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A NEW MANUAL OF THE PROTOZOA.

The Protozoa. By Gary N. Calkins. Columbia University Biological Series, VI. Pp. xvi + 347; 153 text-figures. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1901.) Price 12*s.* 6*d.* net.

BIOLOGISTS have understood for a long time past the importance of the study of the Protozoa as an indispensable aid to the solution of some of the most fundamental problems of biology. Of recent years, however, a lively interest in this class of organisms has been awakened in many others besides those whose field of investigation includes the Protozoa amongst its recognised subjects. Medical researchers, for instance, require now to know more about the simplest forms of animal life than they were taught, as students, in their elementary courses of biology, and even the general public has had its attention directed to "microbes" by the recent discoveries concerning the etiology of malaria and the wonderful life-history of its minute parasite. The time is opportune, therefore, for the publication of a general account of the Protozoa, and the latest addition to the well-known Columbia Series is a handy volume which will be welcomed by many classes of readers. The author has not aimed at putting forward an exhaustive, severely scientific treatise upon the group in question. His work may be described rather as a simple and intelligible introduction to the study of the Protozoa and of the many fascinating biological problems connected with, or illustrated by, this subdivision of the animal kingdom, in such a way as to awaken the interest of the beginner, no less than to strengthen the hands of the expert. The book is written in plain language, with avoidance of unnecessary technicalities, and is profusely illustrated by a great number of very excellent figures, in the preparation of which the author acknowledges the assistance of his wife, whose skilful draughtsmanship cannot be praised too highly.

The author treats his subject, as stated in the preface, from three points of view: (1) the historical, which occupies the first chapter; (2) the comparative, on which five chapters are spent; and (3) the general, to which the last three chapters are devoted. The historical and introductory chapter gives an extremely interesting account of the progress of our knowledge of the Protozoa, and traces the gradual elimination of the many erroneous notions prevalent even not so very long ago.

The comparative account is a useful review of the whole group and of the four principal subdivisions, the Sarcodina, Mastigophora, Sporozoa and Infusoria. The author is extremely up to date in his facts, and makes use of the most recent observations and discoveries. In the chapter on Sporozoa we find Siedlecki's recent account of the conjugation of the sporoblasts in *Monocystis* (*Lankesteria*) *ascidiae* taken as typical for the class (p. 151) and made the basis of six good diagrammatic figures representing the "scheme of sporulation in gregarinida" (Fig. 84, p. 152). The book must have been out of the author's hands before the publication of Cuénot's recent memoir describing a perfectly similar type of conjugation in the common Monocystis of the earthworm, but it is nevertheless unfortunate that the now exploded account put forward by Wolters for this type should be quoted so frequently (pp. 157, 235 and elsewhere), especially as Wolters' statements are directly at variance with the "scheme of sporulation" to which reference has been made.

The three general chapters deal with sexual phenomena in the Protozoa, with the special morphology of the Protozoan nucleus, and with some problems in the physiology of the Protozoa respectively. The sexual phenomena are divided into four categories—union of similar adult individuals, of similar but different-sized individuals, of swarm spores or reduced individuals, and, lastly, of "eggs and spermatozoa," *i.e.* of highly differentiated gametes. A great deal of very interesting matter is brought forward under each heading, but the facts relating to the Coccidia, which form the bulk of the fourth subdivision, are set down in a very inaccurate manner, and require revision. It is not true, for instance, to say that "so far as the nucleus (of the macro gamete) is concerned, . . . no maturation process has been recorded," unless the term maturation be used in a very restricted sense. In *Adelea ovata* the entrance of a male element is not effected through a special opening or micropyle, as stated; but perhaps *Coccidium proprium* is meant, where this does occur. Again, it is incorrect to say that in *Adelea ovata* the microgamete divides twice while in contact with the macrogamete, and that three of the resulting nuclei are eliminated. It is the microgametocyte which divides in this way to furnish four microgametes, one of which fertilises the "egg." In a book which bears evidence of so much careful and well-considered work, it is strange to find so many misstatements so close together, but the whole paragraph (pp. 229-232), from which is taken the above statement concerning the microgamete, is confused and contradictory, since, beginning by referring to Adelea by name, and without introducing the name of any other species, it goes on to make statements which evidently refer to Coccidium, and then to institute comparisons between the facts stated and the processes occurring in other Coccidia, including Adelea itself.

