating to elementary education for fuller consideration another year.

This course would be precisely similar to that adopted by Mr. W. E. Forster in 1869, the year before the Elementary Education Act. He had been a member of the Schools Inquiry Commission, which had recently issued a memorable and most comprehensive report, the work largely of the late Lord Lyttelton and the present Archbishop of Canterbury. As Vice-president of the Council, he introduced the Endowed Schools Bill, which was designed to deal with the whole problem of secondary as distinguished from elementary instruction. The Bill was divided into two parts, the former providing for the urgent need of the moment, the reform of the ancient and often obsolete and useless endowed foundations, and the latter constituting central and local authorities for the coordination and improvement of all classes of secondary schools—private, proprietary and municipal—for the registration of teachers, for the provision of needful schools, and for the construction of a coherent system of secondary education for the whole country. But it happened then, as it is happening now, that such a large and far-reaching proposal touched many interests and involved many difficulties, and that it proved impossible to pass the whole Bill in one session. So Mr. Forster wisely abandoned the second part of the Bill, and resolutely secured the passing of the first. The Endowed Schools Act thus simplified and placed on the statute book is still in force, and has proved to be one of the most beneficent of modern Acts of Parliament. It created a special Commission, with power to inquire into the history and resources of educational foundations, to revise and modernise their statutes and deeds of gift, to reform the governing bodies, and to secure the permanence and increased public usefulness of educational endowments generally. Other attempts have been made in subsequent years to deal piecemeal with the larger projects of educational reform contemplated by the Government of 1869; but it remains on record that if an attempt had been made to enforce the enactment of the whole measure, the Endowed Schools Act, which has proved of such signal public service, would never have been passed.

Without renewing any discussion as to the merits or demerits of the new Bill, it may interest your readers to be reminded of the precedent thus set more than thirty years ago. If that precedent were followed in the present case, it would at least give an opportunity to the newly constituted local authorities to deal at once with technical and secondary education, and thus to gain a new title to public confidence. The public would then be enabled to judge, after one or two years' experience, of the expediency of entrusting to these bodies the larger and more difficult task which the present Bill proposes to hand over to them—the virtual reconstruction of the whole existing system of elementary education. J. G. Fitch.

Athenæum Club, April 22.

I find myself in entire agreement with the views expressed by Principal Lodge in the last number of Nature. And if any practical illustration were needed to support them, I think ti is afforded by the invaluable work which has been done for secondary education in the county of Surrey.

Until the County Council took the matter up, the educational destitution of western Surrey as regards secondary schools was deplorable. There was no provision for either carrying on the education of the best boys at the primary schools, or for educating the large class of sons of artisans and others for whom the primary schools were insufficient and such private-adventure schools as existed altogether inadequate. As a governor of the Richmond School I am able to speak with confidence of the remarkable success which has attended its establishment.

As regards Surrey I do not see, therefore, that the Bill will put us in a much better position than we are at present. But the present crying need is that primary education should be dealt with on the same lines. It would, in my opinion, be a real disaster if the part of the Bill relating to it were to be dropped, as has been proposed in these pages.

In the Borough of Richmond the arrangements for primary education can hardly be described as other than chaotic. I am by no means persuaded that the establishment of a School Board would make matters much better. We might gain something in one direction at the cost of losing all chance of coordinating our arrangements for primary with those for secondary instruction. The one should dovetail into the other, which it is little likely to do if they are in different hands. I am wholly at a loss to see why an organisation which has solved one problem should not be able to solve both.

Kew, April 21. W. T. Thiselton-Dyer.

The Dangers of Coral Reefs to Navigation.

In consequence of a paper which I recently read before the Royal Geographical Society on "The Formation of the Maldives," I have received several letters from officers of the mercantile marine. These lead me to believe that the danger incurred by too closely approaching coral reefs and islands is not generally perceived. Further, I have myself seen large passenger steamers coasting round the south of Minikoi Atoll within 300 yards of its encircling reef. Indeed, one large liner was so close in that the look-out man at the mast head could not have failed to see the bottom. The practice of approaching so near *where unnecessary*—to enable passengers to get a good view of the land and reef—is one attended with considerable danger and greatly to be deplored.

It is generally known that most reefs on their seaward faces slope gradually from their edges to 25–50 fathoms, and then more steeply to 100–200 fathoms. The breadth of this inner slope or reef-platform varies in the Maldives and Laccadives from half-a-cable to half-a-mile. Its surface, especially down to 20 fathoms, is extremely uneven, great buttresses and masses of rock arising to within a few fathoms of the surface. Such rocks are very generally covered with green corals or dark-coloured, calcareous algæ, so that except in absolutely calm weather they may not readily be perceived. Further, isolated coral heads—separate coral colonies—may grow up on any rocks within about 20 fathoms of depth almost to the surface. I have in Maldivan lagoons been twice stranded on such heads, arising respectively from 8 and 14 fathoms. At the seaward ends of passages into atolls of the same group, where the conditions are not very dissimilar to those outside atolls, similar heads not infrequently grow from 15 fathoms or even deeper to within 2 or 3 fathoms of the surface. The tops of these are often only a few yards across, so small indeed that they may be easily missed in any survey, however careful.

It is apparent then that dangerous rocks may arise on any part of the reef-platform. The outer steep slope is often so precipitous that the edge of this platform is only separated by a few yards from the 100-fathom line. The latter is usually very carefully charted, but for safety liners and deep-draught steamers should pass well to seaward of it. J. Stanley Gardiner.

Gonville and Caius College, Cambridge, April 20.

Rearrangement of Euclid Book I.

I have always taken it for granted that the *chief*, if not the *only*, objection to Euclid's Elements as forming an introductory course in geometry is that a very large proportion of beginners *are unable to work riders for themselves*, and consequently they are reduced to the necessity of merely reading up the propositions in such a way as to be able to reproduce them more or less mechanically in the examination room.

This difficulty does not exist in algebra because, taking simple equations as an instance, it is easy by varying the numerical coefficients to furnish the beginner with an unlimited variety of *numerical examples* which, being all solved by the *same* method, do not present such difficulties as Euclid "riders," each of which is practically a separate problem or theorem requiring a *different* method of solution.

The wide gap between the reproduction of bookwork and the devising of methods of solving riders presents a serious obstacle to the progress of beginners. What I at present fail to see is how the gap would be bridged over either by a rearrangement of the propositions in Book I. or by any of the substitutes for Euclid which have been suggested of recent years, and I much hope that this letter may be the means of eliciting fuller information on the direct connection between the present unsatisfactory state of affairs and the proposed remedies. G. H. Bryan.

Bangor.

The Morphology of the Pleuronectidæ.

Absence from Liverpool has prevented me replying to Mr. J. T. Cunningham's criticisms of the work on the anatomy of the Plaice recently published by Mr. Johnstone and myself. The passage which Mr. Cunningham chiefly objects to is as follows:—"If [the dorsal fin] occupies the mid-dorsal line of the head, then it is obvious that the left eye must have actually passed through the substance of the head to reach the ocular side. This supposition, absurd as it may seem to us now, was in fact believed by such an observer as Steenstrup." In "correcting" this passage Mr. Cunningham says:—"The truth of the matter is that Steenstrup did not believe any supposition, absurd or otherwise, on the subject, but stated from actual observation that in certain larval Pleuronectidæ the eye of one side passed through the tissues of the head and emerged on the other side. The form in question was long known as Plagusia, and is now known to be the larva of Rhomboidichthys. The truth of Steenstrup's observations was fully confirmed by Alexander Agassiz at Newport, R.I."

Now on referring to Steenstrup's memoir again I find that it is Mr. Cunningham himself who has misunderstood that author. For whilst Steenstrup certainly observed an *apparent* passage of the eye through the head, he also *supposed* that the eye passed actually through the tissues of the head itself, as apart from those of the dorsal fin, which cannot, of course, be considered a part of the head. This is the theoretical deduction that I characterised as absurd, since it is needless to say that neither Steenstrup nor Agassiz ever witnessed so impossible a phenomenon. Indeed, both Agassiz and Ehrenbaum state, quite correctly, that the migrating eye lies between the base of the dorsal fin and the roof of the head, and therefore only "apparently passes through the head" (Agassiz).

The significance of the asymmetry of "Plagusia" has been made quite clear by the short but important paper recently published by Nishikawa. This paper renders almost certain the deduction which I think most morphologists would have drawn from Agassiz's work, viz., that the metamorphosis of Plagusia is in all essential respects similar to that of the Plaice. The fact that here the dorsal fin grows forwards *before* metamorphosis sets in has not affected the fundamental character of the torsion, for the migratory eye is, of course, *morphologically outside the head during the whole of its transit*. Nishikawa says, and very truly:—"In every case, the passage of the eye from one side to the other in flat fishes is morphologically along the dorsal surface of the head." The statement, therefore, to which Mr. Cunningham takes exception is absolutely correct, and it seems that, living remote from scientific libraries and doubtless unable to consult the original, Mr. Cunningham's memory has led him astray.

Mr. Cunningham's second point involves an academic issue that I must leave others to discuss. Prof. Mitsukuri once remarked to me, in connection with his having undertaken some systematic work, that he had temporarily abandoned the morphological pursuit of similarities, in favour of the systematic search for differences. Thus, whilst many systematists, with their taxonomic details, would widely separate the Pleuronectidæ from the Gadidæ (although Jordan and Evermann, whom we followed, do not), most morphologists, taking a much broader if less precise view of the question, would say that a Plaice was simply an asymmetrical cod-fish. And both may be right judged by their own standards. F. J. Cole.

University College, Liverpool, April 14.

Swarm of Velella.

The brief note from Alassio by Mr. Isaac Thompson on the extent and density of a swarm of Velella off that coast this month recalls to my mind seeing a similar scene on each of two occasions when staying at that place in April. On each occasion of the swarm there was, as I well remember, a strong wind from the east; on each the shore became so thickly strewn with the organisms as to become unpleasantly odorous from their decay. Ch. S. Sherrington.

Felixstowe, April 19.

Referring to your correspondent's letter on the swarms of this little marine animal that strewed the shores of the Riviera di Ponente early in April, I was at Alassio and remarked that the wind had been easterly for some days before the advent of the swarm. Alassio is situated on a sandy bay facing the east; on the western side of the bay, two miles away, lies a fishing village called Laiguelia; here the Velella were in far greater numbers, thickly piled on the shore, thinning off gradually towards Alassio, while beyond Alassio, at the extreme eastern end of the bay, the Velella were comparatively thinly scattered on the sand. The clear horny oval disc over the little colony of polypes, with its diagonally-set, triangular sail, places Velella at the mercy of the winds; a shoreward wind blowing for several days must end in the wreck of the little "Barca di San Giovanni" (boat of St. John), as the Alassian fishermen call it. I am told it is usually in early June that the swarms are swept ashore, and then in immense numbers—far more than strewed the bay this April. The prevailing wind in summer at Alassio is easterly. Rose Haig Thomas.

Hotel Palais d'Orsay, Paris, April 21.

Habits of the Gar-fish and Mackerel.

Beyond the fact that the bodies of other fish are occasionally pierced by them, no evidence seems to exist concerning the special function of narrow elongated jaws of the gar-fish (*Belone vulgaris*, Fleming). These fish are usually captured in drift nets along with mackerel, and there appears to be some vague idea among fishermen that they either guard or guide the mackerel shoals. In the cases on record where a mackerel or other fish has been pierced by the gar-fish, the upper jaw of the latter has usually been found broken off and remaining in the wound. This fact is inconsistent with the supposition that the normal function of the elongated beak is to be used as a spear, and there is no evidence that the gar-fish feeds on the flesh of large fishes.

Examination of the beak itself shows that the end of it is formed by the tip of the lower jaw, which is about half an inch longer than the upper. This tip is not hard and sharp, but soft and blunt; the upper jaw is narrower, and ends in a harder and sharper point. Thus the lower jaw is by no means adapted for use as a piercing weapon. Recently I opened the stomach of one of these fish landed at Newlyn, and found in it the partly digested remains of a slender silvery fish, which at the time I could not identify. The next day I opened a number of mackerel and found in some of them copepods and amphipods, but in nearly all remains of fish food, and in one, two specimens of the smaller sandeel (*Ammodytes tobianus*) only slightly digested. I was then able to satisfy myself that the fish on which the Belone had been feeding was also the sandeel, and I was impressed with the similarity in the structure of the jaws between the Belone and its prey. It then occurred to me that the proper function of the beak of the Belone was to penetrate the sand in pursuit of sandeels. The latter fish burrow into sand by means of the projecting lower jaw, and it is evident that the beak of the Belone is as well adapted for probing the sand, finding and seizing the sandeel, as is the beak of the woodcock for probing soft ground in search of worms and burrowing insects. The flexible tip of the fish's beak is doubtless a sensitive tactile organ, while the narrow toothed upper jaw is eminently fitted for seizing and holding the slippery and agile prey.

It seems very probable that special adaptation for the pursuit of sandeels in the sand explains, not only the peculiar beak of Belone, but also the elongation and structure of the whole body. Narrowing and elongation of the body are related in fishes and many other animals to creeping or burrowing habits. Probably, not merely the beak, but the greater part of the body of Belone also is thrust into the sand in pursuit of its prey, and this would explain why the dorsal and ventral fins are placed far back, so that the propelling apparatus remains in the water, and why the abdominal region is nearly cylindrical, with a somewhat flattened ventral surface, without dorsal or ventral ridges.

The fact that the mackerel were also feeding on sandeels further suggests a special reason for the association between mackerel and gar-fish. It is true that many predaceous fish eat sandeels when they can get them, but the jaws of the mackerel are not specially fitted for dislodging sandeels from the sand. In the early part of the year mackerel feed largely on copepods and other pelagic animals, having long, close-set gill-rakers through which they can strain the sea-water, like clupeoid fishes. In summer and autumn mackerel feed chiefly on small fishes which swim near the surface, such as the young of sprats, herring, gadoids, &c. But it seems probable that mackerel accompany the gar-fish in order to feed on the sandeels which leave the sand in their efforts to escape from their special enemy.

I have not yet made any observations on the food or habits of the saury-pike (*Scomberesox saurus*), but it is probable that, as in the case of Belone, injury to pilchards or other fishes by the beak of this fish is rather accidental than intentional. Couch and Matthias Dunn believed that the saury-pike was the enemy of the pilchard, and that it attacked the latter. When a number of both kinds of fish were enclosed in a seine, many of the pilchards had their eyes or bodies pierced by the beaks of the saury-pikes, but the latter are very active and violent in their movements, and if they were rushing about among a dense crowd of pilchards, the beaks could scarcely fail to pierce the latter. J. T. Cunningham.

Flint Implements at Chelsea.

While planting in the garden of this house last Wednesday, I turned up a small flint implement, an inch and a half long and an inch wide in the widest part. It is so thin and transparent, that it is possible to read large print through it. This is the second I have found, the previous one being angular and pointed. A. B. Marshall.

Belle Vue House, 92 Cheyne Walk, S.W., April 18.

The Misuse of Coal.

Prof. Perry, in his manifesto in Nature of March 20 (with which, subject to a reservation in respect of the following extract, I venture reapectfully to agree) says (p. 464):—

"For the heating of buildings Lord Kelvin pointed out long ago that the very law of thermodynamics which makes a heat-power engine inefficient makes it possible to obtain from one unit of energy the effect of 50 or 100 units by direct heating. . . Discover the energy engine and you multiply your power to heat buildings from coal, seventy and seven times."

May I ask if Prof. Perry adheres to the foregoing statement, and if so, ask him through you to kindly add some elucidation of it? Subscriber.

Derby, April 15.

"Subscriber" may be referred to § 196 of my book on "Steam," where I explain Lord Kelvin's suggestion and give a numerical example. I assume no better utilisation of coal than one gets from a gas engine using Dowson gas and practical conditions, and yet here are the two answers for one pound of coal:—

(1) By direct heating, all the heat of the coal being given to the air (it is unusual to give nearly so much), the air gets 8300 units (Centigrade pound) of heat.

(2) By using a gas engine and reversed heat engine, 37,620 units of heat are given to the air. This is only four and a half times and not the seventy-and-seven of which I somewhat rhetorically spoke. But with the perfect energy engine of the future we may get nearly six times what we get from the gas engine now. Also I considered an atmosphere at 10° C., the air to be heated to 20° C. for the warming of a building. If the rise of temperature is only 5 degrees we get twice the benefit.

It looks at first sight like a creation of energy, but this is not so. The reversed heat engine (some refrigerating machines work on this principle) receives work energy 1422 (specified in heat units); this work is converted into heat 1422, and the extra heat 36,198 is merely *transferred* from air at 10° C. to air at 20° C.

What is disadvantageous in the heat engine becomes advantageous in the reversed heat engine, whether it is used for heating or refrigerating. J. P.

A Correction.

IN my letter *re* "Birds attacking Butterflies and Moths," in NATURE for March 6 (p. 415), there occur the words, "I conclude, therefore, that they were last year's birds, which knew and disliked *D. limniace*." There is some slip here, for what I meant to say was, "I conclude, therefore, that last year's bird knew and disliked *D. limniace*." This, it will be seen, agrees with the context; I only used one Babbler last year, and offered *D. limniace* to this only. F. FINN.

Indian Museum, Calcutta, March 27.

SOME SCIENTIFIC CENTRES.

IV.—THE HEIDELBERG PHYSICAL LABORATORY.

MOST travelled Englishmen are doubtless acquainted with the ancient town of Heidelberg, so famous for the beauty of its situation and the grandeur of its ruined castle. But far fewer know the charms of the long and romantic valley of the Neckar, at the almost sensational exit of which, from the Odenwald into the level plain of the Upper Rhine, Heidelberg stands. So also it is true that while most educated people connect Heidelberg with the great names of Kirchhoff and Bunsen and their epoch-making discoveries in spectrum analysis, it is only the special students who know how large in extent and how important in result and example is the work which has steadily gone on for many years in the physical laboratory in the Friedrichsbau.

Its small beginnings in the middle of the last century are marked by the name of Kirchhoff scratched on the window of what is now the private room of the senior assistant. From this window one may look out over the Rhine plain towards busy Mannheim, as Bunsen and Kirchhoff did one night when a fire was raging there, and they were able by spectroscopic examination of the flames to ascertain that barium and strontium were present in the burning mass. But the same window also looks across the Neckar to the Heiligenberg, along the slopes of which runs the "Philosophers' Walk," the chief of the many paths among the wooded hills around the town, which the two friends were wont to traverse in their daily "constitutionals." Bunsen is known to have said that it was during such walks that his best ideas came to him. One day the thought occurred, "If we could determine the nature of the substances burning at Mannheim, why should we not do the same with regard to the sun? But people would say we must have gone mad to dream of such a thing." All the world knows now what the result was, but it must have been a great moment when Kirchhoff could say, "Bunsen, I *have* gone mad," and Bunsen, grasping what it all meant, replied, "So have I, Kirchhoff!"

Kirchhoff's four-prism spectroscope, together with other apparatus of his, is preserved in the collections of the Laboratory, and well deserves the almost reverential awe with which it was examined by a certain foreign professor, who protested that objects of such historic interest should be kept in a fire-proof safe.

Kirchhoff, who in his later years suffered much from ill health, left Heidelberg in 1875 on his appointment as professor of theoretical physics at Berlin, where, by the way, he had no official laboratory, and carried on his experimental work (*e.g.* the research on the conductivities of the metals for heat and electricity) in the laboratory of his friend von Hansemann. His successor at Heidelberg was his former pupil, Quincke, who has been professor there ever since, and is now the "doyen" of German physicists, both by length of service—for though only sixty-seven he has been a professor for more than forty years—and by the amount and variety of his scientific work. It is true that this work has not been of the kind that gets into the newspapers, but the real students will certainly value it none the less on that account, and even the beginner in science has heard of "Quincke's Interference Tube" and his standard measurements of capillary constants. English students may well take some special interest in Quincke, for his personal relations with English men of science (*e.g.* Lord Kelvin and Sir Henry Roscoe) have been particularly close; he is never tired of dwelling with admiration on the achievements of Young, Faraday and Kelvin—and in the case of Young in particular of vindicating his priority in respect of many of the ideas in light and sound often regarded as original to Fresnel and Helmholtz—and nowhere have his own researches been more highly valued than in this country, as is shown by the long list of Universities (Cambridge, Oxford, Glasgow) and learned societies (from the Royal Society downwards) which have conferred their honours upon him.

Georg Hermann Quincke was born at Frankfort a. O. in 1834 of partly Huguenot extraction. One who has seen the diagrams, with circles worthy of Giotto, which he draws on the blackboard, or had experience of his apparently intuitive knowledge of the possibilities of the most various materials and mechanical processes, might well be inclined to regard this kind of power, so valuable to the physicist, as an inheritance from some skilful Huguenot ancestor. From 1852 onwards he studied at Berlin, and then for a time at Königsberg, attracted thither (with others, such as Kirchhoff and Clebsch) by the fact that F. E. Neumann was delivering the only course of lectures on mathematical physics then to be heard in Germany. Neumann's mathematical and experimental genius had considerable influence on Quincke, and it was here that the profound interest in molecular physics which has dominated his life-work was aroused in connection with the theory of capillarity. But Neumann allowed his pupils too little scope for originality, and Quincke removed to Heidelberg, where (in 1854) Kirchhoff had just been appointed professor of physics. Under him Quincke carried out (in 1856) his first physical research, an investigation of the lines of flow of an electric current from one point to another of a metal plate. With a plate made of adjoining semicircles of copper and lead, Kirchhoff's law of the refraction of currents was confirmed, viz. that the *tangents* of the angles of incidence and refraction are in a constant ratio, though, curiously enough, this ratio was not found equal to that of the conductivities of the two metals, as the theory requires, but only about half as great. During this time—in which Matthiessen and Roscoe were among his fellow students—Quincke also worked much with Bunsen, especially in gas and mineral analysis, and, indeed, his first published paper was on the red and grey gneiss of the Erzgebirg (1856). Doubtless the association with Bunsen did something to cultivate Quincke's native faculty for the ingenious adaptation of the simplest materials, of which more hereafter.