In the chapter dealing with the nucleus, an attempt is made to trace the steps in the elaboration of the structure of Protozoan nuclei and of the mechanism of nuclear division. Four stages are recognised in the evolution of nuclear structure: (1) compact spheres of chromatin, multiple division of which is the prelude to the reproduction of the cell; (2) nuclei with membranes, enclosing each one or more chromatin masses or "karyosomes," which break up to form granules, and the granules unite secondarily in lines forming primitive chromosomes; (3) nuclei without karyosomes, with granules distributed widely over the nuclear framework; (4) nuclei with granules as in (3), or aggregated into "net knots" which break up into granules at the period of nuclear division, the granules then coming together in lines which segment into chromosomes of definite number and size. The fourth and highest of these stages is that found in Metazoa and Metaphyta. The author comes to the conclusion

that "the centre of activity in the division of the Protozoan cell, as in the Metazoa, resides in a special structure," which he terms the division centre, regarding it as "a specific substance different from the chromatin and from the cytoplasm." The origin of the division centre is doubtful, but "the widespread intranuclear condition favours the view that it originated there." It is not possible to deal here with the wealth of interesting facts which are marshalled in support of these conclusions, but it is strange that although Schaudinn's now well-known figure illustrating the life cycle of Coccidium is given twice over, no mention is made of his striking observations upon the origin of karyosome, and the *rôle* played by it in nuclear division, in the "endogenous" cycle of this type, nor is Schaudinn's memoir (1900) cited in the bibliography, which contains few references later than 1899.

In the chapters upon physiology, the facts and conclusions are arranged under the headings Intracellular Digestion, Respiration, Secretion and Excretion, Irritability and, finally, General Considerations.

In a work of this size there is, of course, much to criticise, and we may draw attention to a few errors or omissions, such as will always creep into the best regulated manuscripts. Spermatozoa are said, on p. 8, to have been withdrawn from the Protozoa during the present century! The Coccidian genus Minchinia is termed Myxinia on p. 20 (description of Fig. 6). In Fig. 31 B (p. 63) is depicted an associating couple or "syzygy" of polycystid gregarines, which look not unlike the common *Clepsydrina ovata* from the meal-worm; but the figure is labelled *Monocystis agilis*, Leuck. (*sic*). For Fig. 77, illustrating the development of a gregarine, Wasielewski is given as the authority, instead of the veteran investigator of the Sporozoa, Aimé Schneider. When the author states, on p. 146, that the Sporozoa are mononucleate (*sic*), "with the exception of the multinucleate Myxosporidiida," he should have added "and Sarcosporidiida," since a uninucleate Sarcosporidian has not yet been seen, leaving out of account the spores and reproductive bodies.