From Heidelberg Quincke returned to Berlin, "promovierte" in 1858, became "Privat docent" in 1859, in 1860 was appointed professor at the Royal Prussian "Gewerbe Akademie" and in 1865 "ausserordentlicher" professor at the University of Berlin, posts which he held till 1872. His courses of lectures included the only one in mathematical physics then given in Berlin. But as regards original work the young professor was much hampered by the fact that he had neither stores of apparatus nor even a decent library of scientific literature at his disposal. In both respects he was much aided by his friend Wilhelmy (of invert sugar fame), who possessed a good deal of apparatus brought from Paris, and by Mitscherlich. Before this Mitscherlich had introduced him to G. Wiedemann, and a beautifully kept juvenile note-book had led to his drawing the figures for some of Wiedemann's publications. How well he was capable of such work will be clear to all who have seen his lithographed sheets of instructions for practical work in use in his present laboratory, with their admirable diagrams.

With Wilhelmy's apparatus, and much which he constructed for himself, often out of the simplest materials, he was able to exhibit many of the chief optical experiments which could at that time be seen nowhere else out of Paris, and to inspect which some of the leading men of science in Berlin, such as the mathematician Kronecker, were glad to visit him. To take but one instance of his ingenuity in devising efficient substitutes for the complicated and expensive forms of apparatus generally used, we may mention his method of constructing a Fresnel's double mirror. Two equal plates of black glass are fastened to a suitable wooden slab by means of four wax pellets, two under the corners of the adjacent edges, and one each under the centre of the opposite ends of the plates. If now a thin sheet of glass is laid over the whole and gently pressed down in the centre, the two glass plates become inclined to one another at slightly less than 180°, forming— *experto crede* —a perfect Fresnel's mirror. In this way the students in his present "Praktikum" construct this piece of apparatus for themselves as required.

Quincke's settlement in Berlin was signalised by his discovery of the "Strömungsströme," or electric currents produced by the flow of liquids past solid walls, which is the inverse phenomenon to the "elektrische Fortführung," or transport by an electric current of suspended particles through liquids in narrow channels. This he examined in an extensive research, leading to the conclusion that both phenomena were due to electrification by contact of the liquid with the solid wall or the suspended particles. The range of cases in which electrification is produced by contact of dissimilar substances was thus largely increased, and *inter alia* it was shown that a bubble of air in contact with water carries a negative charge, a result which accounts for the interesting discovery of Lenard that in the neighbourhood of Alpine waterfalls the air is invariably strongly negatively charged.

To this same period belong two extensive series of researches in optics and capillarity respectively. The optical investigations, recorded in close upon a score of lengthy papers in *Poggendorff's Annalen*, deal with the most difficult questions connected with the optical properties of metals, the researches of Cauchy, Stokes and Jamin, and the behaviour of polarised and diffracted light in general. From among the results obtained we have only space to mention the discovery of "lamellar diffraction,"[1] the proof that neither Jamin's law of polarisation by reflection nor Stokes's theory of the polarisation of diffracted light is in accord with all the facts, the considerable addition to the theory of the diffraction grating, and the startling deduction from some of the work of the fact (long afterwards confirmed by Kundt and others) that the refractive index of silver and gold for sodium light is less than 1, a result which of course means that light travels faster through these metals than in air. It is an interesting fact that these researches were originally prompted by the hope of penetrating more deeply into the secrets of the molecular constitution of matter. Many of them were carried out by the help of thin metallic films deposited on glass. But these very films did not a little to show that capillary phenomena were likely to be more fruitful in this direction. One of the most elegant of modern researches is that in which (1869) he used a wedge-shaped film of silver deposited on glass to measure the range of molecular attraction, by determining the thickness of the silver film through which the capillary action of the glass on water in contact with the plate just vanished. The result was that the radius of the sphere of action of the molecules is about 50 $\mu\mu$ (*i.e.* about one-tenth of an average light-wave). This was the first effective attack on this profoundly interesting problem; the method remains the least exceptionable yet devised, and the result has been confirmed by the later researches of Sohncke (1890),[1] though Röntgen and others, by means of more questionable methods, have found a value many times smaller.

It will be convenient to speak of the capillary researches in a general view presently, but mention must be made here of the well-known acoustic interference tube. The invention of this (1866) was due to a case communicated to him by a doctor, in which a patient, whose hearing was being tested by sounding a tuning-fork at the end of a rubber tube leading to his ear, was found to hear better when the tube was pinched. This was the first of several forms of acoustic interference apparatus devised by Quincke, which have been used by his pupils for investigations on the velocity of sound under various conditions, recently, for instance, in air at high temperatures. From this research it appears that the ratio of the specific heats for air falls from 1·40 at 0° C. to 1·34 at 1000° C.

In 1872 Quincke was appointed to the chair at Würzburg, whence he was called in 1875 to fill Kirchhoff's place at Heidelberg. His work there has been marked by a long series of electric and capillary researches, and by a great increase both in the efficiency of the laboratory and in the number of students. Among those who have studied under Quincke or worked in his laboratory may be mentioned Profs. Lenard (Kiel), Braun (Strassburg), W. König (Frankfort), Max Wolf (Heidelberg), Precht (Hannover), and Willard Gibbs and Michelson of America. The work is still hampered by want of room and by the antiquated character of the building, which compares but poorly with the "Paläste der Physik" recently erected at several of the German Universities. But men are more than buildings, and Quincke has shown astonishing ingenuity in utilising the space and means at command to accommodate the 120 students who attend his "Praktikum."

It is perhaps in association with the practical work of his laboratory that Quincke is seen at his best. He maintains a constant interest in the doings of his "Praktikanten"; no student is too dull nor any experiment too simple to enlist his personal attention. His research students find him unfailing in advice and assistance of the most helpful kind. If he is on occasion "heftig," it is only to become kinder and more helpful than ever. He gives his time ungrudgingly to his "Colloquium" and "Seminar." In the latter (held in the summer Semester) he lectures at length on some classical research, the practical work in connection with which is then carried out by the students, and the theory reproduced and results recorded in full for his approval and criticism. The Colloquium (in the winter Semester) is a small society for the discussion of current physical research. Here one learns to admire alike the patient consideration he shows the "Vortragender" (even if the latter happen to be a foreigner stumbling through his task in the most deplorable German), the independence and originality of his own outlook on current theories, and his extraordinarily wide acquaintance with both the older and the most recent literature of physics.

His lectures deal with an unusually wide range of topics, and are illustrated, not merely by a large collection of diagrams mostly drawn, and where necessary coloured, by his own hand, but also by many experiments rarely exhibited elsewhere. To quote a few instances almost at random, it is not often that one has the opportunity of seeing Cornu's hyperbolas (formed by reflection of monochromatic light from the surface of a bent glass strip), or water spread out in a capillary film on the surface of mercury, or experimental proof of the fact that super-

[1] Precht (*Wied. Ann.* lxi.) believes he has found a similar phenomenon in the case of Röntgen rays.

[1] And by the investigation of R. Weber (1901) on oil films (referred to in Prof. Rücker's recent presidential address), which was carried out in Quincke's own laboratory.

saturated water vapour only condenses in presence of suitable nuclei, or the production of double refraction by electrostatic stress (Kerr effect) in liquids, or Faraday's pretty experiments on the electrolytic action of the current from a frictional machine, or the beautifully ingenious demonstration, by manometric measurement of the pressure of an air bubble between the plates of a condenser immersed in an insulating fluid, of the pressure perpendicular to the lines of force in the electric field and its relation to the difference of potential between the plates. This last experiment was originally devised by Quincke in connection with an important research on the dielectric constant (sp. ind. cap.) of liquids, which he measured in three different ways—the ordinary "capacity" method, the measurement of the attraction between the plates in air and in the liquid (*i.e.* of the force parallel to the field), and, as just mentioned, of the pressure perpendicular thereto. The three methods yielded results which were, on the whole, in very satisfactory agreement with one another and with Clerk Maxwell's theory, *e.g.* for CS_2 2·64, 2·67, 2·74 (square of refractive index for D line 2·69).

This was only one of a long series (1880–1888) of electric and magnetic researches. These dealt, *inter alia*, with the alteration in elasticity, volume and refractive power produced by electrification ("electric expansion" and electrostatic double refraction, with the suggestion that the latter may be explained by the former). Deserving of especial mention is the discovery of the changes in level of magnetic (and diamagnetic) liquids contained in the capillary limb of a U-tube placed in the magnetic field. These changes are due to the difference of the "magnetic pressures" perpendicular to the lines of force in the liquid and the surrounding gas (compare the electric case above); they are proportional to the susceptibility of the liquid and the square of the field strength, and if the latter be independently determined, the susceptibility is deduced. By varying the gas in contact with the liquid, the susceptibility of gases may be measured. A method similar in principle is applicable to solids in the form of wires or electrolytic deposits on suitable rods. When once the susceptibility of suitable liquids (ferric and manganese chlorides are among the best) has been determined, the method can be used with great advantage to measure the strength of magnetic fields.

All this opened a wide field of research, but space forbids us to dwell on the interesting developments respecting "atomic magnetism" and other points.

Georg Quincke

Quincke is probably most widely known by his researches in capillarity, which have been of the most extensive and laborious kind. For the fundamental liquids, as we may call them, *i.e.* water and mercury, he has made great use of the methods of flat drops, and of air bubbles in the liquid, and therewith found values of the surface tension somewhat higher than those obtained by himself and others in other ways, in particular (for water) by the well-known capillary-tube method. He regards these higher values as the more probable, and concludes that the angle of contact of water and glass is not zero, as usually assumed, and therefore the water does not rise so high in capillary tubes as it would if the angle actually vanished. He has confirmed this by devising methods for measuring this angle of contact both on flat surfaces and in capillary tubes, and thus shown that for water and glass the angle may be 20° or so. He has also proved how sensitive the angle is to slight and often imperceptible changes in the condition of the surface. For water on cleavage surfaces of mica, for instance, it varies from 0° to 30° or more, according as the surface is quite fresh or has been exposed for shorter or longer periods to the air. By this principle of the variation of the angle of contact, and consequently of the size and appearance of small drops of liquid (water, mercury) deposited on a surface different parts of which are in imperceptibly different conditions, he has explained the formation of the curious "breath figures" and of Daguerreotype photographs. Daguerre discovered these through the accident of having left some of his silver iodide plates, which he had until then been unable to make permanent, in a cupboard where some mercury had been spilt. The vapour deposited itself in different-sized droplets on the different parts of the plate and gave a picture which could be made permanent.

The very extensive series of researches Quincke has made on salt solutions lead to the general result that the surface tension of such solutions increases with greater concentration by a term proportional to the number of equivalent weights of salt in the solution. For fused solid substances he has measured the surface tension by the methods depending on the weight of falling drops, and on the size and form of drops formed on a flat surface. Employing, then, a quantity a^2 which he calls the "specific cohesion" of the substance (defined by $a^2=2$ [surface tension]/density), he found the remarkable result that ("to a degree of approximation closer than that which holds good for Dulong and Petit's law of atomic heats") all pure substances fall into one or other of six classes the specific cohesions of which are in the ratio of ½ (*e.g.* phosphorus, sulphur, bromides, iodides): 1 (*e.g.* Hg, Pb, chlorides, nitrates, sugars): 2 (*e.g.* water, Ag, carbonates, sulphates): 3 (*e.g.* Zn, Fe): 4 (K): 7 (Na). It may be noted that a^2 measures the capillary attraction of a fluid sphere of unit radius on unit mass at its surface. That this quantity for various fluids is proportional to 1, 2, 3 . . . is in remarkable contrast to the fact that gravitational attraction is independent of the nature of the substances involved.

One of Quincke's most interesting and characteristic researches relates to the motions produced in drops clothed with oil films when an alkali is brought into contact with the oil, forming soap, which locally disturbs the existing surface tensions and causes a movement of the drop. Quincke sees in this the explanation of the movements of protoplasm. To quote his own words, "Ich glaube gezeigt zu haben, dass der Zellinhalt (das Protoplasma und der Zellsaft) jeder Pflanzenzelle von einer dünnen Oelhaut bekleidet ist: dass dünne Oellamellen mit festem und flüssigem Eiweiss die Plasmamasse durchziehen, und dass durch Einwirkung des alkalischen Eiweiss auf das oelsäurehaltige Oel periodisch 'Eiweissseife' entsteht, aufgelöst und an der Grenze von Oel und umgebender Flüssigkeit ausgebreitet wird. Diese periodische Ausbreitung der wässrigen Lösung von Eiweissseife gab dann die physikalische Erklärung der im Innern der Pflanzenzelle beobachteten Bewegungserscheinungen." Quincke's most recent researches relate chiefly to his favourite problems of molecular physics, but are, for the most part, still unpublished.

Reference has already been made to the Heidelberg "Praktikum," or course of practical physics, for which Quincke has devised many ingenious forms of simple and cheap apparatus, which are yet capable of giving surprisingly good quantitative results. Here one may see an optical bench which, though chiefly made of a half-metre scale and some cork, sealing wax and glass strips, yet enables the student to make all the usual measurements with mirrors and lenses, without dark room, and with an accuracy equal to that obtainable with apparatus many times larger and more expensive. Again, Quincke has invented a form of reflecting galvanometer[1] which costs some fifty shillings in all, but is sufficient for all ordinary electric measurements, not merely for learners, but also for research students. Want of space forbids us to tell of the almost innumerable devices for solving just those problems which confront so many of our science teachers in England at this moment which the Heidelberg laboratory contains. A word may be spared for two seeming trifles which are astonishingly useful. One is the lidless box used as a seat, giving three different heights, according as it is placed on its short, long or open side. A few of these can be combined with a screw clamp or two in endless ways to serve as supports for apparatus, &c. The other is a form of trestle[2] (with the two slant legs at one end replaced by one vertical one), which is very convenient as a support for pendulums and other such apparatus.

[1] This, together with Quincke's invaluable "Cathetometer Microscope," is visible on the table behind the Professor's right arm in the photograph reproduced herewith.
[2] Visible on the right of the photograph.

It is much to be hoped that Prof. Quincke may see his way to publish his laboratory notes in book form, and if he would accompany such a book with directions for carrying out what a witty Heidelberg student described as "Quincke's cork-wax-pfennig system," he would be conferring a boon on many students and more teachers. But we fear it is hardly likely that the claims on his time as teacher and investigator will allow opportunity for this to be done.

EMILIEN JEAN RENOU.

M. RENOU was born at Vendôme, March 8, 1815, and, naturally, went to the Lycée there. He entered the Ecole Polytechnique in 1835 and later the École des Mines, where he studied under Élie de Beaumont. He subsequently visited German universities for two years, especially the lectures of Gauss at Göttingen.

From 1839–42 he was attached to the Scientific Commission of Algeria and published a "Description Géologique de l'Algérie." In 1846 he was directed to collect all the information as to Morocco which he could find, and the result was a valuable work, "Description de l'Empire du Maroc." He made a second visit to Algeria, at his own expense, to verify previous geographical determinations.

In 1850 he resolved to devote himself almost exclusively to meteorology, and he was one of the founding members of the Société Météorologique in 1853. He has published numerous papers in its *Annuaires*. He acted as its secretary for eleven years, not consecutive, and no less than four times was elected to fill the office of president.

In 1868 he was one of the members of a committee, under the presidency of Charles Ste. Claire Deville, for the organisation of the observatory of Montsouris. After the events of 1870–72, this establishment was placed under M. Marié Davy, and M. Renou had to leave.

In 1872 he was officially appointed director of a laboratory for meteorological research, an office which he held until his death. This establishment was first located at Choisy le Roi, but in a few months it was moved to Parc St. Maur, to a locality rented by M. Renou. On the official establishment of the Bureau Central de Météorologie, M. Renou's station was selected as the central station for the climate of Paris, and the instruments were moved to a plot of ground which was assigned to the Bureau, and where they now remain. M. Renou has contributed to the *Annales* of the Bureau three important papers on the climate of Paris.

M. Renou deservedly received many honours, the principal being Legion of Honour, Chevalier (1847), Officier (1884), Officier de l'Académie (1873), and Officier de l'Instruction Publique (1891).

He died on April 6 at Parc St. Maur at the age of eighty-seven; and he has bequeathed his large library to the public library of his native place, Vendôme.

R. H. S.

NOTES.

The first of the two annual soirees of the Royal Society will be held on May 14. This is the soiree to which gentlemen only are invited.

The meeting of the Paris Academy of Sciences on April 14 was adjourned as a sign of respect for the late Prof. A. Cornu, whose untimely death was announced by the president in the following words:—"The Academy of Sciences has suffered a great loss. Prof. Cornu died on Friday, carried away rapidly by a disease which no one could foresee would terminate so sorrowfully. Our colleague was relatively young; he entered the École Polytechnique in 1860 and was nominated a member of our Academy in 1878, at thirty-seven years of age. Esteemed as a professor at the École Polytechnique, and contributing to the Bureau des Longitudes every year notices written in perfect language, he died while in active scientific work, leaving saddened parents and friends behind him, and universal regret in the scientific world."

LORD KELVIN has met with an enthusiastic reception in New York, and the signs of profound regard which have been shown to him are expressions of a feeling shared by the whole civilised world. On Saturday he attended the ceremony of the installation of Prof. N. B. Butler, the new president of Columbia University, and when he appeared in the procession a student cried, "Hats off to Kelvin," and all the students, men and women, lifted their college caps. In an article upon Lord Kelvin's career, the New York *Sun* says:—"There are few instruments used on land or sea that do not owe something or everything to Lord Kelvin's active brain. His presence does honour to the United States of America. We welcome him heartily." The *Tribune* says:—"It is natural that many Americans, especially those engaged in scientific pursuits, should covet an opportunity of paying their respects to our distinguished visitor." Similar sentiments appear in other journals, all testifying to Lord Kelvin's greatness of mind and character. A booklet by Mr. John Munro, just published by Mr. H. J. Drane in a series of "Bijou Biographies" (No. ix.), contains many interesting anecdotes and incidents connected with Lord Kelvin's remarkable career, and is well worth reading by those unfamiliar with his life and work.

ON Monday a brilliant reception in honour of Lord Kelvin was given at the Columbia University by the American Institute of Electrical Engineers, the National Academy of Sciences, and other leading scientific associations. Mr. Elihu Thomson, president of the Houston-Thomson Electrical Company, Prof. F. B. Crocker, Prof. Butler, president of the Columbia University, and Prof. R. S. Woodward all delivered addresses in honour of the achievements of Lord Kelvin. The New York correspondent of the *Times* reports that when Lord Kelvin rose to reply the whole audience rose and cheered him enthusiastically for several minutes. He thanked the speakers for their kindly reference to himself in connection with the laying of the Atlantic cable, "but," he added, "Americans must never forget, as the world will never forget, the name of that great American, Cyrus Field. Science has advanced greatly during the years along all lines. One of its greatest achievements has been made by Signor Marconi with wireless telegraphy. It is a great achievement to have sent a message inland from several hundred miles out at sea in this way, and it indicates that the time will come when messages will be sped right over the ocean without the use of any intervening wire. But still, submarine telegraphy will continue to serve us well, even with wireless telegraphy established as a commercial success." Lord Kelvin then proceeded to review modern scientific events, and paid a high tribute to the work done by Mr. Edison in the field of electric lighting. Mr. Edison, who was amongst those present, rose and bowed his acknowledgments to Lord Kelvin, the audience cheering him heartily. Lord Kelvin concluded his speech with a reference to the invention which made possible the transmission of power at a high voltage, and the "harnessing of Niagara Falls." He predicted that a power plant would be established at Niagara that would transmit 40,000 volts a distance of 300 miles. When Lord Kelvin resumed his seat the applause was prolonged for several minutes. After that hundreds of the distinguished audience filed past and shook hands with Lord and Lady Kelvin.

AT the Royal Institution on Thursday, May 1, Dr. A. Smith Woodward will deliver the first of three lectures on "Recent Geological Discoveries." The Friday evening discourse on May 2 will be delivered by Mr. A. E. Tutton, on "Experimental Researches on the Constitution of Crystals"; and on May 9 by Prof. J. Norman Collie, his subject being "Exploration and Climbing in the Canadian Rocky Mountains."

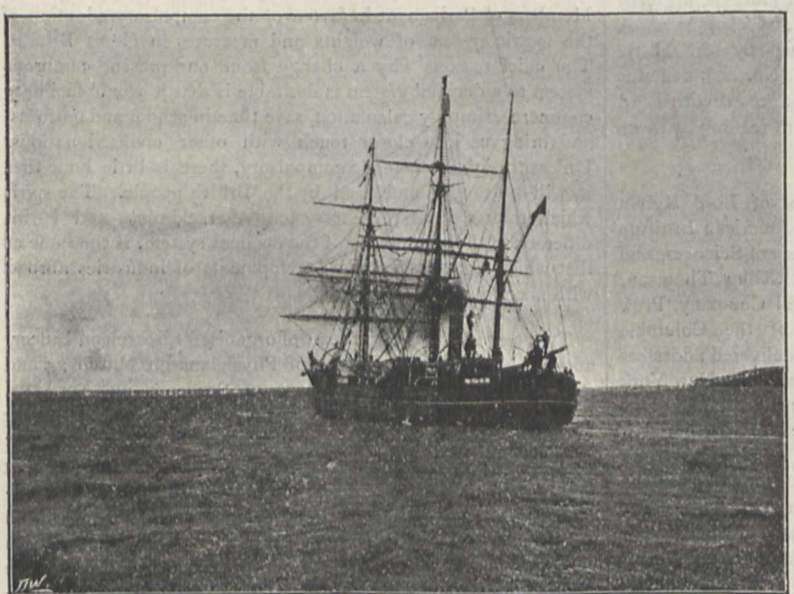
THE Easter vacation party at the Port Erin Biological Station has suffered by the absence abroad of Prof. Herdman and Mr. I. C. Thompson, so that it was not possible to arrange any steam dredging expeditions. Nevertheless, much good work has been done on the shore and with the tow-net, and several workers have spent a profitable vacation at the station. These include Dr. Darbishire, Miss Pratt and Miss Drey from Owens College, Messrs. Pearson and Tattersall from University College, Liverpool, and Mr. Laurie from Oxford. Mr. Cole was to have conducted a vacation class, but was unable to cross owing to a family bereavement. The new and greatly improved station is progressing rapidly and will be opened in the summer.

THE Decimal Association has just published a pamphlet containing strong expressions of opinion received from many Members of Parliament in favour of the compulsory adoption of the metric system of weights and measures in Great Britain. The chief reasons why a change from our present cumbrous system to a decimal system is desirable is that it would facilitate commerce, simplify calculation, save time in school and business, and bring us into closer touch with other civilised nations. Unless the system is made compulsory, there is little hope that it will be taught and used by the British people. The spirit which tolerates the present system of reckoning, and is indifferent to the advantages of the decimal system, is the same as that which regards scientific developments of industries abroad with unconcern.

THE text of the draft scheme of organised research on cancer, adopted by the Royal College of Physicians on March 24 and approved by the Royal College of Surgeons on April 10, has now been published. The scheme states that in order to promote investigations into all matters connected with, or bearing on, the causes, prevention and treatment of cancer and malignant disease, steps are to be taken, (1) to provide, extend, equip and maintain laboratories to be devoted exclusively to cancer research; (2) to encourage researches on the subject of cancer within the United Kingdom or in the British dominions beyond the seas; (3) to assist in the development of cancer-research departments in various hospitals and institutions approved by the executive committee; (4) and generally to provide means for systematic investigation in various other directions into the causes, prevention and treatment of cancer. Should the object of the fund be attained by the discovery of the cause and nature of cancer, and of an effective method of treatment, the Royal Colleges, with the consent of the trustees, are to be empowered to utilise the fund either (*a*) for equipping with the necessities for such treatment such hospitals as they may select, or (*b*) for forwarding research into other diseases. The fund is to be administered by a president, vice-presidents, trustees, honorary treasurer, general committee, and executive committee consisting of twelve members, one to be nominated by the Royal Society.

WE have received a reprint of the important paper by Col. G. E. Church, published in the March number of the *Geographical Journal*, on "Interoceanic Communication on the Western Continent." The paper first discusses possibilities of transcontinental railways in South America, but the main subject dealt with is the geographical conditions affecting the different canal schemes in Central America. The probable traffic of a canal, when constructed, is analysed, and its chance in competition with North American railways estimated.

THE first place in the April number of the *Geographical Journal* is given to a series of three papers on the voyage southward of the *Discovery*, by Dr. H. R. Mill, Mr. George Murray, and Sir Clements Markham. Dr. Mill describes the equipment and routine work on board in meteorology and oceanography, and gives an account of his week's voyage to Madeira. Mr. Murray's paper continues the voyage from Madeira to the Cape, but it is chiefly occupied with an interesting account of a landing expedition on South Trinidad, an oceanic islet the name of which is familiar to readers of the "Cruise of the *Falcon*." Sir Clements Markham describes, from reports which have been sent home, the experiences of the *Discovery* from the time of leaving Cape Town until her final departure from Lyttelton for the Antarctic. During the eastward voyage, the *Discovery* met with exceptionally heavy weather and acquitted herself well, showing that so far as sea-going qualities are concerned her design leaves nothing to be desired, while the constructional defects developed, and partly made good in dock at Lyttelton, are not such as to cause apprehension of any kind. The chief features of the voyage were an excursion to lat. 63° S. in long. 140° E.—with the double object of observing the change of magnetic force along the agonic line, and of giving the ship and her crew a first taste of the ice—and a visit to Macquarie Island, where valuable collections were made. In conclusion, Sir Clements Markham describes the arrangements in progress for sending out a relief ship next June. A Norwegian whaler, the *Morning*, of Tonsberg, has already been purchased, but more funds are urgently needed for her proper equipment and dispatch. The photograph we reproduce from the *Journal* shows the *Discovery's* departure from Lyttelton.



The *Discovery*.

THE United States Weather Bureau has published a discussion of the oss of life in the United States by lightning (*Bulletin* No. 30). The inquiry was begun in 1890, and has therefore extended over eleven years. The number of persons killed during 1900 was 713; of this number 291 were killed in the open, 158 in houses and 57 under trees. In the same year, 973 persons were injured; of these 327 were in houses, 243 in the open and 29 under trees. During the eleven years 1890-1900, the average number of persons killed yearly was 377. The greatest mortality by lightning, considering both unit area and density of population, is in the Ohio Valley and the Middle Atlantic States; but if density of population only be considered, it is in the Upper Missouri Valley and middle Rocky Mountain region. The great majority of storms occur in the summer season, but winter thunderstorms are not infrequent in the Gulf States and occasionally extend eastward along the Atlantic coast to Massachusetts. The *Bulletin* has been prepared by Prof. A. J. Henry, and contains some useful rules to be observed during thunderstorms and on the treatment of persons struck by lightning, even though they may be apparently dead.

MESSRS. A. GALLENKAMP AND CO., the London agents of a well-known firm of opticians of Zürich, have lately introduced to our notice two very handy and effective little instruments for obtaining the dew-point and humidity of the atmosphere without the necessity of calculating the different hygrometric values by means of the usual tables. One of the instruments, Lambrecht's polymeter, so-called from its showing several conditions, is a combination of the thermometer and hair-hygrometer, each provided with two scales, showing temperature in Fahrenheit degrees, elastic force of vapour in millimetres (or weight of vapour in grammes), the relative humidity and "number of degree," or the difference between the dew-point and the temperature of the air. For showing the temperature of the dew-point independently (if desired) a neat little instrument is used, consisting of a drum, to which a thermometer and polished disc are attached; a small quantity of ether is introduced into the drum and brought into contact with the bulb of the thermometer by forcing air into the drum by a very simple contrivance; as soon as the deposition appears on the disc, the temperature of the dew-point is indicated by the thermometer. The chief feature of these instruments is their portability and the facility with which they can be used. Both instruments will be found valuable in connection with questions of health and in certain industries which are affected by moisture; also for the prediction of weather, so far as it depends on the same cause. For the latter purpose a series of rules has been compiled by Dr. A. Troska.

IT was remarked by Laplace that when a liquid is free to rise in a capillary tube there may be several positions of equilibrium if the section is not uniform, and, moreover, that from general dynamical grounds positions of stable and unstable equilibrium follow each other alternately. A fuller investigation of this problem is now given by Signor G. Morera in a note contributed to the *Atti dei Lincei*, xi. 6. The author obtains, from mathematical considerations, a curve the intersections of which with the meridian section of the tube determine the positions of equilibrium. If in ascending the curve passes from the outside to the inside of the tube, the corresponding position of equilibrium is stable; if the contrary is the case, the position is unstable. Of course an exceptional case of what is sometimes called "stable-unstable" equilibrium occurs when Signor Morera's curve touches the meridian section of the tube. In the investigation it is assumed that the interior surface of the tube is a figure of revolution about a vertical axis. The interest of the paper centres round the determination of the curve from which the positions of equilibrium are found.

The properties of focal lines have always presented a certain difficulty to the student of geometrical optics. In 1844, Sturm enunciated the theorem that all the rays constituting a small pencil emanating from a luminous point will, after any number of refractions, pass through two focal lines which are at right-angles to each other and to the middle ray of the pencil. Now if the refracting surfaces are surfaces of revolution on a common axis on which the luminous point is situated, the rays after any number of refractions will all intersect this axis, although it is not at right angles to the middle ray. On the contrary, if a screen be placed perpendicular to the middle ray at the point where it meets the axis of revolution, it is easy to see experimentally that the section of the pencil by this screen is approximately a figure of eight, not a straight line as Sturm's theorem would appear to indicate. We are glad to find that this point has been considered by M. H. Bouasse in a note contributed to the *Journal de Physique* for April, and his explanation should help to clear up the obscurities which exist in the conventional treatment of focal lines.

Our present state of civilisation has of necessity resulted in an annual increase in the amount of capital borrowed by man from the store of energy accumulated by our earth in bygone times, and the diversion of this capital to uses for which the world's annual income of solar energy was formerly deemed adequate. An instance of this tendency is afforded by the experiments of Dr. Selim Lemström, of Helsingfors, on the uses of electricity in stimulating the growth of cereals, vegetables and other plants. A German translation of Dr. Lemström's paper has now been issued by Dr. Otto Pringsheim. The investigation seems to have been suggested in the first instance by an attempt to connect the luxuriant growth of plants in high latitudes with the influence of electric currents associated with the Aurora Borealis. The experiments showed that for plants growing on arable land of medium quality an increase of 45 per cent. in the crops is obtainable; but the better the field is ploughed and cared for the greater will be the increase. On poor soil the effect is trifling. Certain plants, such as peas, cabbages and turnips, only lend themselves to electrical treatment after being watered. It is, however, injurious to most, if not all, plants to submit them to the influence of electricity in hot sunshine. In the introduction, Dr. Pringsheim makes some estimate of the cost of applying the method to agricultural purposes, and arrives at the conclusion that it can be made to pay. A further suggestion is that we have here an explanation of the needle-shaped leaves of coniferous plants which are well adapted to facilitate the passage of electricity, or, in common parlance, "attract electricity."

With the March number, the *Electro-Chemist and Metallurgist* starts its second volume in a new form. It is now issued as a magazine instead of, as hitherto, in the form of a weekly paper, and it must be admitted that its present style is much more suited to its contents and to the fact that it is only published bi-monthly. We wish the journal all success in its endeavour to concentrate attention on a branch of science in which this country is particularly behindhand. The present issue, amongst other interesting articles, contains an account, by Mr. J. R. Crawford, of the Crawford-Voelker electric lamp. This lamp has attracted considerable attention during the past few months, and one or two articles about it have appeared in the technical Press. There is, however, reason to believe that the problem of its commercial manufacture is not yet fully solved, but the experimental results are very promising. The filament, which is run in a vacuum, is composed of carbide of titanium, and is formed by baking in the arc a carbon filament which has been impregnated with an organic compound of titanium. An energy consumption of 2·5 watts per candle is claimed for a 200-volt lamp, which rises after 1000 hours' run to 3·35 watts per candle, the candle power falling in the same time from 16 to 13. This is a very much better result than can be obtained from a carbon lamp, and puts the Crawford-Voelker lamp almost on a level with the Nernst lamp. If the simplicity of the lamp, which requires no pre-heating, is taken into account, it will be seen that, for small units at any rate, it is likely to prove superior to Nernst's invention. In the interests of the electric light user it is to be hoped that the lamp will soon emerge from the laboratory stage of development.

The Society of Chemical Industry is gradually extending its borders, and in time, no doubt, will embrace all divisions of the English-speaking races. The New York Section, formed in 1900, is already equal to the London Section of the Society in numbers and importance, and Canadian and Australian Sections are now being formed. The first meeting of the Canadian Section was held on March 6, 1902, in Toronto, and was favoured with a paper by Mr. B. E. F. Rhodin upon the new electrolytic alkali works at Sault Sainte Marie, Ontario. These works were erected in 1900 to operate the Rhodin cell and process for production of alkali and chlorine by electrolysis, and a portion of the plant has been in use since early in 1901. The cell is of the non-diaphragm mercury type, and differs from the better-known Castner cell only in the mechanical means adopted for producing circulation of the sodium amalgam and of the mercury between the anodic and kathodic compartments of the cell. The Rhodin cell cannot be worked in this country owing to litigation, which is still pending, relating to the validity of the Rhodin patents, and the works in Canada represent the first industrial application of the cell and process. The Canadian Electro-Chemical Company are the owners of the works referred to, and a decomposing plant of 120 cells, equivalent to a daily production of 4½ tons caustic soda and 9 tons bleach, has been erected at Sault Sainte Marie. Three turbo-generators, each of 220 k.w., have been installed, and these are driven by water from the St. Mary's River, giving a head of 19 feet at the Power-house. The works are not yet in full operation, as the commercial conditions in Canada are not at present favourable for the sale of the maximum output. It is hoped by the promoters of this Company that at an early date the whole of the Canadian requirements of caustic soda and bleach, will be met by the production of the electrolytic process operated at Sault Sainte Marie.

We have received from Messrs. Friedlander, of Berlin, a copy of "Naturæ Novitates" for 1901, containing the usual valuable lists of zoological literature.

In the April number of the *Zoologist* a correspondent directs attention to the probable duration of life in the great white snail. A number of these were turned down at Blaxhall, Suffolk, in 1882 and again in 1884, and as they do not appear to have bred and some are still living, the inference is that the survivors cannot be less than eighteen years of age, while some are probably much older.

At the auction rooms of Mr. J. C. Stevens on Thursday last there was sold a portion of the collection of birds' eggs formed by the late Mr. Philip Crowley, and containing a fine series of British birds' nests with eggs, and also eggs from another property. The three lots of chief interest were a fine specimen of the Great Auk, 315*l.*; an egg of the Great Auk, 252*l.*; and a very fine specimen of the egg of the Great Æpyornis, slightly cracked, 42*l.*

A LARGE portion of part iii. and the whole of part iv. of the *Archives de Zoologie experimentale* for 1901 are occupied by an elaborate dissertation on the structure and function of the ciliated epithelium of animals—the result of experiments and investigations carried out by Monsieur P. Vignon during the last three years. The main result of the observations, according to the author, is to prove or confirm the existence of "biological coordination." In the same journal M. E. Topsent describes the sponges of the Algerian coast.

WE have received a copy of an interesting paper by Herr W. Voight, from the *Verhandlungen* of the Natural History Association of Prussian Rhineland, &c., describing the extermination of two species of annelids from the freshwaters of the district and their replacement by a third. It appears that until recently *Planaria alpina* inhabited the streams of the Hundsrückgebirge, in the north-western Thuringerwald, and *Polycelis cornuta* those of the Taunus. It is inferred that they have been inhabitants of these regions since the Glacial epoch. At first *P. alpina* alone inhabited both areas; in the Hundsrückgebirge it persisted, but in the Taunus its territory was invaded by *P. cornuta*, which became the dominant form. As the climate grew warmer, a third species, *Planaria gonocephala*, appeared in the lower past of the streams, and has since been gradually spreading upwards until it has replaced both the others over the greater part of their area, the disappearance of *P. alpina* from many streams in the one district and of *P. cornuta* from those of the other being recent events.

IT is but seldom that it falls to the lot of the same individual to reoccupy the presidential chair of a scientific (or any other) society after an interval of twenty-one years, and we have accordingly much pleasure in offering our congratulations to Prof. R. Meldola on his assumption of that position at the recent "coming-of-age" of the Essex Field Club. Indeed, the club is to be congratulated on the "staying powers" of its officials generally, the president remarking that, with a single exception, the whole of the office-bearers during its twenty-one years of existence are still among us. Probably this is absolutely unique. In his presidential address on the occasion referred to, which is fully reported in the April number of the *Essex Naturalist*, Prof. Meldola summarises the scientific work of the Society; and it is a record of which the Society may well be proud. In many respects Essex is a county offering peculiarly favourable opportunities for local scientific research. It has a large seaboard, in common with Suffolk, it contains deposits of "Red Clay," the brick-earths of Ilford and elsewhere teem with remains of Pleistocene mammals, and prehistoric and other ancient works of man abound within its limits. Moreover, in Epping Forest it possesses a tract full of interest alike to the naturalist and the antiquarian. To the workers in all the branches of local scientific research the president does full justice.

IN the *Jahrbuch der k.-k. geol. Reichsanstalt*, Band li., Heft 1 (1901), Dr. O. Abel contributes a very interesting paper on some curiously marked pebbles from the Algerian Sahara. The pebbles, as the result of exposure to desert erosion, possess a characteristic surface sculpture of ridges and furrows, which have a more or less regular radial disposition. The special interest of this character lies in its wonderfully close resemblance to the sculpture frequently exhibited by moldavite, made more particularly familiar to us through Dr. F. E. Suess's advocacy of the meteoric origin of this mineral. The sculptured pebbles dealt with in this paper are of discoid form, and radial furrows are impressed on both sides of the disc. At the periphery the furrows become more plainly marked, and tend to pass across the margin of the disc in a direction at right angles to the flattened surfaces. The author examines the possible causes of this curious sculpture, and concludes that the ordinary action of the wind, driving sand-grains against the motionless pebbles, would be quite inadequate to produce the stellate figures on opposite surfaces of the stone. He believes, however, that the natural sand-blast is, in fact, the true eroding agent, but that the pebbles were rotating when attacked by it, while raised from the ground and driven forward over the surface of the desert during repeated sand-storms. That the stellate sculpture would result from such agencies the author considers to be proved by certain experiments carried out by Dr. F. E. Suess, to which he refers. As regards the analogous sculpture of moldavite, the author suggests that it might also have been produced by the prolonged exposure of the moldavite fragments to desert conditions, an idea which is supported by the form and size of the moldavite specimens, as well as by the relative softness of this glass when compared with quartz sand. At the same time, he considers that the theory of the cosmic origin of moldavite is in no way weakened by such a conclusion. The paper is excellently illustrated.

THE University of Texas Mineral Survey, under the direction of Mr. W. B. Phillips, has issued a report on sulphur, oil and quicksilver in Trans-Pecos (*Bulletin*, No. 2, 1902). In the Cretaceous area in Texas both heavy and illuminating oils are found at no great distance from each other. The subject was dealt with in *Bulletin* No. 1; some further particulars are now given, and complete analyses of all the coals, lignites and asphalt rocks, together with tests of the fuel value of the different oils, are in preparation. Quicksilver ores, chiefly cinnabar, occur in Brewster county in hard Cretaceous limestone and in decomposed shale, the rich stringers and pockets of cinnabar being found along bedding-planes and in cracks of the limestone associated with shaly matter. Intrusions of dolerite occur near by, and with them are probably connected the disturbance of the strata and the deposition, most likely from aqueous solution, of the metallic impregnations. Important sulphur deposits are met with in El Pasco county, and it is considered that 300,000 tons are available within forty feet of the surface in the vicinity of Maverick Springs. The area is described as consisting of a white plain of gypsum with a few small hills upon it, those on the west of gypsum, and those on the east of more recent conglomerate and white dolomite. The beds of gypsum overlie Upper Carboniferous sandstones and shales and are probably of Permian age. Throughout the tract sulphur springs are common, sulphur occurs in various forms, and the soil in places contains as much as 5 per cent. of free sulphuric acid. The gypsum beds are from 300 to 500 feet thick, and sulphur occurs in small crystals embedded in white gypsum, sometimes to the extent of 25 per cent. Elsewhere the sulphur occurs as a bluish ore in a siliceous earthy gangue, yielding 70 per cent. of sulphur. The matrix is locally bituminous, and it is noted that in all localities there are signs of oil. From a careful study of the subject, Mr. B. M. Skeats is of opinion that the richer bluish ores were formed from sulphur waters at a time when they were above ground, and probably through the agency of certain algæ which are plentiful in the sulphur springs to-day. All the sulphur occurs in and with gypsum and in connection with water containing sulphuretted hydrogen. The ores in which the sulphur occurs as crystals were probably formed by the decomposition of sulphuretted hydrogen given off from the highly charged water when it entered a porous or broken stratum. It is further considered that the gypsum may have been at one time carbonate of lime, for in many places it is difficult to say where limestone ends and gypsum begins.

WHILE we have large engineering workshops all over the country supplying machinery for practical use, it is with interest we note that a journal dealing with model making on a very practical scale is published for the benefit of young engineers and amateurs. The *Model Engineer and Amateur Electrician* forms the medium for enthusiastic students fond of engineering, and we find in its columns practical working drawings and photographs contributed and explained in a very lucid manner. Under the heading of "Queries and Replies," readers in difficulty for information get their wants adequately supplied in a subsequent issue. A good example of this is found on p. 165 (April number), where a working general arrangement of a model locomotive is given for a two and a half-inch gauge railway and drawn to a scale of half inch to a foot, in the design of which we notice water tubes placed inside and across the firebox, an idea only introduced into actual locomotive practice a few months ago. Electricity and petrol motors also form an important part within the columns of the periodical, practical types of dynamos, motors, &c., being thoroughly dealt with. A paper of this description brings within the scope of students a practical application of science to mechanical engineering, enabling them to grasp the fundamental ideas of construction and also to carry them through into a practical working form.

IN the article by Sir Michael Foster, on the Regina Margherita Observatory, in last week's NATURE (p. 569), the height of the Gnifetti hut, given as 4560 feet, should be 4560 metres; the height in feet is 14,961.