These are all trifles, but there is one feature of the book to which we wish to take exception; that is the author's practice of altering the form of well-known and familiar names of classes and orders. A similar tampering with names universally accepted and employed, in the vain effort to strive after uniformity—vain because in many cases it is very doubtful whether a given group of animals should be considered as a subclass, order or suborder—was a blemish upon the encyclopædic treatment of the Protozoa by Delage and Hérouard in the "Zoologie Concrète," where we find such monstrosities as "Ciliæ" and "Flagellia" for what everyone terms Ciliata and Flagellata. The desire of the author under review is to make all the subclasses end in "idia," the orders in "ida," and he adds this termination even to groups which in common usage already have it, *e.g.* "Myxosporidiida," "Hæmosporidiida." But the author has not the courage of his convictions to the same extent as Delage, for while writing "Flagellidia" he shrinks from "Ciliidia" or "Suctoriida," retaining the usual appellations Ciliata and Suctoria. Endeavours to alter names in this way, however desirable, are absolutely useless unless proposed by some international convention, sufficiently representative and authoritative for all to be agreed to follow its ruling. When attempted by individuals it only leads to confusion. Are we to speak o "Flagellia" with Delage, or of "Flagellidia" with Calkins? The majority of us will continue to say and to write "Flagellata" to the end of our days. While on the subject of terminology and nomenclature, it may be noted that the author actually names two new species; one in the description of Fig. 13, on p. 41, and another in that of Fig. 134, p. 251. The professed systematist and bibliographer must surely consider this a most reprehensible act in a work of this kind.

The work is provided with short special bibliographies at the end of each chapter, as well as with a general bibliography at the end of the book. The excellence of the figures has been pointed out, but it should be further noted that many of them are original, and of the latter we would draw special attention to the figure of division in Gonium (p. 129), to that illustrating a phase in the conjugation in Arcella (p. 218), and to the figure of mitosis in *Tetramitus chilomonas* [n. sp.] (p. 270). In conclusion, we heartily congratulate the editors of the Columbia University Biological Series on their latest volume, which keeps up the high standard of excellence of its predecessors. E. A. M.

GREEK TOPOGRAPHY IN RELATION TO HISTORY.

The Great Persian War and its Preliminaries. By G. B. Grundy. Pp. xiii + 590. (London: John Murray, 1901.) Price 21*s.* net.

MR. GRUNDY has laid students of Greek history under an obligation by this work, but the obligation would have been greater if the bulk and price of the book had been less. The author seems, indeed, to have fallen between two publics. The scholar, who knows the literature of the subject, ancient and modern, will complain that he here labours the obvious and there ignores the essential, that his acquaintance with Greek history is superficial and his estimate of authorities uncritical, that the pages which present anything at once new and valuable are few out of many. The general reader will require more literary skill and lucid order in the story, and cannot be blamed if he prefers Herodotus in his native simplicity.

But it is probably neither as literature nor as history that Mr. Grundy would have us judge the book, but as a contribution to the topography of Greece and an essay in military criticism. Here he has done excellent service. The large-scale surveys of Thermopylæ and the field of Platæa are good bits of work, and will put the detailed discussion of those battles on a new plane. Mr. Grundy's topographical sketches are a welcome supplement to the maps, and show him to be no mean draughtsman. Most of them are better than the photographs with which they are interpersed, some (for example, the views of Marathon at p. 163, of Artemisium at p. 264, of the sound of Salamis at p. 392, of the panorama from Platæa at p. 502) are admirable pieces of line drawing.

To come to details, we could wish that the map of Thermopylæ covered more ground, even at some sacrifice

of scale. In the pass itself the mound and the Phocian wall are the only debatable points, and they might have been relegated (if necessary) to a little inset plan. (It is ridiculous, by the way, to treat the pretty story of the Spartans combing their hair as serious evidence for topography or "autopsy"—the other Greeks had to be invisible and the wall was a good excuse for hiding them, that is all !) But the real problems are concerned with the valley of the Asopus, the road into Doris, the site of Trachis and the path Anopæa, about the identification of which we have sometimes felt doubts. There must be a railway survey of the valley somewhere, which would give a base to work from, but Mr. Grundy is here less helpful than M. Hauvette, and does not even elucidate his own text—where, for example, is the Great Gable (p. 302)? Why is not Trachis the same as Heraclea, or its acropolis? What is the point of the polemic against Leake, who seems to have accomplished the not unprecedented feat of riding at six miles an hour? There is a useful note on p. 262 to show that "it seems to have been a recognised principle in later times that an effective defence of Oeta included the occupation of Heraklea as well as of Thermopylæ." But why not in earlier times too? Surely, if topography is worth anything as a test of the narrative of Herodotus, it points here to a serious omission.