SEVEN volumes belonging to the valuable "Scientia" series have been received from the publisher, M. C. Naud, of Paris. Six of the volumes (Nos. 13–18) are in the physical section of the series, and one (No. 12) is in the biological section. Each volume may be described as a short review of knowledge of the subject with which it deals, or a statement of observations and results interpreted in the light of recent scientific thought. The titles and authors of the volumes which have just come to hand are "Cryoscopie," by the late M. F. M. Raoult; "Franges d'interférence," by Prof. J. M. de Lépinay; "La Géométrie non-euclidienne," by M. P. Barbarin; "Le Phénomène de Kerr et les Phénomènes électro-optiques," by M. E. Néculcéa; "Théorie de la Lune," by Prof. H. Andoyer; "Géométrographie, ou Art des Constructions géométriques," by M. E. Lemoine; and "L'Hérédité acquise: ses conséquences horticoles, agricoles, et medicales," by M. M. J. Constantin.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*), a Hocheur Monkey (*Cercopithecus nictitans*) from West Africa, presented by Captain Joseph C. Verey; a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, a Black-headed Lemur (*Lemur brunneus*), a Red-fronted Lemur (*Lemur rufifrons*) from Madagascar, two King Penguins (*Aptenodytes pennanti*), a Thick-billed Penguin (*Eudyptes pachyrhynchus*) from the Macquarie Islands, two Common Rheas (*Rhea americana*) from the Argentine Republic, a Raven (*Corvus corax*) European, two Eupatorian Parrakeets (*Palaeornis eupatria*), three Indian Rat Snakes (*Zamenis mucosa*), five Tigrine Frogs (*Rana tigrina*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY.

May 1. 1h. Jupiter in conjunction with moon. Jupiter 5° 59′ S.
1. 13h. 12m. to 14h. 7m. Moon occults c' Capricornii (mag. 5·2).
4. 5h. Venus in conjunction with moon. Venus 4° 19′ S.
7. Sun partially eclipsed, invisible at Greenwich.
14. 12h. 9m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc = 0·589, of Mars = 0·996.
17. 8h. 58m. Minimum of Algol (β Persei).
May 20. Saturn. Outer minor axis of outer ring = 14″·84.
20. 13h. 18m. Moon makes a near approach to α Libræ (mag. 3).
26. 20h. Saturn in conjunction with moon. Saturn 5° 18′ S.
28. 6h. Mercury at greatest elongation, 23° 3′ E.
28. 12h. Jupiter in conjunction with moon, Jupiter 5° 57′ S.
29. 4h. Mercury in conjunction with Neptune. Mercury 2° 52′ N.

COMET 1902 *a* (BROOKS).—The discovery of the first new comet of the present year was made by Mr. Brooks at Geneva on April 15, and the following data are supplied for the position at discovery and various subsequent epochs:—

1902.	h. m.	Place.	R.A. ° ′ ″	N.P.D. ° ′ ″	Observer
April 15	16 0	Geneva	347 2 0	62 35 0	Brooks.
,, 16	14 37	Kœnigsberg	348 55 16	63 53 25	—
,, 16	15 8·1	Copenhagen	349 3 12	63 58 39	Pechüle.
,, 16	15 30·2	Bamberg	349 6 54	64 1 1	Hartwig.
,, 16	15 45·6	Lick	350 16 56	64 47 34	Aitken.

The original announcement of discovery described the comet as being bright, with a tail. A later description by Prof. Hartwig states that the comet is about 8·5 magnitude, circular in form with a diameter of 3′. There is a central condensation and a tail somewhat less than 30′ in length.

At discovery the new comet was quite close to β Pegasi; it is now moving to the south-east rather rapidly.

NEBULÆ AND THEIR VELOCITIES IN THE LINE OF SIGHT.—Dr. J. Hartmann, of the Potsdam Observatory, gives (*Sitzungsberichte der Kön. Preuss. Akad. der Wissenschaften zu Berlin*, February 27, 1902) an interesting account of his investigation to determine the velocities in the line of sight of several gaseous nebulæ, the spectra of which he has photographed. The work was suggested to him after he had secured a very strong image of the planetary nebula G.C. 4390 with the Potsdam photographic refractor of 80 cm. in the short time of exposure of 15 minutes. In the investigation two spectroscopes were employed, that which he designates apparatus I. consisting of a flint glass prism of 60°, a collimator of 530 mm. and a camera of 720 mm. focal lengths; while apparatus III. has three flint glass prisms of 63°, a collimator of 480 mm. and a camera of 410 mm. focal lengths. The exposures of the different negatives obtained varied from 90 to 270 minutes, and the comparison spectrum photographed in each case was that of the arc spectrum of iron; the nebulæ photographed and the spectra of which were examined for movement in the line of sight were G.C. 4390, 4373, and N.G.C. 7027. Dr. Hartmann determined first of all the velocity of the nebula G.C. 4390 from the measurements of the hydrogen lines Hβ and Hγ, and from this value deduced the wave-lengths of the two chief nebula lines. All the values for the velocity as determined from the different negatives agreed well among themselves, and the deduced mean values for the wave-lengths of the two nebula lines were 5007·04 and 4959·17. While the former value is practically identical with the wave-length obtained by Prof. Keeler for the Orion nebula 5007·05 ± 0·03, the latter is somewhat greater than Keeler's value, namely 4959·02 ± 0·04. Dr. Hartmann finds that the discrepancy is easily explained, as Keeler used a spark spectrum of iron for comparison, and the two lines of iron close together at this wave-length behave differently under the two electrical conditions (arc and spark). If it be assumed that Keeler's comparison line was that at wave-length 4957·78 instead of at 4957·63—and Dr. Hartmann seems to have good reasons for making this assumption—then his own result is brought in complete accord. The paper further gives details of each of the measurements on the different photographic negatives employed, but the following table shows only the mean results obtained, giving Keeler's values for comparison:—

Nebula	Velocity Hartmann km.	Velocity Keeler km.
G.C. 4390 ...	−10·5	− 9·7
G.C. 4373 ...	−65·8	−64·7
N.G.C. 7027 ...	+ 4·9	+10·1

It is interesting to note that Dr. Hartmann finds slightly different values of the velocity for the middles in relation to the edges of the nebulæ; and the curved and inclined nature of the lines, when compared with those in the comparison spectra, indicate still more clearly relative movements in the nebulæ themselves.

The Red Spot on Jupiter.—In the *Astronomische Nachrichten* (Bd. 158, No. 3786), Mr. A. Stanley Williams gives a discussion of his observations of the red spot on Jupiter during 1901. The planet was badly placed owing to its great southerly declination, but during the summer months the definition was exceptionally good. Tables are given of the times occupied in the transit of the spot over the mean meridian of the disc, measures being taken from both the middle and following end of the marking. The mean rotation period thus determined is 9h. 55m. 40·92s., which is 1·38s. shorter than the value deduced from the observations of the previous year. This shortening of the length of the rotation period has also been noted by several other observers. In appearance the spot was very faint, especially at the preceding end. The following extremity, however, was fairly dark; a distinct though faint reddish tinge was generally noticeable.

Several reductions of measures of the length of the spot are given as evidence in favour of Prof. G. W. Hough's statement that the spot has not materially changed in size during the last twenty years.

THE MEANING OF THE WHITE UNDER SIDES OF ANIMALS.

PROF. E. B. POULTON has sent us the following account of a discovery of great interest to naturalists made by Mr. A. H. Thayer, and a paper in which Mr. Thayer himself describes his observations and conclusions. This paper has been specially revised for publication in Nature, and with Prof. Poulton's introduction will be welcomed by many observers of nature.

No discovery in the wide field of animal coloration has been received with greater interest than Mr. Abbott H. Thayer's demonstration, by means of models presented to the Natural History Museums of London, Oxford and Cambridge, of the cryptic effect of the gradation of animal tints, from dark on the back to white on the belly. In spite of the intense interest aroused in students of animal life from the side of art as well as from the side of zoological science, the underlying principles have been frequently misunderstood.

Mr. Thayer has seen some of the accounts of his discovery which have appeared in this country, and he feels that the explanation offered has been inadequate and sometimes misleading. He has therefore sent for publication in Nature a further statement, which may be regarded as an appendix to his original memoirs in *The Auk* for April and October, 1896. In this statement he makes a too generous acknowledgment of my partial discovery of the same principle (unknown to him in 1896) in two isolated cases in 1886 and 1887. I should wish, therefore, to state that I did not discover, and could never have discovered, what it required the eye of an artist to see—viz. the manner in which the total colour-effect of the cold white under side of an animal bathed in shadow and yellow earth reflections matches exactly its earth-brown back bathed in the cold blue-white of the sky. I furthermore failed to see the wide application of that part of the principle which I did discover, and not only failed to see it, but actually applied to the white under sides of animals and the white eggs of certain birds the erroneous interpretation which was then commonly received, the interpretation which Mr. Thayer disposes of so completely in the article printed below.

The following account was drawn up by the present writer for the models presented by Mr. Thayer to the Oxford University Museum. It is believed that the description of the principles concerned may be useful to students in other museums. I should add that Mr. Thayer cordially approves this description of the principles he has discovered:—

"Models to show the manner in which wild animals are commonly hidden.

"Made and presented by Abbott H. Thayer, Esq., of Scarbro, N.Y., U.S.A.

"If the two model ducks in this case be looked at from a little distance, the left-hand model will appear almost invisible, transparent and ghost-like, while the right-hand one stands out in startling contrast. The former has a colour arrangement similar to that commonly found among wild animals in nature, while the latter is entirely different.

"There are two quite distinct elements in the concealment of the left-hand model, and of such an animal as a hare or a woodcock. First there is loss of all appearance of *solidity*, secondly there is the harmony with the *colour* of the background.

"We are led to believe that any small object is *solid* and possesses a definite shape solely because of the varying depth of shade on parts of its surface more or less shielded from light. (In the case of a very large object, such as a mountain, the adjustment required when the eye focusses its near and distant parts may also aid the judgment, but this could not apply to anything so small as an animal). Thus an artist can make an object on the flat surface of his canvas appear to stand out as a solid because he paints the shadows as they would be caused by the varying degree of light on the surface of a solid. Mr. Thayer has shown for the first time that the opposite operation is quite possible, viz. that an artist can paint a solid object so as to obliterate the shadows and as a result to remove all appearance of solidity. In the case of an object illuminated, as animals are in nature, by the direct and reflected light of the sky, this is achieved by colouring the object darkest on the top where the light is strongest, gradually less dark on the sides where the light progressively lessens, and white underneath where the light is least, the darkening of the colour corresponding exactly to the strengthening of the illumination. This will be seen at once by turning the handle at the side of the case. The right-hand model is, on the other hand, of uniform colour, and appears far darker on the sides than the back, and darker still, almost dead black, underneath.

"In fact the model which is the same shade of colour all over appears to be a different shade everywhere because of the difference in illumination; while the model which is of a different shade at every level appears to be the same shade all over because the differences of shade exactly counterbalance the differences of illumination.

"Animals in nature are commonly graded in colour like the left-hand model; and Mr. Thayer's discovery of this great and yet simple principle was made because he, as an artist, recognised the ghost-like appearance of wild animals and then set to work to analyse its cause.

"But the obliteration of solidity would not effectually conceal if the *colour* did not harmonise with the environment. The back of the model, and of animals generally, is of the same tint as the brown of the earth bathed in the cold blue-white light of the sky; the under side of the model and the belly of animals is of a cold blue-white bathed in shadow and yellow earth reflections. These two mixtures produce colour effects which are similar to each other and to the mixtures of intermediate components on the sides.

"Hence with *solidity* eliminated and with *colour harmony* between environment and object, the latter appears to be but a part of the former. It is thus possible to explain the concealment of the left-hand model, or of such an animal as the hare crouching motionless on bare earth, or the numerous sand-coloured quadrupeds, birds and reptiles of the desert; but upon the surface of most animals markings are added which suggest the details of a more varied environment, such as that presented by masses of brown leaves, twigs, reeds, grasses, lichen, &c. It is obvious that in an environment full of varied detail a colouring producing a uniform effect would not conceal; hence the markings on the woodcock, ptarmigan, &c. In such cases the animal itself appears to become part of the background while its markings are seen as the details.

"Mr. Thayer has also gained further proof of the accuracy of his interpretation by painting out the gradation of colour on the sides and belly of a stuffed bird, thus extending the colour of the back over all parts of the surface. Although a living bird with its natural colouring would be almost invisible in nature, the painted specimen became extremely conspicuous when placed in the natural attitude and amid natural surroundings.

"It is not too much to assert that the broad fact of the colour gradation on the sides of animals passing into white underneath has now for the first time received its interpretation. "Edward B. Poulton.

"Oxford, January 22, 1902."

THE LAW WHICH UNDERLIES PROTECTIVE COLORATION.

I desire at the outset to point out that my demonstration of the principle of Protective Coloration is not the demonstration of a *theory*, but of an indisputable fact, namely, that if an object be coloured so that its tones constitute a gradation of shading and of colouring counter to the gradation of shading and of colouring which light thrown upon it would produce, such object will appear perfectly flat, retaining its length and breadth, but having lost its appearance of thickness, and when seen against a background of colour and pattern similar to its own will be essentially indistinguishable at a short distance. All persons who have seen the models which illustrate this fact know that they prove it.

Now, if this stands proved, *the fact that a vast majority of the whole Animal Kingdom wear this gradation, developed to an exquisitely minute degree, and are famous for being hard to see in their homes speaks for itself.* It is plain that their colour-gradation can no more escape effacing their look of solidity than the Law of Gravitation can escape drawing a projectile to the earth.

This is so obvious that one hears on all sides expressions of wonder that it was so long unnoticed. I may add that all persons of trained sight, such as artists, perceive it everywhere among wild creatures. Other people supplement their undeveloped sight sense by their other senses, and if they *know* the animal is solid think he *looks* solid. But the time will come when even at zoological gardens, where animals are more or less abnormally environed, people will find a new charm in recognising everywhere this wonderful adjustment of their colouring, and in perceiving its effect.

Let anyone look at a ball, or egg-shaped object, placed anywhere out of doors, and when he has recognised its shading from its light side to its dark, try to so colour it, where it stands, as to obliterate both its shading and its colour-gradation. (The sky-lit side is commonly the bluer). If he succeed, he will find that Nature has swiftly guided him through the same process which has taken her so long on the coats of animals, and that he has given the object the counter-gradation I speak of, and it will have dawned on him that so long as light makes its *one* gradation on objects, there is only the *one* way to neutralise it. In short, I simply prove that this arrangement of animals' colours is what so marvellously effaces them, and leave it to others to discuss the question whether concealment be a benefit to an animal and whether the fact that it is a benefit be the cause of his being concealed.

All who believe in Natural Selection will, of course, feel that this colour law is its work, and since it is so almost universally in use, and accounts, apparently, so almost exhaustively, for all the attributes of graded animal colouring, I believe it will ultimately be recognised as the most wonderful form of Darwin's great Law.

It stands alone in the startling attribute of being the only known or so far conceivable device for making objects in *full light not appear to exist.* This is a distinct plane above even the great beauty of Protective Resemblance, where the deception is of a more material nature, one thing passing itself off for another *thing.* The beautiful sequence of this law, which causes the grading colours to become a picture of the background, I will not force upon those who have not yet digested the first part.

It might be worth pointing out that the old theory that the bellies of fish and tree birds were white to match the sky when seen from below finds itself essentially done away with, since the fishes' or birds' opacity causes even their white to look very dark against an ordinary sky, while this same white proves to work so brilliant a success for the purpose I have shown. All people know the ghostly transparent look of fish in the water. The white bellies of birds do help them to match the *translucent foliage overhead* when seen from below, but the cold sky-holes between the leaves are far too bright. Natural Selection has, of course, surely modified all attributes to suit, not merely main ends, but all minor ones, according to the rank of their importance.

Since publishing my papers in *The Auk* for April and October, 1896, I find that Prof. Poulton perceived years before their appearance the power of a countergrading of light to make the round surface of a pupa appear flat, and in another case the power of light colour in a depression to make the concavity disappear. In both of these cases he perceived the very *Law of Light and Shade* on which the Fact of Protective Coloration rests, and recognised the Fact itself in these instances. In his "Notes in 1886 upon Lepidopterous Larvæ, &c.," read April 6, 1887, he says (*Trans.* Ent. Soc. Lond., 1887, p. 294), "Although the cleft [between the posterior part of the body of the larva of *Rumia crataegata* and the branch] is largely filled up, . . . a considerable furrow remains, but this is not apparent because of the light colour of the fleshy processes, which prevent the attention from being directed to the shadow which would otherwise indicate the position of the groove. The processes, therefore, attain the object of softening the contact between the larva and its food-plant in a two-fold manner, by partially filling up the cleft and by neutralising the shadow in the groove which remains. I have also noticed the processes in the larva of *A. betularia*, and I believe that they are of very general occurrence in *Geometrae.*"

His other case is to be found in his "Notes in 1887 upon Lepidopterous Larvæ, &c.," read October 3, 1888. He says (*Trans.* Ent. Soc. Lond., pp. 595–6), "The most extraordinary thing about this resemblance [of the pupa of *Apatura iris* to a sallow-leaf] was the leaf-like impression of *flatness* conveyed by a pupa which was in reality very far from flat. Thus the length of the pupa was 30·5 mm.; the greatest breadth (dorso-ventral diameter), 11·5 mm.; the greatest thickness (from side to side), 8·5 mm. . . . But exactly in these places, where the obvious thickness would destroy the resemblance to a leaf, the whole effect of the roundness is neutralised by the increasing lightness of these parts—a lightness which is so disposed as to just compensate for the shadow by which alone we judge of the roundness of small objects. (Much larger objects can be judged of by the change of focus, which becomes necessary as their near or distant parts are observed.) In shading the drawing of an object so as to represent roundness, the shade is made to become gradually less and less deep as the tangential planes represented come nearer and nearer to a right angle with the axis of vision. So here, the converse of shading—the whiteness neutralising the shadow which shading is intended to represent—dies off gradually as the [representation of the] mid-rib is approached.

"The whiteness is produced by the relative abundance of white dots and a fine white marking of the surface which is present everywhere, mingled with the green. The effect is, in fact, produced by a process exactly analogous to stippling.

"By this beautiful and simple method a pupa, which is 8·5 mm. from side to side in its thickest part, appears flat and offers the most remarkable resemblance to a leaf which is a small fraction of 1 mm. in thickness." ABBOTT H. THAYER.

Scarbro, New York.

REPORT OF THE SMITHSONIAN INSTITUTION.

DR. S. P. LANGLEY'S report upon the operations of the Smithsonian Institution for the year ending last June has just reached this country. Many subjects of interest are referred to in the report, but we are only able to mention a few, which will, however, be sufficient to show that the Institution is taking a foremost part in the advancement and diffusion of knowledge among men of all civilised nations.

Hodgkins Fund.—Among the many applications for grants from the Hodgkins fund, it has been found practicable to approve several which conform to the conditions of the bequest. Prof. Wallace C. Sabine, of Harvard University, has received a grant for the aid of his investigations on sound, the particular phase of the problem under investigation being the subject of loudness and interference. This research requires apparatus of special design, part of which is now complete and is satisfactory. Prof. Sabine, who had charge of the design of the new symphony hall in Boston, has for several years given much attention to the problem of architectural acoustics, or the science of sound as applied to buildings. It is expected that his complete report will be of much practical interest in connection with this subject.

Details of the progress of the research mentioned in the last report as conducted by Dr. Victor Schumann, of Leipzig, have been received. The most noteworthy points in the results so far refer, perhaps, to the relation of light and electricity and to the probable insight into the nature of the Röntgen rays to be gained in the course of this investigation.

The investigations of Dr. von Lendenfeld, of the University of Prague, are still in progress, and it is anticipated that his final report, which is now awaited, may furnish data available for greatly improving the construction of the meteorological kites now in constant use, and thus be the means of adding materially to our knowledge of atmospheric conditions at high altitudes, the practical application of which is of such general interest and usefulness.

The interesting experiments in connection with kites and with air currents at varying altitudes, which have been prosecuted for some time at the Blue Hill Meteorological Observatory by Mr. A. Lawrence Rotch, are still in progress, an additional grant having been approved this year on behalf of Mr. Rotch. It will be remembered that the original grant mentioned was made for the purpose of securing automatic kite records at a height of more than 10,000 feet, an altitude which so lately as four years ago had never been attained. Successive grants have since been made, and the persistence and skill of Mr. Rotch and his assistants have enabled him to surpass his own extraordinary record of 14,000 feet.

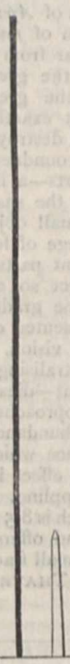


FIG. 1.—Diagram illustrating height of packing boxes, resting one upon another, used in transmitting exchanges from the United States to foreign countries during the fiscal year ending June 30, 1901, as compared with the height of the Washington Monument. Height of monument, 555 feet; height of boxes, 2,775 feet.

Dr. Carl Barus, of Brown University, has completed his research on ionised air, and his report is now in course of publication in the Smithsonian Contributions to Knowledge. This research on atmospheric conditions, in investigating the production of nuclei, determining their number per cubic centimetre, their velocity, their association with ionisation, the effect of the presence of the electric field, &c., proves interesting, not only in its own methods and results, but because of its agreement with the data obtained by other investigators from different experiments and theoretically different points of view.

The research of Prof. Louis Bevier, of Rutgers College, in connection with the analysis of vowel sounds, is steadily progressing. During the year detailed studies of several vowel sounds have been made with results which agree well with the conclusions arrived at through an entirely different method by von Helmholtz in his analysis of German vowels. The lower resonance detected in our vowel sounds by Dr. Bevier, and not recorded by von Helmholtz save for "*a*," will later be the subject of detailed discussion which will endeavour to establish and explain these facts.

Dr. Marey, of the French Institute, has received a grant in aid of his experiments on air currents. This research has been materially furthered by the successful application of chrono-photography, a field in which Dr. Marey's experiments have heretofore been noteworthy. By this means it has not only been possible to analyse the movements of waves and currents of liquids which are invisible to the naked eye, but even the displacements of molecules. From reports so far submitted, but as yet necessarily incomplete, it is believed that this research will aid materially in the solution of various problems connected with the mechanics of propulsion in fluids, at the same time rendering service in solving practical questions of ventilation, &c. The reader, if he has not noticed the rare experiment of successful machine flight of heavy bodies through the air, has probably had his attention called at times to the extraordinary difference between the performance of small steam vessels like yachts or tugs, where with equal power one glides through the water almost as though it offered no resistance, while another labours in rolling a formidable wave before it. The same differences occur in still more subtle form in the air. We cannot with the naked eye see separately, in either case, the currents that produce the effect, but by Dr. Marey's ingenious experiments photographic records can be obtained from which the forms which offer the least resistance can be studied.

The experiments of Prof. A. G. Webster, of Clark University, on the propagation, reflection and diffraction of sound, have achieved a result of practical value in the construction of an instrument capable of emitting an accurately measured sound. It is thus possible, in treating persons of defective hearing, to decide with exactness as to the degree of deafness in a subject, and to say if the power of hearing varies at different times. An instrument which furnishes the means of accurately determining these points should prove of value in medical treatment.

Prof. William Hallock, of Columbia University, New York, is conducting a research on the motion of a particle of air under the influence of articulate sound. General investigations allied to this subject, which are carried on in the laboratory of Columbia University, although in no way aided by the Hodgkins fund, have contributed helpfully to a knowledge of the principles underlying these experiments, and especially to certain parts of the investigation referring to the relation between the amplitude of vibration of an air particle and the amplitude of vibration of a film, or dust particle, suspended in the air. Dr. Hallock's research will be continued during the present year, when a final report is expected.

International Exchanges.—The importance of the work accomplished by the International Exchange Service is now well understood among men of science, and the benefits derived from it in the interchange of the publications of the civilised world are appreciated. The liberality of the American people in gratuitously supplying their scientific literature to appreciative students of it, wherever they may be, and the provision for its transmission at the expense of the United States Government and of the Smithsonian Institution jointly, are highly valued in the scientific world.

The term "International Exchanges" is now applied to the mutual exchange between Smithsonian correspondents everywhere of printed books on subjects of interest to the student in any branch of human knowledge.

The field covered by correspondents of the Smithsonian Institution and the contributors and recipients of its exchanges is now represented by one hundred and forty-eight countries, covering every part of the civilised world and extending to several countries where enlightenment has only commenced to manifest itself. In the latter are some of the most appreciative correspondents of the service. Outside the United States the Smithsonian correspondents now number 27,556, and including the United States there is a grand total of 35,705, an aggregate increase of 1754 during the year. The parcels received for transmission in 1900 numbered 121,060 (many of which contained several separate publications), representing an increase over the previous year of 7497 (Fig. 1).

In his last report Dr. Langley presented an account of his visit to London and Berlin during the summer of 1900 for the purpose of impressing upon the British and German Governments the desire of the Institution that they should each establish an international exchange bureau, or at least arrange for the transmission and distribution of exchanges so far as the United States is concerned. This work has been carried on between the United States and Germany and Great Britain from the beginning at the expense of the Institution, which has paid all expenses, even to the employing of a salaried agent in both countries. As yet no definite action has been taken by either Government.

Astrophysical Observatory.—It will be remembered that the observations of last year's eclipse by the Smithsonian expedition raised interesting questions as to the existence of intramercurial planets and as to the nature of the coronal radiations. So far did the interest in these problems extend that it was thought worth while to send an expedition from the Astrophysical Observatory to Sumatra to observe the total eclipse of May 18, 1901, and to repeat and extend the bolometric observations on the coronal radiation and the photographic observations for possible intramercurial planets. Solok, Sumatra, was the point selected for the observations. But, unfortunately, at the time of the eclipse the whole sky, excepting a perfectly clear belt around the horizon, was overcast with a sort of checkerwork of clouds, so thick that the corona could barely be distinguished. During the latter part of totality the very position of the sun was doubtful. Merely to have something to show to prove that the expedition had observed an eclipse, the programme for the intramercurial-planet apparatus was carried through, and the plates were developed. Those exposed in the first half of totality showed the corona faintly, extending out possibly a quarter or half a diameter, and showed the planets Mercury and Venus. Nothing else could be distinguished, not even the first-magnitude star Aldebaran. The plates exposed during the last half showed even less, as the clouds were then thicker.

The accompanying illustration (Fig. 2) shows the instrument used to obtain the photographs. If the weather had been fine it would have been possible to have obtained photographs which

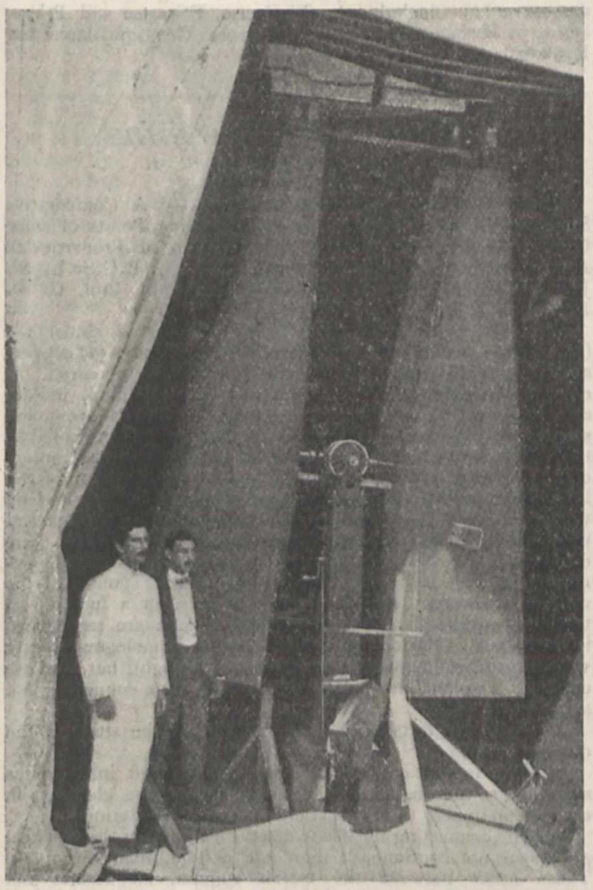


FIG. 2.—The Intra-Mercurial Planet Apparatus of the Smithsonian Institution.

would have decided whether the impressions of the supposed small planets within the orbit of Mercury, which appear upon the photographs of the previous eclipse, represent real bodies or not.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A FEW particulars of the late Mr. Robert Irvine's bequest for the chair of bacteriology in Edinburgh University are given in the *Lancet*. Certain shares in the Christmas Island Phosphate Co., Ltd., are to form a separate trust to be invested until the property accumulates to the value of 25,000*l*. or 30,000*l*., when the trustees are to pay the sum over to the Association for the better Endowment of the University of Edinburgh, or to such authorities in connection with the University of Edinburgh as the trustees shall deem expedient, for the purpose of founding a professorship of bacteriology in the University and the equipment of a class-room and laboratory for the teaching of the same, and for conducting original investigation in that subject.

FOLLOWING the example of the London Technical Education Board, the Central Welsh Board has arranged for a conference of science teachers, to be held on Thursday, May 15, at the County Buildings, Festiniog. At the morning meeting, papers will be read by Mr. J. Griffith, on "The Teaching of Science as a Preparation for Industrial Life," and Miss Holmer, on "The Value of Biological Teaching for Girls." At the afternoon meeting, papers will be read by Dr. J. J. Findlay, on "The Correlation of the Teaching of Science and Mathematics in Lower Forms," and Mr. W. Saunders, on "Nature Study as an Introduction to Science Teaching." It is hoped that the conference will assist the development of science teaching in Welsh intermediate and technical schools.

AT the Glasgow meeting of the British Association last year, a committee was appointed in connection with the section of Educational Science to consider the conditions of health essential to the carrying on of the work of instruction in schools. The committee is collecting information and tabulating records with reference to original observations on the periods of day appropriate for different studies, the length of lesson, and the periods of study suitable for children of different ages; anthropometrical and physiological observation forms in use in various schools, with a view to prepare a typical form for general use; anthropometrical and physiological observations recorded in different schools for a series of years on the same children; investigations into the causes of defective eyesight in school children and a definition of the conditions necessary for preserving the sight, and the practical knowledge of hygiene possessed by school teachers. Cooperation in obtaining information on these points is invited. Any facts or references relating to the subjects under consideration should be sent to the chairman, Prof. C. S. Sherrington, F.R.S., or to the secretary, Mr. E. White Wallis, 72 Margaret Street, W.

A NOTABLE event, marking the progress made by agricultural education in the States, will take place on July 7, when the first classes of the Graduate School of Agriculture assemble in the Townshend Hall of the Ohio State University. The Graduate School will provide advanced instruction in agricultural science for teachers and investigators. It meets under the auspices of the Ohio State University (where the movement originated), the Department of Agriculture, and the Association of American Agricultural Colleges and Experiment Stations. The session will last for four weeks, and parallel courses of instruction in animal husbandry, dairying, the culture of field crops and other subjects will be given by a special staff of thirty professors and lecturers, including many of the best-known teachers at the American agricultural colleges. The class-rooms, laboratories and apparatus of the Agricultural College of the Ohio State University will be placed at the disposal of this staff. Typical animals will be provided for demonstration purposes, and lectures will be illustrated by specially prepared specimens and diagrams. Admission to the school is limited to graduates, or to persons specially recommended by college authorities. The fee for instruction is six dollars, and the entire cost of the course, apart from travelling expenses, need not exceed thirty dollars.

SCIENTIFIC SERIALS.

American Journal of Science, April.—On the use of the stereographic projection for geographical maps and sailing charts, by S. L. Penfield. In continuation of previous papers on the same subject, the various modes of stereographic projection are described with photographic illustrations from models, with remarks on the use of the stereographic protractor for measuring distances along great circles, of measuring spherical angles at a given point, together with various applications in navigation.—On the hind limb of Protostega, by S. W. Williston. A description of a hind limb of what is probably *P. gigas*, found in the Kansas chalk two years ago. The specimen had for the most part been washed from its matrix, and the original relations of the bones lost. It is characterised by the femur being much more slender than the specimen described by Case.—The physical effects of contact metamorphism, by Joseph Barrel. Although much has been developed in past years concerning the physical, chemical and mineralogical effects of the metamorphism produced in sedimentary beds by the contact of igneous masses, but little has been said concerning the wholesale liberation of gases from the sediments so affected. The shrinkages of volume, the formation of vein fissures, impregnation deposits, and new intrusion of igneous matter and other phenomena due to this cause are considered in the present paper.—An expedition to the Maldives, by A. Agassiz. The most important result of the expedition was the contribution to our knowledge of atoll formation. The present definition of atolls appears to be unjustifiable, as there is every possible gradation between a curved open crescent-shaped bank of greater or less size and an absolutely closed ring of land surrounding a lagoon without direct communication with the sea.—The flower-like distortion of the coronas due to graded cloudy condensation, by C. Barus. —Varying degrees of actinism of the X-rays, by J. O. Heinze, jun. It was found that the rays which are the most active in producing fluorescence are not those which act most vigorously in the photographic plate, and hence that the maximum effect on a platinocyanide screen does not coincide with the greatest photographic effect.

Bulletin of the American Mathematical Society, March. —The application of the fundamental laws of algebra to the multiplication of infinite series, by Prof. F. Cajori. Following up his previous work (see *Transactions* of the Society, vol. ii. pp. 25-36, and *Science*, vol. xiv., September 13, 1901) and also Pringsheim's (also in vol. ii. of the *Transactions*, pp. 404-412), Prof. Cajori here establishes a class of series with real terms which possesses the property of his former paper, but which seems to be distinct from the class given by Pringsheim. He then considers the validity of the fundamental laws in the multiplication of these infinite series, and next he points out another method for obtaining divergent series whose product is absolutely convergent. Lastly he generalises a theorem of Abel on the multiplication of series.—Dr. Fite gives a notelet concerning the class of a group of order p^m that contains an operator of order p^{m-2} or p^{m-3}, p being a prime.—Dr. Epsteen contributes a proof that the group of an irreducible linear differential equation is transitive.—Another short note follows by Dr. Eisenhart, on lines of length zero on surfaces.—Dr. Kasner, writing on some properties of potential surfaces, extends some of the results of a previous paper (*Bulletin*, vol. vii. pp. 392-9) to the surfaces expressed in rectangular coordinates by an equation $\phi(x, y, z)=0$, where ϕ is a rational integral solution of the potential equation $\Delta\phi \equiv \frac{\delta^2\phi}{\delta x^2}+\frac{\delta^2\phi}{\delta y^2}+\frac{\delta^2\phi}{\delta z^2}=0$. The last four notes were read before the Society and have numerous useful references.—Prof. Osgood gives an extended review of Prof. G. A. Gibson's "Elementary Treatise on the Calculus," in which he remarks that though many teachers may not see their way to use it as a text-book during the early part of the course, yet the book can be commended for collateral reading from the very beginning, and that teachers will have to consider whether it may not be taken as the chief text-book in the second course.—Further short notices follow of Cahen's "Éléments de la Théorie des Nombres" and of R. Dedekind's "Essays on the Theory of Numbers" (Beman's translation) by Prof. L. E. Dickson, and of the "Annuaire pour l'An 1902" by Prof. E. W. Brown.

Memoirs of the St. Petersburg Society of Naturalists, Botany, vol. xxx.—On parasite fungi found in the neighbourhoods of St. Petersburg, by K. S. Ivanoff. List of 153 species, with a few remarks.—Critical review of the flora of Moscow, by A. N. Petunnikoff. Second part, continued from *Botanicheskiya Zapiski*, part xiii., 1896; full summary in German.—Botanical researches in the province of Orel, by M. D. Zalessky; summary in German. A portion of this paper is given to a detailed description of a Scotch-fir forest on a Loess soil, which is a rare case in Russia, and which the author explains in accordance with the views of Litwinow (*Bull. Soc. Nat. Moscou*, 1890, No. 3) on the survival of fir forests during the great Pleistocene glaciation.—On dormant buds, by W. Lubimenko, with twenty-nine figures; summary in German.—Exploration of the flora of Pskov in 1899-1900, by N. Puring.—The flora of the Polyesie, by Joseph Paczosski, continued. The Monocotyledones, Nos. 951 to 1291, are now given, and this most valuable work is thus concluded.

Vol. xxxi.—The whole of this volume is given to the first and the second fascicules of "Flora Caucasica Critica," by N. Kuznetsoff, N. Busch and A. Fomin. The intention of the authors is to give, in a series of monographs disposed in the same system as in A. Engler's "Pflanzenfamilien," the necessary materials for an abridged "Flora of the Caucasus." This latter would be for general use, while the present work must be a sort of preparatory work for specialists only. The successful accomplishment of this grand undertaking seems to be guaranteed—the editor, Prof. Kuznetsoff, having reasons to believe that the work will find the support of specialists. We may remark that under the heading of habitus we find for certain species extremely valuable and most interesting descriptions, which will be welcome to both the systematist and the geographer. The present volume includes the Pirolaceæ, Ericaceæ and Primulaceæ, by Kuznetsoff, and the Nymphaceæ, Ceratophyllaceæ and Ranunculaceæ, by Busch.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 28, 1901.—"A Comparative Study of the Spectra, Densities and Melting Points of some Groups of Elements, and of the Relation of Properties to Atomic Mass." By Hugh Ramage, B.A., A.R.C.Sc.I., St. John's College, Cambridge. Communicated by Prof. G. D. Liveing, F.R.S.

The properties of nineteen elements were studied, namely:—(1) Lithium, sodium, potassium, rubidium, cæsium; (2) copper, silver, gold; (3) magnesium, zinc, cadmium, mercury; (4) calcium, strontium, barium; (5) aluminium, gallium, indium and thallium. The flame spectra of the metals are much simpler than the arc or spark spectra; they may be regarded as the fundamental spectra of the metals. They furnish purely experimental data with which to begin an investigation of the laws which govern the distribution of lines in spectra and by which to study the relations of the physical and chemical properties of the metals to their spectra. Diagrams were drawn with the oscillation frequencies of the lines in the fundamental spectra, or the densities, or the melting points, of the metals as abscissæ, and the atomic masses, or a function of these, as ordinates. Two diagrams of spectra are reproduced in the paper. The corresponding lines in homologous spectra were joined by lines some of which are straight, but most are curved. The densities and melting points were connected in a similar way.

The following facts have been observed in the study of the diagrams:—

(1) The metals considered may be classified into groups according to the characters of their spectra. The elements in each group appear to have a similar atomic constitution.

(2) The connecting lines between the members of the chemical groups are not continuous; there are certain breaks in them. These occur between the metals sodium, magnesium and aluminium, and the metals of their respective groups with higher atomic masses. The break between the sharp series in the spectra of the aluminium group is very slight; that between the diffuse series is very marked and corresponds to marked changes in the densities and melting points of these elements.

(3) The cause of the displacement of corresponding lines in some strictly homologous spectra is intimately connected with the atomic masses. The shift of the subordinate series of potassium, rubidium and cæsium is approximately proportional to the atomic mass, whilst the shift of the principal series is very nearly proportional to the square of the atomic mass.

(4) The second diagram, drawn from the spectra and the squares of the atomic masses, shows that the lines which connect the corresponding members of homologous doublets and triplets approach one another as the atomic mass decreases and intersect on the line of zero atomic mass.

The spectra of potassium, rubidium and cæsium change regularly with the atomic mass, and it should be possible to express the series in these spectra by a formula in which the atomic mass is the only variable. There are obvious difficulties in modifying Kayser and Runge's formula in this way, but Rydberg's formula is more general and the constants are more easily calculated. Rydberg's formula and method give better results for the subordinate series than for the principal series; also for the series in the spectra of elements of low atomic mass than for those of high. The best results were obtained for the principal series of the three metals when in Rydberg's general formula

$$n = n_\infty - \frac{N_0}{(m+\mu)^2}$$

we substituted

$$n_\infty = 35349 - aW^2 ; \; N_0 = 109675$$

and

$$\mu = \{1{\cdot}19126 + 0{\cdot}00103W + (0{\cdot}04377 + 13W^2 \times 10^{-7})\,(1 - 3^{1-m})\},$$

where

$$n = 10^8\lambda^{-1} ; \; a = 0{\cdot}2233 ; \; W = \text{atomic mass, and } m = 1, 2, 3 \ldots$$

This formula gives the second principal series of the three metals; the first principal series are obtained by increasing the value of μ by $182W^2 \times 10^{-8}$. The agreement between the observed and calculated numbers is very close. The formula, though empirical, involves only seven adjustable constants, and it represents in the table, given in the paper, thirty-two lines. It thus affords striking evidence for the fundamental identity of type of the spectra of the three metals to which it applies, and indicates that their differences depend on the atomic mass alone. This evidence is further strengthened when it is remembered that, being only an approximation to an unknown formula, it will naturally come nearer it for large values of m than for small ones. Additional evidence supporting these views is given by the above observations upon the subordinate series of these three metals. The fundamental lines in the spectra of calcium, strontium and barium are given by the formula

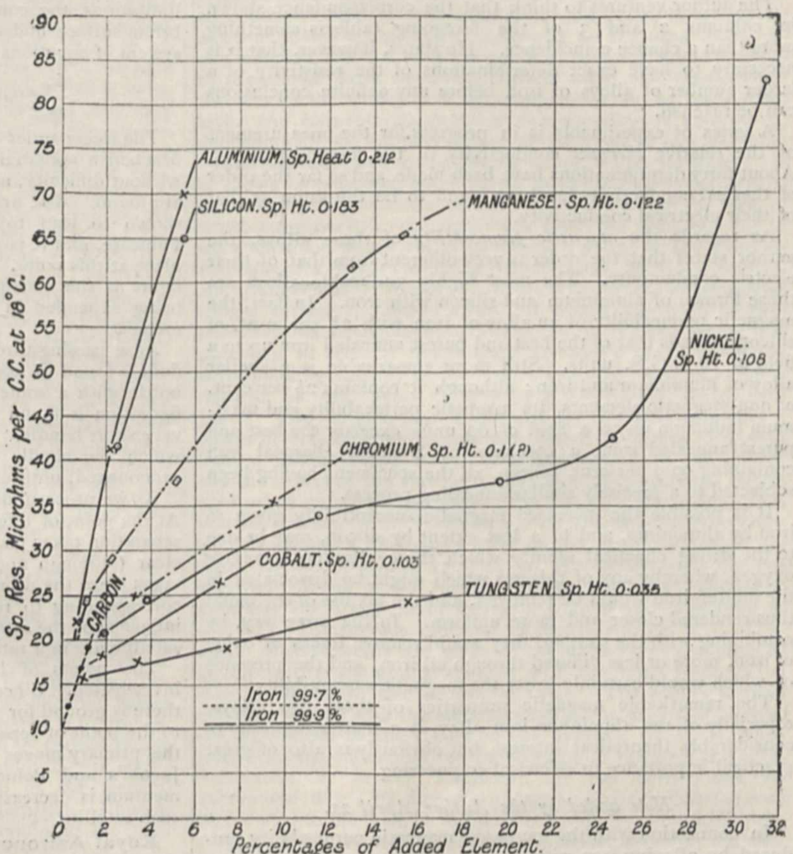
$$n = 24170 - 0{\cdot}3232W^2.$$

Many points of interest are revealed by a study of these diagrams, but perhaps the greatest interest lies in the comprehensive view one gets of the order of change in the properties of the elements. The diagram of densities is easier to understand than that of melting points, and the double connections in it, from sodium to potassium and copper, from magnesium to calcium and zinc and from aluminium to scandium and gallium, are seen to be quite natural. The changes in some of the corresponding lines in the spectra agree with the changes in the densities and melting points of the elements. Other lines in the same spectra change in a manner which is independent of these.

The whole study indicates that the properties of the elements are fundamentally due to the structure of the atoms as revealed by their spectra rather than to the quantity of matter in them. It seems, for instance, inconceivable that the transition from calcium to strontium proceeded through the intermediate elements when we consider that the strontium atoms must have a similar structure to those of calcium, and that this structure is so simple that the fundamental spectrum of each of these elements consists of a single line. The anomaly, according to Mendeléeff's law, in the atomic masses of tellurium and iodine is further evidence of this. The genesis was not in the direction of tellurium to iodine, but from, or perhaps through, oxygen and fluorine respectively.

February 6.—On the increase of electrical resistivity caused by alloying iron with various elements to the specific heat of those elements. By Prof. W. F. Barrett, F.R.S.

In this paper the author draws attention to a connection which appears to exist between the electric conductivity of certain alloys of iron and the specific heats, and hence atomic masses, of the particular elements with which the iron is alloyed. In previous memoirs, the author, in conjunction with Mr. W. Brown, has determined the electric conductivity and magnetic permeability of 110 different alloys of iron prepared with great care by Mr. R. A. Hadfield, of Sheffield.[1] The results of these experiments show (1) that the conductivity of iron is diminished by alloying it with another metal even though that metal be a much better conductor than iron; (2) that this reduction of conductivity is not related to the resistivity of the added metal; on the contrary, an alloy of very high specific resistance can be produced by adding to iron an element of much lower specific resistance than the iron itself, *e.g.* the metal aluminium is upwards of three times better a conductor than iron, yet the addition of 5 per cent. of aluminium to iron makes the conductivity of the alloy five times worse than iron; (3) the greatest reduction in conductivity in a given alloy is produced by the first increments of the added element. This is shown in the accompanying diagram, where the specific resistances of some of the alloys examined (deduced from their conductivities), are plotted against the percentages of the added element: the specific resistance of iron alone being shown by the horizontal dotted lines, the upper containing 0·3 and the lower only 0·1 per cent. of carbon and other foreign bodies. The series of fairly smooth curves thus obtained for each alloy are seen to be steepest near their origin, a curious flexure being



found in the nickel steels; (4) a relationship does appear to exist between the specific heat of the added element and the resistance of the alloy it forms when united with iron. In the diagram the specific heats of the various elements are placed after their names. Thus the specific resistance of an alloy of $5\frac{1}{2}$ per cent. of aluminium with iron is seen to be 70 microhms, the same amount of silicon with iron 65 microhms, of manganese with iron 38 microhms, of nickel 27 microhms, and of tungsten 18 microhms; now the specific heats of these elements are, aluminium 0·212, silicon 0·183, manganese 0·122, nickel 0·109, and tungsten 0·035. Those elements having high specific heats, and therefore small atomic or molecular masses, produce the greatest increase in electric resistivity of the corresponding alloy with iron.

Dividing the *increase* in electric resistivity by the percentage of the added metal, we obtain the increase in the specific resistance of iron produced by 1 per cent. of the added element.

[1] *Scientific Transactions of the Royal Dublin Society*, vols. vii. and viii. "Researches on the Physical Properties of the Alloys of Iron," by W. F. Barrett, W. Brown and R. A. Hadfield.

This is shown for a 2 per cent. alloy (except in the case of carbon) in the second column of the accompanying table, along with the specific heats and atomic weights of the elements named in the first column.

Alloy of iron.	Increase of resistivity for 1 per cent.	Specific heat.	Atomic weight.
Tungsten ...	2·0	0·035	184
Cobalt... ...	3·0	0·107	59
Nickel... ...	3·5	0·109	59
Chromium ...	5·0	0·1 (?)	52
Carbon[1] ...	5·0	0·160[2]	12
Manganese ...	8·0	0·122	55
Silicon... ...	13·0	0·183	28
Aluminium ...	14·0	0·212	27

The author ventures to think that the correspondence shown in columns 2 and 3 of the foregoing table is something more than a chance coincidence. He states, however, that it is necessary to have exact determinations of the resistivity of a larger number of alloys of iron before any definite conclusions can be reached.

A series of experiments is in progress for the measurement of the relative *thermal* conductivity of the foregoing alloys. About forty determinations have been made, and so far the order of thermal conductivity has been found to be the same as that of their electrical conductivity.

As regards the *magnetic permeability* of these alloys, the author states that the order is very different from that of their electric conductivity. The most highly permeable alloys are those formed of aluminium and silicon with iron. In fact, the magnetic permeability of an alloy of iron with $2\frac{1}{2}$ per cent. of silicon exceeds that of the best and purest annealed iron up to a field of 10 C.G.S. units. Still more remarkable is a similar alloy of aluminium and iron; although it contains $2\frac{1}{4}$ per cent. of non-magnetic elements, its magnetic permeability and maximum induction up to a field of 60 units exceeds the best and purest annealed iron, a specimen of Swedish charcoal iron containing 99·9 per cent. of iron, all the specimens having been subjected to a precisely similar annealing process.

It is possible the increased magnetic susceptibility given to iron by aluminium, and to a less extent by silicon, may be due to the strong chemical affinity which these elements have for oxygen, whereby any of this gas which might be dissociated in the molten iron would be removed, and the texture of the metal thus rendered closer and more uniform. In the same way, by combining with the oxygen, they would remove traces of oxide of iron, more or less diffused through all iron, and the presence of which would certainly lower the magnetic susceptibility.

The remarkable magnetic properties of these two alloys, especially of the aluminium-iron alloy, is a matter, not only of considerable theoretical interest, but obviously is also of great practical importance in electrical engineering.

Note added by the Author April 21.

In connection with the increased magnetic permeability produced by alloying iron with a small percentage of aluminium, Principal Hicks draws attention, in the last number of NATURE, to the interesting fact—of which I was unaware, and which I believe has not hitherto been published—that some years ago he noticed this property of aluminium; and he attributes it "to the increased size of the iron crystals" produced by the foreign body. This may be the explanation, but I am disposed to think it is closely allied to the one I have suggested, and with the known metallurgical effect of aluminium on iron, to which Prof. Wilson has drawn attention in his contribution to the discussion at the Institute of Electrical Engineers. W. F. B.

March 20.—"The Equilibrium of Rotating Liquid Cylinders." By J. H. Jeans, B.A., Isaac Newton Student and Fellow of Trinity College, Cambridge. Communicated by Prof. G. H. Darwin, F.R.S.

The most serious obstacle to progress in the problem of determining the equilibrium configurations of a rotating liquid lies in the difficulty of determining the potential of a mass of homogeneous matter of which the boundary is given.

The present paper deals only with two-dimensional problems, and for these a method is developed enabling us to write down the potential by transformation of the equation of the boundary. The method is not of universal applicability, but is adequate to the problem in hand.

As applied to the determination of equilibrium configurations, the method is as follows. Starting from the general equation (in polar coordinates)

$$r^2 = a_0 + 2a_1 r\cos\theta + 2a_2 r^2 \cos 2\theta + \ldots,$$

we transform by the substitution $\xi = re^{i\theta}$, $\eta = re^{-i\theta}$, and attempt to solve the resulting equation explicitly for ξ in the form

$$\xi = b_1 + b_2\eta + b_3\eta^2 + \ldots + \frac{c_1}{\eta} + \frac{c_2}{\eta^2} + \frac{c_3}{\eta^3} + \ldots,$$

this solution being such that the right hand shall give the true value of ξ at every point of the surface. Subject to certain limitations, the condition that the surface shall be an equilibrium surface under a rotation ω is found to be given by the system of equations

$$\frac{b_n}{n} = a_n\left(1 - \frac{\omega^2}{2\pi\rho}\right), \quad (n=1, 2, 3, \ldots).$$

The linear series of circles and ellipses (corresponding to the Maclaurin spheroids and Jacobian ellipsoids) are investigated without difficulty, and the points of bifurcation on these series are found. The first point of bifurcation on the latter series is shown to lead to a pear-shaped curve, similar to that of Poincaré, and it is shown that an exchange of stabilities takes place at this point. The linear series of which this pear-shaped figure is the starting point is now investigated, the equation being expanded in an ascending series of powers of a parameter θ.

After passing through various pear-shaped configurations, the fluid is found to assume a shape similar to that of a soda-water bottle with a somewhat rounded end. Beyond this the configuration is found to be suggestive of a tennis-racquet with a very short handle. A "neck" gradually forms at the point at which the handle joins the racquet, and this becomes more pronounced, until ultimately the curve separates into two parts.

As we proceed along this series the rotation steadily increases. At the point of bifurcation the value of $\omega^2/2\pi\rho$ is 0·375; when separation takes place this value is about 0·43. It is tolerably clear (although not rigorously proved) that when separation takes place the primary may be regarded as the Jacobian ellipse, corresponding to rotation $\omega^2/2\pi\rho = 0·43$, distorted by the tidal influence of the satellite. The linear diameters of primary and satellite are in a ratio of about 4 : 1.

The points of bifurcation on the Poincaré series are not investigated. Since the Jacobian ellipse is known to be stable, there is ground for supposing that the series remains stable up to the point of separation. It therefore appears probable that the primary moves through a cycle of configurations in which Jacobi's and Poincaré's figures alternate. The angular momentum is decreased by about 30 per cent., at the ejection of each satellite.

Royal Astronomical Society, April 11.—Dr. J. W. L. Glaisher, F.R.S., president, in the chair.—Among the presents announced, special attention was called to Circular No. 9 of the Paris Astrographic Conference, by M. Lœwy, dealing with the accuracy of measures of star images on photographs, and with the planet Eros.—In a third paper on stationary meteor radiants, Prof. Turner considered the possible effect of atmospheric retardation of meteors passing near the earth, concluding that such effect would be so small as to be negligible.—Prof. Turner also read a paper on the relative number of star images photographed in different parts of a plate. Counts of star images on plates taken at Oxford, Paris, Algiers, Toulouse and San Fernando showed that the density of star images in different parts of a plate varied by about 50 per cent. The region of greatest density is not in the centre, but a ring of 35′ to 60′ radius, plates taken at different observatories giving different results. On the other hand, the photographic doublet used for the Cape Photographic Durchmusterung gave sensibly uniform density; it was therefore suggested that the doublet may be the best instrument for star charting.—Dr. Rambaut read a paper by Mr. W. H. Robinson on κ Persei and 36 Persei,

[1] For a 1 per cent. alloy. The molecular weight of carbon would appear to be at least four times its atomic weight if this analogy holds true.
[2] As *graphite*; as *diamond* the specific heat of carbon is 0·113, according to H. F. Weber.

which had recently been announced as variable. Examination of the photographs taken at Oxford appeared to show that the variability of these stars had been assumed on insufficient grounds.—Lantern slides of a Leonid meteor, taken by Prof. Rees and Mr. Post, were shown on the screen.—The secretary partly read a paper by Mr. Whitmell, calling attention to the circumstances on July 17, 1902, when there will occur a transit of the earth over the sun, which will be partially visible to an observer on Saturn through the Cassini division of the ring. At the same time a terrestrial observer, suitably placed, will be able to view, through that division, a portion of the planet's disc lit up by sunlight, so that a part of the division will appear bright instead of dark.—The secretary also partly read a paper by Prof. Barnard on the proper motion of stars in the dumb-bell nebula. The author concluded that the supposed proper motion was not real, but due to inaccuracies in earlier measures of position.

Mathematical Society, April 10.—Dr. E. W. Hobson, F.R.S., president, and, temporarily, Dr. J. Larmor, F.R.S., in the chair.—Dr. Hobson communicated a note on divergent series. After explaining the method by which Borel attaches a definite arithmetical meaning to certain classes of divergent series, by the use of related convergent series, he gave an account of an extension to a wider class of series which are such that the radius of convergence of Borel's related series is zero. This extension involves the use of Bessel's functions of imaginary argument in place of Gamma functions.—Prof. Love gave a preliminary account of some researches concerning stress and strain in two-dimensional elastic systems. Solutions of two-dimensional problems, besides being useful for purposes of illustration, often lead to important results in regard to the strength of long prisms or of thin plates. The strain and displacement can be obtained by the superposition of effects due to singularities of functions of a complex variable; and there are relations between problems connected with prisms of different sections, the areas within the two sections being transformed, one into the other, by a conformal representation.—The following papers were communicated from the chair:—Dr. Baker, Further applications of matrix notation to integration problems. The finite equations of the adjoint group of any continuous group, whether the parameters are canonical or not, are expressed in terms of certain matrices, and it is shown that any transformation of the adjoint group can be resolved into a succession of two transformations respectively of the first and second parameter groups. A formula is obtained for the general integral of any set of simultaneous linear differential equations with variable coefficients, in a form valid for the whole of the Mittag-Leffler star region over which the integrals exist. The method of obtaining this formula can be applied to establish the existence of, and to calculate, the integrals of a system of differential equations with real independent variables, the coefficients in the equations being integrable functions, but not necessarily continuous functions.—Dr. L. E. Dickson, The groups defined for an arbitrary field by the multiplication tables of certain finite groups. The object of the paper is to discuss, for all the cases that arise, the groups defined by certain simple types of finite groups. The methods employed are quite elementary and are practically independent of the general theory, as worked out by Frobenius and Burnside. Illustrations are given of a general method of determining the irreducible factors of the group-determinant.—Prof. T. J. I'A. Bromwich, The convergence of series that represent a potential. It is shown that the harmonic series by which the potential of a body at an external point can be represented, in the neighbourhood of the point, converges generally at points within the body. The nature of the domain of convergence is determined, and illustrated by examples.

Royal Meteorological Society, April 16.—Mr. W. H. Dines, president, in the chair.—Captain D. Wilson-Barker delivered a lecture on clouds. After some remarks on the composition and the height of the atmosphere, the lecturer said that until recent years comparatively little scientific attention had been paid to the subject of clouds. This he largely attributed to the lack of a simple practical classification. The French naturalist Lamarck was probably the first to formulate one, but Luke Howard, a London merchant, about 1802 introduced the first practical classification, which is still in use among many observers. Clouds are formed by one of two causes, viz. (1) the mixing of two masses of moist air of unequal temperatures; or (2) through changes occurring in the atmosphere, where expansion and consequent loss of heat take place, causing condensation of moisture. Captain Wilson-Barker said that a simple primary classification is best arrived at by a two-fold division of cloud types, viz. (1) "stratus," or sheet clouds, and (2) "cumulus," or heap clouds. The former may be roughly considered the cloud of a settled and the latter of an unsettled state of the atmosphere. He showed by means of lantern slides a number of cloud pictures illustrating certain varieties of both main types. Under "stratus," or sheet cloud, the lecturer included fog stratus, high stratus, cirro-cumulus, cirrus, nimbus and scud; and under "cumulus," or heap clouds, he included the ordinary cumulus, the shower cumulus, the squall cumulus and roll cumulus.

PARIS.

Academy of Sciences, April 14.—M. Bouquet de la Grye in the chair.—The president announced the death of M. Alfred Cornu, member of the section of physics.—Researches on electromotive forces, by M. Berthelot. A discussion of the relations between the heats of dilution and the electromotive force of concentration cells. From twenty-four to forty-eight concentration cells of sodium chloride were placed in series, the electromotive force of which, measured by the usual open circuit methods, was 5-7 volts; it was not, however, found possible to decompose water by such a battery.—On the fundamental theorem of the theory of Abelian functions, by M. Paul Painlevé. An elementary and direct demonstration is here given, depending on the ordinary theory of functions of one variable.—The resistance due to companion waves, by M. de Bussy. It is shown by reasoning based partly on the author's own experiments and partly on those of Froude, that in a ship the form of which corresponds to the maximum speed the resistance due to the companion waves varies as the sixth power of the speed.—Principle of a new interference refractometer, by M. G. Sagnac. An arrangement of Fresnel's mirrors is described giving circular fringes without the use of a slit. It would appear to be preferable to the arrangement of Michelson in the case where it is necessary to have a temperature rigorously the same in the corresponding regions of the two interfering bundles.—Some remarks on the theory of Duddell's singing arc, by M. Paul Janet. The singing arc discovered by Duddell furnishes a means of obtaining an alternating current by means of a continuous electromotive force. The distribution of the energy and the values of the current in the different parts of the circuit are worked out and a summary of the results given.—Variations in spark spectra, by M. B. Eginitis. On sparking between poles of two metals, a gradual increase in the self-induction of the spark circuit frequently resulted in the elimination of the spectrum of one of the metals. It was not found possible to eliminate the spectrum of mercury, sodium and potassium in this way.—Retrograde diffusion of electrolytes, by M. J. Thovert. Measurements are given of the diffusion of a solution of an electrolyte containing an acid with the same negative ion into a solution of the electrolyte alone. The results were in complete accord with the electrolytic diffusion theory of Nernst.—Contribution to the theory of the dynamo, by M. N. Vasilesco-Karpen.—Remarks on the working of coherers and autodecoherers, by M. O. Rochefort. It has been found by experiment that all coherers with spontaneous decohesion may be reduced to the state of ordinary coherers by diminishing the pressure of the imperfect contacts: sufficient experimental data have not yet been accumulated as regards the reciprocal of this. It has, however, been found that in certain cases with metal-metal or powder contacts the radio-conductor can be brought to the state of auto-decoherers by simple increase of pressure.—Luminous sensation as a function of the time, by MM. André Broca and D. Sulzer.—Values of the electrical resistance, the index of refraction and of the rotatory power of normal blood serums, by MM. Dongier and Lesage. With a view of utilising various physical methods for the study of certain pathological cases, data were accumulated for more than 200 samples of blood serum, care being taken to collect from only healthy subjects.—On the composition of gaseous hydrates, by M. de Forcrand. After remarking on the experimental difficulties in the determination of the exact composition of the hydrates of such a gas as sulphur dioxide, the author develops a new method based on the fixed ratio between the heat of formation of the solid hydrate and the absolute temperature at which this hydrate has a pressure of 760 mm.—The action of hydrogen upon strontium amalgam, by M. Guntz. The dissociation pressures of strontium hydride are measured at various temperatures, and by the application of the formula of Clapeyron to the data thus obtained, the heat of formation of the hydride is calculated, and compared with the value given by direct experiment. From these experiments it was also possible to give the exact conditions necessary to the preparation of metallic strontium from its amalgam.—On the combinations of alumina with chromium sesquioxide, by M. Duboin.—On the composition of the amidotariric acids, by M. Arnaud. The application of Beckmann's reaction to tariric ketoxime gave undecylamine, pimelic acid, lauric acid and amidocaproic acid, from which the formula $CH_3-(CH_2)_{10}-C\equiv C-(CH_2)_4-CO_2H$ is deduced for tariric acid.—On diacetylbenzoylethane and acetylmethylphenylfurfurane, by M. F. March.—On methoethenylbenzene, by M. M. Tiffenau.—On oxyisopropylphosphinic acid, by M. C. Marie.—The action of the organo-magnesium compounds on the β-ketonic esters, by M. V. Grignard. Acetoacetic ethyl ester reacts with magnesium methyl iodide entirely in the enolic form; its mono-alkyl derivatives appear to behave as a mixture of the enolic and ketonic forms; the product of condensation of acetoacetic ester with aldehydes react with the magnesium alkyl compounds in a manner corresponding to the formula of Classen.—On the ichthyological fauna of the basin of the Adour, by M. G. de Saint-Paul.—On the epithelio-glandular origin of the seminal cells, by M. G. Loisel. The conclusion is drawn from the experiments cited that in all vertebrates, including mammals, birds, reptiles and fishes, the seminal cells are derived from a glandular epithelium.—On the generic identity of *Zygodia axillaris* and the *Baissea*, by M. Henri Hua.—The treatment of rickets by cod liver oil containing lecithin, by M. G. Carriere. The cod liver oil used contained 0·41 per cent. of lecithin derived from eggs, and was applied in five cases, with the result that the disease was arrested and cured in from four to six months.—Researches in the variations arising in the toxic power of certain mineral and organic compounds, according to the chemical groups to which they are linked in their soluble compounds, by M. Marc Laffont.

DIARY OF SOCIETIES.

THURSDAY, April 24.

Royal Society, at 4.30.—On Skin-currents. Part III.—The Human Skin: Dr. A. D. Waller, F.R.S.—Antarctic Origin of the Tribe Schœneæ: C. B. Clarke, F.R.S.—A New Interpretation of the Gastric Organs of *Spirula Nautilus* and the Gastropods: J. E. S. Moore and W. B. Randles.—Absolute Magnetic Observations at the Valencia Observatory (Cahirciveen, Co. Kerry), 1899, 1900 and 1901: J. E. Cullum.

Royal Institution, at 3.—The Oxygen Group of Elements: Prof. J. Dewar, F.R.S.

Institution of Electrical Engineers, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper. (Adjourned discussion).—Form of Model General Conditions, for use in connection with Contracts for Plant, Mains, and Apparatus for Electricity Works. As drafted by a Committee.

FRIDAY, April 25.

Royal Institution, at 9.—X-Rays and Localisation: Dr. J. Mackenzie Davidson.

Physical Society, at 5.—An Exhibition of a Mechanical Break for Induction-coils: Dr. Dawson Turner.—A Temperature Indicator for use with Platinum-thermometers, in which Readings are Automatically Reduced to the Gas Scale: R. S. Whipple.—Note on the Compound Pendulum: S. A. F. White.

Institution of Civil Engineers, at 4.—Sir W. C. Roberts-Austen, K.C.B., F.R.S., will repeat the "James Forrest" Lecture on Metallurgy in Relation to Engineering.

MONDAY, April 28.

Society of Arts, at 8.—Glass for Optical Instruments: Dr. R. T. Glazebrook, F.R.S.

Royal Geographical Society, at 8.30.—Trade Routes in Eastern Persia: The Earl of Ronaldshay and Edward Penton.

Institute of Actuaries, at 5.30.—Vaccination and the Act of 1898: A. F. Burridge.

TUESDAY, April 29.

Anthropological Institute, at 8.30.—Stone Axes and other objects from Queensland: R. D. Darbishire.—Notes on the "Goura," the Musical Instrument of the Bushmen and Hottentots: H. Balfour.

Institution of Civil Engineers, at 8.—Annual General Meeting.

WEDNESDAY, April 30.

Society of Arts, at 8.—The Timber Resources of the Australian Commonwealth: E. T. Scammell.

Chemical Society, at 5.30.—(1) On the Preparation of Absolute Alcohol from Strong Spirit; (2) On the Vapour Pressures and Boiling-point of Mixed Liquids; (3) The Correction of the Boiling-points of Liquid from Observed to Normal Pressure: S. Young.—(1) On the Properties of Mixtures of the Lower Alcohols; (2) On the Properties of Mixtures of the Lower Alcohols with Benzene, and with Benzene and Water; (3) Fractional Distillation as a Method of Quantitative Analysis; (4) Vapour Pressures and Specific Volumes of Isopropyl Isobutyrate: S. Young and E. C. Fortey.—Nitrogen Bromides containing the Propionyl Group: F. D. Chattaway.

Geological Society, at 8.—The Origin and Associations of the Jaspers of South-eastern Anglesey: E. Greenly.—The Mineralogical Constitution of the Finer Material of the Bunter Pebble-Bed in the West of England: H. H. Thomas.—Revision of the Phyllocarida from the Chemung and Waverly Groups of Pennsylvania: Prof. C. E. Beecher.

THURSDAY, May 1.

Royal Society, at 4.30.—*Probable Papers*:—Coefficients of the Cubical Expansion of Ice, Hydrated Salts, Solid Carbonic Acid, and other Substances at Low Temperatures: Prof. J. Dewar, F.R.S.—The Conditions determinative of Chemical Change and of Electrical Conduction in Gases, and of the Phenomena of Luminosity: Prof. H. E. Armstrong, F.R.S.—On the Insulation Resistance of the Capillary Electrometer, and the Minimum Quantity of Electricity required to produce a Visible Excursion: G. J. Burch, F.R.S.

Royal Institution, at 3.—Recent Geological Discoveries: Dr. A. Smith Woodward, F.R.S.

Linnean Society, at 8.—(1) On the Mammalian Cerebellum, with special reference to the Lemurs; (2) On the Brain of the Elephant Shrew, *Macroscelides proboscideus*: Dr. Elliot Smith.—On the Early Condition of the Shoulder-Girdle in the Polyprotodont Marsupials, Dasyurus and Perameles: Dr. R. Brown.

Institution of Electrical Engineers, at 8.—Automatic Relay Translation for Long Submarine Cables: S. G. Brown.

Röntgen Society, at 8.30.—The Relation between X-Rays and allied Phenomena in Light and Electricity: Ernest Payne. (*Discussion.*)

FRIDAY, May 2.

Royal Institution, at 9.—Experimental Researches on the Constitution of Crystals: A. E. Tutton, F.R.S.

CONTENTS.

3810

SUPPLEMENT TO "NATURE."

FIRST FRUITS OF THE CAMBRIDGE ANTHROPOLOGICAL EXPEDITION TO TORRES STRAITS.

Head-Hunters, Black, White and Brown. By Alfred C. Haddon, Sc.D., F.R.S. Pp. xxiv + 426. (London: Methuen and Co., 1901.) Price 15*s*.

UNDER this sporting title, Dr. Haddon has published a preliminary and popular account of the Cambridge Anthropological Expedition to Torres Straits and its unofficial extension to Sarawak. Expeditions for various scientific purposes have long been familiar. Expeditions for specifically anthropological purposes have been frequently organised in the United States and in Germany; but in this country such an expedition is a "new departure." Contributions to the cost of the Torres Straits Expedition came from more than one source; the chief part of the funds, however, was supplied by the University of Cambridge—hence the name. The expedition was led by Dr. Haddon, whose interest in the natives had been excited ten years before, when he visited the islands of Torres Straits on a scientific mission of a different character. He secured as colleagues Dr. W. H. R. Rivers, Dr. C. S. Myers, Mr. W. McDougall, Mr. Sidney H. Ray, Mr. C. G. Seligmann and the late Mr. Anthony Wilkin—the majority of them Cambridge men. They left London on March 10, 1898, and the last of them returned on May 31 in the following year. Nearly seven months were spent by most of them in Torres Straits, on the islands and on the mainland of New Guinea, with a short visit to the contiguous part of Australia. Upwards of four months were spent by the leader of the expedition, Mr. Ray and Mr. Seligmann at Sarawak, whither Dr. Myers and Mr. McDougall had preceded them.

The object of the expedition was not merely to investigate the physical and mental development of the islanders of Torres Straits, but to determine, if possible, their ethnological position, situated as they are geographically between the Papuans and Melanesians of New Guinea and the islands further to the eastward, on the one hand, and the Australian race on the other. The result has been to trace the population wholly to the north and east, without any recognisable admixture of the Australian element, although many of the islands, and those the largest, are within a few miles of Cape York. The amount of work done in the way of physical observations, mental tests and investigations into the civilisation of the natives will only be rendered appreciable when the official reports are complete. A very slight examination, however, of the part (by Dr. Rivers) which has already been issued will suffice to convince everyone of the extreme care with which the inquiries were conducted, and of the value of the information obtained as data for induction and as a guide for future researches.

The fact that the islanders have been under continuous European influence for a quarter of a century rendered them more docile and capable of assisting the investigations into their physical and mental qualities. But it had the inevitable disadvantage that their customs were undergoing rapid change; many interesting ceremonies and institutions had been abandoned; the old lore and many of the old superstitions were beginning to be forgotten; the shrines of the ancient worship were neglected or desecrated; and European clothing and mission churches were outward and visible signs of the new order. It is true this change was not without its compensations. Communication was made easier by the fact that nearly all the natives knew some pidgin English, as well as by their comparative familiarity with the ways of white men. But again and again things of importance that had been recoverable even ten years previously had vanished. Old men, the depositories of tradition, had died. Ceremonies which the travellers witnessed were often only make-shift and imperfect representations performed for their special behoof, and had to be supplemented by explanations, too often, doubtless, as imperfect as the representations. "It was very saddening," says Dr. Haddon, "to be continually pulled up in our researches by the oft-repeated cry of '*Too late!*'" In spite of all this, however, much survived. Amusing instances are given, showing how the old superstitions lingered in the minds of those who had renounced them and who were doing their best to lead Christian lives according to the standard of their missionary instructors.

Dr. Haddon's narrative of the expedition contains some very entertaining chapters, and some excellent stories of the natives and of the stratagems resorted to by the travellers to obtain the information they were seeking. One of the quaintest things is the account of a missionary meeting on the island of Mabuiag, which Dr. Haddon was suddenly called on to address. After the meeting was over, a war-dance was performed by some of the natives for the delectation of the scientific visitors. It was called Kwoiam's dance, after the mythical hero of the island. Men who had been singing hymns, and evincing their genuine interest in the mission by giving what were really substantial sums of money for the evangelisation of New Guinea, painted themselves with red and black and yellow ochre, adorned themselves with cocoa-nut leaves, and carried bows and arrows and (to represent decapitated human heads, such as they once had borne in grim earnest) cocoa-nuts and pawpaws. So vivid was the representation that in the course of the dance "some old women, excited by the memory of former days, could not refrain from joining also." "Imagine," exclaims the author, "a 'May meeting' in Exeter Hall closing with a war-dance!"

The narrative also contains incidentally pregnant hints for future anthropological explorers. But, on the whole, its interest is secondary to that of the ethnographical information interspersed or set forth in special chapters. Some of this is of high value, though probably not expanded as fully as it will be in the official report. The subject of totemism has during recent years occupied a large space in the discussions concerning the evolution of religion and of social institutions. Until we see the details of Dr. Haddon's discoveries it is, perhaps, premature to say that they will settle any of the questions to which it has given rise. But enough appears in the volume before us to satisfy us of the importance of these discoveries. They point to the economic value of totemism, in which Dr Frazer has suggested its origin is to be found. The dugong-clan on Mabuiag seem to have performed rites to secure plenty of dugongs, the turtle-men to secure plenty of turtles. The office of rain-maker is said to be hereditary in a certain family, though to what clan it belonged and what position it occupied in the clan we are not yet told. The localisation of the totemic ceremonies, the use of the same word (*augŭd*) to mean the totem itself, the sacred objects used in the ceremonies, and a human ancestral (though probably mythical) hero suggest that totemism was passing into the worship of ancestors, or at least into hero-worship, "and a hero-worship that is suspiciously like the origin of a god." Not less important than the meaning and development of totemism is the delimitation of its area. Here, too, good work has been done. Although totemism was flourishing in the western islands of the Straits and bore evidence that it had been brought with the immigration from New Guinea, the travellers failed to trace it in some of the powerful stocks of British New Guinea; they ascertained that there was no true totemism in the eastern islands, and their researches in Borneo seem definitely to negative any connection between the animal-cult of the tribes in Sarawak and totemism.

Where the totem-clan does not exist, a point of great interest is the organisation of society and the conception of relationships. On this we are told nothing directly. We learn, however, that Dr. Rivers made minute inquiries into the genealogy of the Murray Islanders and some other peoples. It is to be hoped that when these are published we shall have some data for inferences, not merely as to hereditary qualities, but also as to social relations.

Interesting as the chapters relating to Torres Straits and New Guinea are, those which narrate the author's experiences in Borneo and discuss some of the superstitions practised there are in no way inferior. Balan's love-story is delightful, and the chapter on the peace-making at Baram forms an artistic conclusion to the mission. On the omen-animals Dr. Haddon is able to contribute some additional facts to our knowledge, as well as to describe the ceremonies he witnessed. The chapter on the cult of skulls, and the scenes in which he was an actor as the purchaser of skulls, are perhaps even more suggestive. We learn that the practice of taking skulls is not an ancient one among the Kayans and Kenyahs, two of the larger and more influential tribes. We are told that "some tribes believe that the persons whose heads they take will become their slaves in the next world," and that the vendetta is a common reason for the hunt of heads. But Dr. Haddon expresses no opinion on the origin and real meaning of the custom. Mr. Kruyt, a Dutch *savant*, has recently published an account of it as practised by the Toradja of Central Celebes. In that neighbouring island it would seem that the tribe referred to recognise a three-fold soul in every living being. There is, first, the breath; secondly, the personal soul; and lastly, a part of the universal soul or vital ether. It is the last which is attached to the skull and the scalp of man and other animals. To procure the skull, therefore, is to render oneself the possessor of the victim's share of the vital ether. By depositing it in the shrine of the ancestral gods, this share is offered to them. As the gods appear to be the manes of ancestors, the possession of this share of the vital ether fortifies the vital ether of the family or the clan; in other words, their portion of the universal soul is augmented. Mr. Kruyt, after examining the beliefs and customs of the Dayaks and Battaks, comes to the conclusion that their head-hunting is based upon substantially the same belief. We shall be glad to know whether Dr. Haddon has observed any facts which corroborate this theory.

The volume is adorned with numerous reproductions of photographs by the author and his colleagues, as well as by many sketches. The photographs are for the most part good, some excellent. In many cases, however, the reproduction is on too small a scale for proper exhibition of the details.

Full of interest for the general public, the volume is admirably calculated to awaken scientific curiosity and bespeak attention for the detailed results of the expedition, now in course of publication by the University Press.

E. SIDNEY HARTLAND.

THE SEA-COAST OF ENGLAND.

The Sea-coast: (1) *Destruction*, (2) *Littoral Drift*, (3) *Protection*. By W. H. Wheeler, M.Inst.C.E. Pp. xii + 361. (London: Longmans, Green and Co., 1902.) Price 10*s*. 6*d*. net.

THE sea-coast is always a fascinating object to the hydraulic engineer, for besides the varieties of its conditions, it is the place where the most vehement attacks of the orces of nature have to be encountered and provided against. The sea is an ever-present foe, the power of which when lashed into waves by gales is almost incalculable, always quick to pierce any weak point in the defences and to push forward its advantage by enlarging the breach, and sometimes producing wide-spread ruin before the initial damage can be repaired. Moreover, in some cases, the protection of one part of the coast leads to the weakening of an adjacent portion, and the sea, foiled in a direct attack, overcomes opposition by a sort of flank movement on an unprotected place. On some coasts the gradual advance of the sea can only be checked for a time; and the erosion of the cliffs during storms is promoted by the disintegrating action of rain and frost, the débris being scattered over the beach and eventually carried away by littoral drift. The rate of encroachment of the sea depends mainly on the exposure of the coast, the slope of the beach and foreshore, and the nature of the cliffs or shore; for on a very open sea-coast exposed to strong winds, with deep water near the shore, the erosive action of the large waves rolling in is very great, especially when breaking against cliffs composed of clay or other readily disintegrated materials. Irresistible secular changes appear to be taking place along some coasts, for a slow but steady advance of the sea may be noted in some places, and a distinct retrogression observed in other parts. The protection of land against the ravages of the sea must depend upon the value of the land and its position. Where villages and towns have been built alongside the sea-coast, large sums may be advantageously expended in securing such valuable sites from injury, and in forming and preserving promenades in front of them; and where low-lying or reclaimed lands, extending a considerable distance inland, are protected by sea banks, it is very important that these barriers against extensive inundations should be efficiently maintained. In places, however, where long stretches of agricultural land, well above sea-level, bordering the sea-coast are subject to gradual erosion, the cost of adequately protective works would amount to more than the value of the land lost.

The author has for many years taken an interest in the changes taking place along the coasts of England, and the results of the various means adopted at different places for their protection; and his researches into records and observations of littoral drift, the action of waves and tides, sea-coast protection, and shingle-banks and sand beaches have formed the subjects of papers read at the Institution of Civil Engineers and meetings of the British Association, and articles contributed to *The Engineer* and this Journal, which have been collected together to form the present book. The subjects are dealt with under three general heads, namely, (1) "Destruction," (2) "Littoral Drift," and (3) "Protection." After a short introductory chapter, the first head is considered in a single chapter on "The Action of Shore Waves"; the second head forms the title and the subject of the following chapter; whilst the protection of the sea-coast is dealt with in three chapters, two relating to sea-walls and the third to groynes. These matters, however, occupy barely more than one-third of the book, and the remainder of the volume is taken up with an inordinately long chapter of above two hundred pages, giving details of the south, east, and west coasts of England, and a comparatively short chapter on the coasts of northern France, Belgium and Holland. These two last chapters constitute an elaborate compilation of facts concerning the sea-coasts referred to, collected from various publications, including naturally the reports and numerous data obtained by the Coast Erosion Committee of the British Association, and also the author's own observations, which should prove useful for reference; but the main interest is comprised in the earlier portion of the book, which embraces the chief object of its publication.

In the chapter on the action of shore waves, the author propounds his theory that the main agent of the littoral drift observed along our coasts is tidal action, and that storm waves are only auxiliary agents of quite minor importance; and he restates this view with greater emphasis, as an established fact, towards the close of the following chapter, on littoral drift, in these words (p. 75):—

"As already mentioned, the agent which is instrumental in building up shingle into banks and transporting it along the coast is the tide, which accomplishes this by means of the waves which are for ever breaking on the beach as the tide rises and falls. The formation and action of tidal shore wavelets has been already described in the chapter on wave-action. These wavelets, aided by the flood current, lift up and carry forward any coarse sand, loose stones, or other material with which they come in contact, and leave some portion of them stranded at the highest point on the beach to which the tide of the day reaches."

In a paper on "Littoral Drift," read at the Institution of Civil Engineers in 1896, Mr. Wheeler enunciated this theory, and in the discussion which followed, remarkable unanimity was manifested by the speakers in dissenting wholly from this view; and it may reasonably be surmised that the author hopes that acceptance of his theory, which was on that occasion denied him by the persons most conversant with the subject, may, when brought forward in the sort of authoritative form of a book, be granted him by the general public. His notion of the power of tidal action is evidently in some measure due to his assumption that the tidal wave is a wave of translation, with the entire body of water composing it in motion throughout its whole depth; and he does not realise that this would involve a continuous movement of the sea in one direction, at the rate of progression of the tidal wave, which in the Pacific Ocean, the cradle of the tides, amounts to about 1000 miles an hour, and even in the English Channel reaches about 55 miles an hour; whilst the clashing together, off the mouth of the Thames, of two of these waves of translation coming from opposite directions would be a remarkable sight. The author, moreover, in attributing littoral drift to the action of the wavelets of the flood tide along the shore, appears to ignore the reverse action of the ebb; though in referring to the effect of tidal currents on submerged sand-beds in channels, he points out that their "movement is one of oscillation and not transportation." A great number of instances might be cited of littoral currents and littoral drift which, in the absence of a tide, could not possibly be attributed to tidal action, as, for example, the littoral movement across the face of the delta of the Mississippi in the almost tideless Gulf of Mexico, the drift which occurs in various places along the shores of the Mediterranean, and the littoral current which diverts towards the south the alluvium issuing from the mouths of the Danube in the Black Sea. The author tries to strengthen his contention as to the paramount effect of the flood tide by ascribing wind waves, the power and influence of which are extended landwards by the increased depth at high water, to tidal action. Thus under the heading of "Tidal Waves" he says:—

"In the great majority of cases the waves which affect beaches, cliffs, and sea-walls are those which occur when the rise of the tide affords the necessary depth of water for their formation. . . . The maximum effect due to the tidal wave is felt at the time of high spring tides, when accompanied by heavy on-shore gales."

Further on also the following passage occurs:—

"Even when the depth of water in front of a sea-wall or cliff is only that due to the rise of tide, water from waves that break is thrown to very great heights. Thus at Hastings, where the beach at the foot of the sea-wall is dry at low water, and the depth of the water is only that due to a rise of 15 feet at high water, during a heavy gale in the winter of 1898 the broken water was thrown as high as the top of a large hotel, as shown in the frontispiece, and shingle was lifted off the beach and carried across the promenade into the bedrooms of the houses fronting the sea. At Peterhead, as already mentioned, the water due to a rise of tide on the foreshore of only 7 or 8 feet has been known to strike the wall with such force as to be thrown upwards 100 feet."

It is certain that the inhabitants of Hastings will have attributed the striking phenomenon illustrated in the book to its true cause, the gale, aided undoubtedly by the raised water-level, due partly to the tide, and also partly to the heaping up of the sea against a lee shore by an on-shore gale; whilst the wave-stroke at Peterhead was not due, as implied above, to a tidal rise of 8 feet, but, as mentioned a few pages earlier, to the depth into which the breakwater has been carried, the great exposure of the site, and the large waves, attaining 30 feet in height and 600 feet in length during storms, which, consequently, come against the structure.

Numerous instances have been frankly quoted in the two chapters on wave action and littoral drift of the effect of waves in storms in transporting material along the coast, reference to two of which must suffice:—

> "In the Solent, near Hurst Castle, a shingle bank, 2 miles long and 12 feet high, consisting principally of flints resting on a clay base, was moved forward in a north-easterly direction forty yards during a storm in 1824. . . . During a heavy gale stones weighing from 2 to 3 cwt., with large masses of seaweed growing on them, were loosened from their bed at a depth of fifteen fathoms, and thrown on to the beach."

Compared with the forces displayed by these effects, and the others given in the book produced by waves in storms, the wavelets of the flood tide sink into insignificance; and, thanks to the fairness with which these examples have been given, it may be anticipated that an unbiassed, intelligent perusal of these two chapters will lead to conclusions at variance with those of the author, and that it will be realised that waves in storms are the chief forces producing changes in coasts and littoral drift, exercising their maximum effect during high water of spring tides, and when acting in unison with the tidal currents.

From an engineering point of view, the most interesting part of the book is comprised in the three chapters on coast protection by sea-walls and groynes. Sea-walls formed of embankments with pitched slopes, or more or less upright masonry or concrete walls, serve for directly warding off the attacks of the waves in storms from the shore, cliffs, or sea-drives and promenades; whilst groynes of timber, fascines, or concrete are projected at intervals down the beach to arrest the littoral drift, and by thus gradually raising the strand prevent the sea from eroding the shore. Unfortunately groynes, by collecting the drift along one part of the beach, deprive the unprotected portion further leeward of the supply by which its losses by erosion would be naturally replenished; and, consequently, the advance of a length of foreshore produced by groynes is accompanied by a retrogression of the adjacent portion from the cutting off of the drift. A pitched slope is adopted where the shore to be protected is low and sandy, and where materials for a wall are deficient, as along the coasts of Holland and Belgium; and a wall is resorted to where cliffs line the coast, or a sea-drive is constructed considerably above the beach; and this variety in construction is due to differences in, the conditions rather than, as suggested by the author to differences of opinion amongst engineers. A simple upright wall has advantages for breakwaters over other forms where the bottom is rocky and the depth moderate; but in contrasting Dover pier, which has not been free from injury, with the breakwaters at Cherbourg, Plymouth, and Alderney, the author has fallen into a very common error of overlooking the differences of exposure and depth of water at these sites; for Dover is situated in one of the most sheltered places of the English Channel, whereas Cherbourg is much more exposed, and the breakwaters of Plymouth and Alderney are open to the Atlantic, and the latter extends into a depth of 130 feet at low water. Sea-walls, however, differ very materially from breakwaters in being built near high-water mark, and therefore upright sea-walls are subject to considerable erosion at their toe, from the recoil of the waves dashing against them, which affects even chalk and shale, so that unless the foreshore consists of firm rock, the sea-wall, which is usually curved or battered on the face, has to be founded below the limit of erosion, or more commonly is provided with an apron to protect the portion of the beach near the sea-wall from the breaking and recoiling waves. A stepped face is sometimes given to sea-walls, so as to impede the upward run of the waves and break up the recoil; but the work must be solidly built, and only a moderate width given to the steps, otherwise the reduction of the weight on the face blocks due to their projection might lead to their dislocation under the impact of the waves. The author regards a sea-wall curving on its face from the apron laid at the slope of the beach, to the vertical at the top, as the best form, and no doubt such a form leads the waves from a horizontal to a vertical course with the least practicable opposition; but at the same time, by minimising the impediments, it causes the waves to rise higher above the wall, and the upper portion of the water is driven over the promenade by the gale. In the chapter on "Examples of Sea-walls," several sections of sea-walls are given; and both this and the succeeding chapter on "Groynes" contain many interesting details of these works; and the book as a whole furnishes a considerable amount of information about the coasts of England, which must have involved much time and trouble to collect.

EVOLUTION AND ANTI-MATERIALISM.

Principles of Western Civilisation. By Benjamin Kidd. Pp. vi+518. (London: Macmillan and Co., Ltd., 1902.) Price 15*s.* net.

TO those who, some years back, read Mr. Benjamin Kidd's "Social Evolution" with great interest and learnt much from it, his new book will be a profound disappointment. Undertaking to settle all the great questions with which our civilisation is confronted, it leaves many important facts out of sight and fails to find a remedy for the main evils. The style is ponderous and difficult. In some parts very careful reading is required if the exact meaning is to be made out.

The line of argument followed is this. Evolution has upset all our old philosophies and obliged us to remodel our way of thinking. Since Darwin's time, evolution has undergone a great development in the hands of Weismann. We now see that the future is predominant over the present. The overwhelming proportion of individuals interested in the struggle for existence are yet unborn. The contending races are struggling for "an advantage, probably always far in the future, to which the individual and the present are alike subordinated." In the struggle, "efficiency in the future" (described as "projected efficiency") "is the determining quality," and so the future controls the present.

There are two epochs of social development. In the former of the two, the existing social organisation counted for everything. In the second, "society, with all its interests in the present, is subordinated to its own future." "Projected efficiency" is the secret of success and of progress. The want of it causes stagnation. In the city States of ancient Greece and in ancient Rome, the present was omnipotent. Marcus Aurelius, noble character as he was, represented a decaying system, bounded by the present. With the spread of Christianity, the horizon enlarges and the future becomes predominant. "The visions of Christianity can never be closed within any limitations of the State or of political consciousness." Turning to politics, we find in England at the time of the Revolution a looking beyond the present to the future. But during a later period our philosophers professed creeds that left out of consideration everything that lay beyond the horizon of the present. Bentham, Ricardo, Mill, Herbert Spencer are interested only in living individuals and their relation to the State. On the other hand, Burke says that society is a partnership "between those who are living and those who are dead and those who are to be born." In Germany, progress is hampered by a frankly materialistic philosophy, the philosophy of Marx, which takes no thought of generations yet to come. Among English-speaking peoples there is a conviction that "the principles of the Democracy which our civilisation is destined to realise are incompatible with a materialistic interpretation of history." We look to the future and not to the present. Hence the marvellous progress of our race, in spite of the fact that the average Englishman is averse to liberal ideas. An age of the free-est competition is beginning, from which immeasurable results may be expected. The present astounding expansion of the English-speaking race is as nothing compared with what is to be. And this magnificent future will be due to free competition, which will not be disgraced by the oppression of the workman by the capitalist, or by the barbarism of our present commercial methods. The predominance of the future will make all this possible. The evolutionary process will be projected altogether beyond the present.

All these theories seem to have their origin in Mr. Kidd's strong anti-materialistic convictions. His formula of the future (to propose a brief name for it), which forms the central doctrine of his creed, serves to unite his anti-materialism with the theory of evolution, which, as he maintains, must now be the foundation of all philosophy. A formula that embraces evolution and transcendental anti-materialism must, of necessity, be very vague. The predominance of the future is, therefore, stated in very indefinite terms, so that it may include things which are essentially different. Thus, evolution regards the future of the race—unborn generations—as of the utmost importance. Christianity puts the future life of the individual above his present life. These two views in a mist of grand phrases are put down as the same, or at least as different aspects of the same, truth. The treatment of philosophical systems seems to involve the same confusion of thought. For evolution, Mr. Kidd says, the unborn generations are everything. Evolution, as we all know, is, largely, independent and will go on whatever our philosophy may be; and yet the views of this or that philosopher are treated as of supreme importance, as if the fate of the nation to which he belonged were involved in them.

When we come to the most interesting and best-written chapters, those in which modern trade and its methods are described, there is again much confusion in the theories which are built upon the facts. Competition, especially in America, is more free than it has ever been before. In the future, we are told, there will be still greater freedom. Yet the fierceness of competition is to be held in check by humane laws which will protect the workman from oppression. Capital, too, will not be allowed to exploit the nation for its own advantage. This is an admirable ideal. But how is it to be combined with a freedom of competition such as has never been known before? Mr. Kidd does not help us here. We are only told that to the English-speaking peoples, free as they are from materialism, everything will be possible. Here we may ask a question:—If anti-materialism is the one secret of progress, how is it that in the East, the birthplace of all the great religions, stagnation is the rule?

We feel much the want of some sound biology. Mr. Kidd adopts some of Weismann's most disputed theories, such as that of the immortality of the unicellular organisms. But other views of Weismann's which conflict with his own theories he says nothing about. Weismann holds, for instance, that as soon as the stress of natural selection is relaxed, a species begins to lose the powers that it has gained. It degenerates. Now, this era of free competition, seen at its best in the United States, is really a time of slackening natural selection. Children are cared for better than ever before, so that many of the weakly survive. The deaf are so well taught that they can make a living and marry, and so leave deaf descendants. The competition, in fact, whether between peoples or individuals, does not lead to elimination. The conditions of life have grown softer, and under such conditions there must be, if there is truth in Weismann's contention, physical degeneration, though it may be screened by the constant influx of numbers of the more vigorous members of the European peoples into the New World. On this subject Mr. Kidd does not touch. Yet the tendency to physical degeneration, more than any other phenomenon of our time, causes anxiety to those who watch the drift of our modern civilisation.

Again, as to the main idea of the book, how is it possible that efficiency in the future, "projected efficiency," can decide a struggle that has to be fought out in the present? It is true that some classes of animals, having succeeded in one period in virtue of their specialisation, have, probably because they were so highly specialised, been unable to take a new line and meet new demands made upon them in the succeeding period. But, apparently, this is not what Mr. Kidd means. His formula is made to refer to evolution as it refers to systems of philosophy or to creeds in which the supremely important future controls the present. He owns that the contending races must fight their battles in the present, and yet in some unexplained way "projected efficiency" decides the issue. When we look facts in the face we find that our anti-materialistic philosophy is not saving us from entering upon the same ruinous course on which the French nation has already proceeded far. Our diminishing birthrate shows that there has already begun among our people that artificial limitation of fertility which must, if it continues, bring national decline with it.

We all wish that these evils should come to an end and that the English-speaking peoples should have a magnificent future before them. Towards this, no doubt, an anti-materialistic philosophy is a help. Materialism is incompatible with real greatness in an individual or a nation. So far we may go with Mr. Kidd. But we cannot allow that he has found a formula in which all our great problems—the problems of evolution, civilisation, religion—find their solution. The problems remain as they were. F. W. H.

GALLS.

British Vegetable Galls, an Introduction to their Study. By E. T. Connold. Pp. xi + 312. (London: Hutchinson and Co., 1901.) Price 10*s*. 6*d*. net.

THIS beautiful book is a great disappointment. The title, the nice paper, with its broad margin and excellent print, and, above all, the majority of the one hundred and thirty full-page plates paraded, and by no means unjustly so, on the title-page, all promise so much, and yet—on looking beneath the surface we find no depth. Typical examples of the disappointments in store for the reader are furnished by Plates 14 and 15; it would be difficult to over-praise the beauty of the process-work of the former plate, and yet practically all the information the author gives is confined to a few meagre lines on pp. 58 and 60, chiefly concerned with a note as to where the specimen was found. True, more careful search shows that Plate 47 is concerned with the same subject, and somewhat more scientific hints are appended to this on p. 126; but why, in the name of all knowledge, are we not told something of the structure and development of these galls and their contents? Unless we are mistaken, or misled by synonymy, the very example here referred to is a classical one. Did not Dujardin describe the mite in the hazel-buds in 1851? and did not Miss Ormerod and Schlechtendal show that witches' brooms on the alder arise from the irritation set up by similar species? In this connection, also, excellent illustrations of the witches' brooms themselves are given on Plates 1, 16, 17 and 18, with such irritating gossip as "this very interesting tree stands just within the confines of the Park"—"Park," with a capital P!

Now, if we may be permitted to direct the attention of the author (who is the honorary general secretary to the Hastings and St. Leonard's Natural History Society) to the grand opportunity he has missed, pointing out at the same time that scientific experts rarely obtain the chance of putting forth their text illustrated in the superb style of this book, some service may be done in advocation of the cause of that most useful branch of biology—good descriptive field-work in the domain of the borderland between zoology and botany.

It is scarcely too much to say of the present book that if the text to these excellent plates had been nothing more than even a fair account of the insect and its gall, such as is given in a handbook like that of Frank, it would have been one of the most worthy and useful books on the subject—how much more so had the text risen to the level of Adler's admirable study of oak-galls! If local natural history societies would only resist the temptation to be popular, in the sense which implies being merely attractive to superficial and "smart" people, what an immense amount of valuable work might be done along the lines suggested by the present volume, which, disappointing though it is, is sufficiently good to show that the author must be capable of far better work.

We sincerely hope that in a second edition the author will give such notes concerning the structure and development of the galls, the habits of the insects producing them, and their effects on the plants infested by them, as could be obtained from such authors as we have quoted, and from the works of, for instance, Küster, Molliard and other modern investigators; such an account, added to the more extensive notes on field-work which Mr. Connold could evidently bring together—as may be judged from the present samples—should be worthy of the subject, and would be far more welcome to his fellow-lovers of nature than these pages of desert margin with their oases of meagre information, however excellent the latter may here and there be in itself. We are the more constrained to urge this because we understand that the author contemplates a separate book on oak-galls. If the illustrations are as good as these, and the text far better, we shall anxiously look for that book.

THE EVOLUTION OF LIFE.

L'Évolution de la Vie. Par le Dr. Laloy, Sous-Bibliothécaire de la Faculté de Médecine de Bordeaux. Pp. xii + 240. (Paris: Libraire C. Reinwald; Schleicher Frères, 1902.) Price fr. 2·50.

THIS volume is the third of a series being issued in France under the designation of the "Petite Encyclopédie du XX^e^ Siècle." The object of the work, as set forth in the preface, is the very praiseworthy one of spreading a sound knowledge of the achievements of modern science among the intelligent public in a popular way. As the author points out, the mental equipment of the man of culture of the present time consists of art, literature and *belles-lettres*. Of modern science he knows nothing and cares to know nothing. Even among scientific workers themselves the extreme specialisation necessitated by original work often prevents a general perspective of the whole subject being gained. The trees prevent the individual hewer of wood from seeing the forest as a whole. We have long recognised the need for imparting scientific "culture" to the reading and thinking public in this country, and many excellent series of popular works by our foremost men of science might be mentioned. How far the present work is likely to give French readers a sound idea of modern evolution is very difficult for an English reviewer to judge. The author deals with the subject in a way that has been made familiar by the writings of Haeckel, and we cannot say that he sheds any new light on the various questions or that his treatment is particularly lucid. Here and there Dr. Laloy lets fall a suggestive analogy or makes a remark which shows that on many of the fundamental questions of modern biology his views are at any rate sound. If he admits of being pigeon-holed at all, we should say that as regards the origin of life he is a neo-vitalist. His suggestion that protoplasm may have arisen in the first place by the direct combination of carbon with water and the subsequent combination of the carbohydrate with nitrogen under the influence of the electric discharge (p. 28) is based upon a statement of Berthelot's—that cellulose and dextrin can "fix" nitrogen under the influence of the silent electric discharge. This view is not likely to find favour, we imagine, until we have some more substantial basis of fact to support it.

Concerning the descriptive part of the book, in which the various groups of animals and plants are dealt with from the point of view of evolution in ascending order, there is little to be said. The chief interest for the student of evolution is really concentrated in the seventh chapter, in which the author reveals his position. After putting forward the well-known arguments from rudimentary organs and embryology in favour of some doctrine of evolution being necessary, Dr. Laloy proceeds to consider the factors of evolution. He considers "la lutte pour la vie et la sélection" of Darwin to be inadequate and he accordingly assigns to natural selection a quite subordinate part in the formation of species. It is difficult, however, to find out precisely what is, according to the author, the prime factor of species formation. So far as can be gathered from the text, he appears to favour a kind of sudden and spontaneous variation of all the individuals simultaneously in the direction required to adapt them to new conditions (p. 104). He relies for this remarkable factor upon the experiments of Bonnier and the observations of De Vries, and he adds :—

"Ce serait selon moi cette variation brusque et totale, cet état de mutation, comme s'exprime De Vries, qui serait la véritable cause de la formation des espèces. La lutte pour la vie et la sélection ne seraient plus que des facteurs secondaires, qui n'entrent en jeu que pour fixer et rendre stables les variations acquises en bloc et surtout, pour supprimer les différenciations fâcheuses. Elles maintiennent les espèces dans leur caractère normal, mais ne sauraient en former de nouvelles. Ainsi, comme cause principale de l'évolution, nous retrouvons encore cette finalité du protoplasma qui lui permet de s'accommoder aux circonstances les plus diverses."

This is the key to the author's position as an evolutionist. It is not likely that many adherents to these views will be found in this country. Pure Lamarckism—however inadequate we may regard it—seems, on the whole, to have something more tangible about it than the variation "brusque et totale" of all the individuals of a species in order to meet any emergency in the conditions of life. It is remarkable that a countryman of Lamarck's should go out of his way in order to introduce a factor which receives such very slender support from the observed facts of nature.

R. M.

OUTLINES OF PHYSIOLOGY.

A Primer of Physiology. By Alec Hill, author of "An Introduction to Science," &c. Pp. x + 105. (London : J. M. Dent and Co.)

IN this tiny primer of 105 pages the author attempts to give a general sketch of the subject of physiology, treating especially of those parts which may be supposed to be of most interest to a reader who is not contemplating the profession of medicine, and has not the appliances of a laboratory at his command.

As the author truly remarks in his preface :—

"'The subject is so vast that a series of primers would be needed to approach its several departments through the elements of physics, chemistry, anatomy, and the other sciences upon which they are based."

Mr. Hill does not state whether these needed primers are subsequently to appear from his pen, but should they do so there is little doubt that they will prove quite as interesting to the student of physiology as the one now under consideration.

Although the space at his disposal is so exceedingly limited, yet the author finds room to dip occasionally into the realms of medicine. Here is an example of such an application taken from p. 14 :—

"The expression to 'purify the blood' is a vestige of a long-abandoned theory of medicine. In the sense in which it is used, to imply that carbuncles, boils and pimples are due to 'bad blood,' it is absurd and misleading. It is none the less true, however, that health, as shown by muscular vigour and perfect freedom from neck-ache, pains in the limbs, and other 'gouty' symptoms depends upon the blood being fully charged with oxygen, and sufficiently free from nitrogenous waste products to keep the juices of the body in a pure state."

Then in a few cogent words the author deals with the *rationale* of massage, the effect of hot baths, and the therapy of diuretics such as "sweet spirits of nitre" or "salts of various kinds"; and all this is done in one short half page.

Terseness is naturally the characteristic of this little primer throughout, but we scarcely agree with the tacitly assumed idea of the author that by the judicious use of leaded type the necessity for wasting precious space in giving definitions can be avoided. For example, the hitherto uninstructed person in physiological matters will scarcely understand at a first glance what is meant by lymph, epithelium and protoplasm, unless some explanation, other than that mentioned above, be given him.

The book opens with a four-page account of the structure, given necessarily in hasty outline, of the mammalian body ; there follow eight or nine pages on minute anatomy, in which half a page is found for a description of "caryokinesis," and then, in less than forty pages, the blood and vascular system, the neuro-muscular system, digestion, absorption, dietetics and respiration are rapidly reviewed. Rather more than half the space is thus left over for the central nervous system and special senses, and here in his own special domain the author is peculiarly at home, and his imageries and analogies are at

POLITECHNIKA BIBLIOTEKA GŁÓWNA WROCŁAWSKA

times perfectly delightful. Take, for example, the analogy given to illustrate the perception of sensation on p. 61 :—

> "An errand boy pulls a bell handle (he stimulates a sense organ); the pull is conveyed up the wire (an impulse travels to the central organ); the bell rings (a sensation is produced); the maid-servant hears the bell (the sensation is perceived); she decides that a person has pulled the bell handle (passes a sensory judgment). Perhaps she is able to infer, from the violence of the ring, that it was a telegraph boy who pulled the handle. Probably she goes to the door and opens it—this is equivalent to translating sensation into action with the acquiescence of consciousness."

There is a touch of genuine humour, perhaps unconsciously given, in the use of the word "probably" in the concluding sentence of this fine description.

Finally, it may be said that few will read Mr. Hill's little primer, with its great wealth of popular allusions and applications, without learning something new, even if they be trained physiologists, although it is somewhat doubtful whether the book is not a little too condensed for a beginner.

The illustrations, like the ext, are original, and are in every respect worthy of it. Attention may here be drawn especially to the great simplicity of the diagrams of a sphygmograph on p. 20 and of the pendulum myograph on p. 33.

B. MOORE.

A PROTEST AGAINST VITALISM.

Mechanismus und Vitalismus. By O. Bütschli. Pp. 107. (Leipzig: W. Engelmann, 1901.) Price 1*s.* 9*d.*

THE work before us is a reprint of an address delivered before the International Congress of Zoology at Berlin in 1901, amplified by the addition of a preface and of explanatory and supplementary notes, which exceed considerably in bulk the original lecture. The author takes as his theme the most fundamental problem of biology, namely, the relation of life and living things to the inorganic world. With regard to this question, biologists fall, consciously or unconsciously, into two camps—on the one hand the vitalists, who do not believe that an ultimate explanation of the phenomena of life can be given in terms of the not-living; on the other hand, the "mechanists," as they are here named, who "consider it possible, even though feasible only to the most limited extent at the present time, to comprehend vital forms and vital phenomena on the basis of complicated physicochemical conditions" (p. 8).

Prof. Bütschli, whose researches on the structure and properties of protoplasm have brought him into the closest contact with the problem of the nature of living matter in its simplest and most elementary form, approaches the question as a partisan of the mechanistic school of thought, and seeks to vindicate this position against the recent revival of vitalism which has been so prominent of late years, especially amongst physiologists. He commences with a brief exposition of his philosophical standpoint, and expresses himself "of the opinion that sensations (Empfindungen) accompany the processes (Vorgänge) of the entire world, but that consciousness, or conscious sensation, on the other hand, has come about through the building up of the nervous system, and consequently of memory, which is the foundation and cornerstone of the conscious object, or of the Ego" (p. 6). Memory is not to be regarded as a property of the living substance as such, but as possible only with a complicated nervous apparatus (p. 52). The author proceeds next to define the mechanistic position and especially to distinguish "Mechanismus" from Materialism, with which it has been confounded by Bunge and other vitalists. "The mechanistic conception does not imply that the psychical can be explained by the physical; to it these two fields appear separate, though not unconnected" (p. 8). This leads to brief discussions as to what is meant by "causal dependence," and as to how far it is possible to speak of an "explanation" of natural phenomena, after which the author passes on to review and criticise the objections raised by neo-vitalists to the possibility of explaining vital phenomena from a physicochemical standpoint.

It is not possible here to follow the author into the details of his arguments upon this abstruse theme, for which we must refer the reader to the original. Suffice it to say that the lecture makes interesting reading, but by no means of a light order, since almost every sentence requires to be pondered over before it can be assimilated, and we imagine that the inevitable butterfly element amongst the professor's audience must have found it difficult to gather honey from such very solid mental food. Perhaps the difference between the mechanists and the vitalists is nowhere brought out better than on p. 17. A neo-vitalist, Cossmann, having asserted that an artificially manufactured body, of the same materials and of the same structure as a plant, would nevertheless not be an organism, Bütschli replies that "a body, built up in exactly the same way, both as regards structure and material, as a given plant, cannot, under suitable external conditions, behave otherwise than would the plant in question, *i.e.*, it would live like it." So long as this ideal artificial organism has not been put together, it seems a little difficult for an unbiassed critic (if there be any such) to assert confidently, either with the mechanist, that it would behave as a living body, or with the vitalist, that it would be in the condition of a dead one. Incidentally, Bütschli declares his belief that the Darwinian theory of evolution, in spite of the many recent attacks upon it, remains the most probable of the various attempts at explanation, and "contains the possible general solution of the problem," especially if combined with the hypothesis of germinal variations, which alone are capable of being inherited (pp. 33 and 89). In conclusion, the author claims that, in vital phenomena, "only that can be comprehended which can be physicochemically explained." As regards the merits of the vitalistic and mechanistic points of view, he is content to declare, "By their fruits shall ye know them!"

E. A. M.