Mr. Grundy has perhaps scarcely sufficiently guarded himself against the natural tendency to fix sites and positions on the authority of Herodotus and then triumphantly claim that the evidence of the topography confirms the story. We believe that he is right in his theory as to the "Island" at Platæa, but where the identification of so many points is so uncertain we cannot avoid an uncomfortable notion that a turn of the spade may any day undermine his whole construction of the campaign, not to say the narrative of Herodotus itself.

On the other battles of the war Mr. Grundy has little that is new to contribute and scarcely anything of a geographical character. His theory of the campaign of Marathon is essentially Busolt's early view, recently revived by Mr. Munro, of the battle of Salamis a development of Prof. Goodwin's. He scarcely seems to appreciate the full significance of the position at Artemisium, which covers all the landing-places between Tempe and Attica. Aphetæ is a dubious point. It is hard to reconcile Mr. Grundy's situation with the remark of Herodotus, that the wreckage of the first sea-fight drifted *out* to Aphetæ, which is badly misrendered in the words "was thrust in upon the Persian fleet." Mr. Grundy is much put about to find a reason for the Greeks taking the offensive in 479. He concludes that they feared the establishment of a Persian frontier at Cithæron. Obviously the Persians would keep all they could conquer, but why should they stop at Cithæron? and is not the real difficulty the Greek *delay* in taking the offensive after the victory of Salamis had entirely changed the situation?

Where Mr. Grundy has seen with his own eyes he generally has something useful to say, but where he has not seen he cannot always be trusted. It is an absurd exaggeration to call the Taurus an "all but blank impassable wall"; and other references to it would certainly suggest that it runs north and south! The theory of the weak strategic situation of the Asiatic Greeks will not hold where any communication by sea is so much better than any by land as in western Asia Minor. Was it either land or sea that divided, *e.g.*, Samos and Miletus? For downright geographical nonsense it would be hard to beat the description of Pteria as "a town whose position renders it the chief strategic point in the Halys region, commanding, as it does, the middle portion of the cleft-like valley through which the river flows" (p. 15). Mr. Grundy does not appear conscious of all the difficulties which beset Xerxes' march through Thrace as conceived by Herodotus. They do not harmonise well with his doctrine that the historian had himself traversed the road.

In the early chapters, the author makes great play with the idea of the "Ethnic frontier." As applied to the Persian attacks on Greece this is no novelty; but will it explain the conquest of Thrace? Are Phrygians and Bithynians still to be called Thracians in the days of Darius?

The book is sumptuously got up. It is a pity that so many misprints have been overlooked. Some of these are very unfortunate, *e.g.* banaustic (p. 94), St. Demetrion (three times), Elataea (four times), Oeroe with initial diphthong (always). Xerxes on p. 69 ought to be Darius. On the map of Marathon, Kynossema ought to be Kynosoura. On p. 350, Mr. Grundy has interchanged *east* and *west*—did he "alter his point of view"? On p. 378, a whole paragraph is based on a childish mistranslation of Herodotus.

In conclusion, we must heartily thank Mr. Grundy for publishing the many exquisite sketches by Edward Lear. They are as accurate as they are beautiful, and even had this book no solid merits of its own to recommend it, they would suffice to make it valuable.

GEOMETRY ON THE SPHERE.

Spherical Trigonometry. By the late I. Todhunter, M.A., F.R.S. Revised by J. G. Leathem, M.A., D.Sc. Pp. xii + 275. (London: Macmillan and Co., Ltd., 1901.) Price 7*s.* 6*d.*

THIS volume gives a systematic treatment of the subject of spherical trigonometry, based on the sound foundation of Todhunter rearranged and amplified. While the merit of the original work is sufficiently indicated by its vitality, the preface bearing the date 1859, it is natural that a text-book designed for the use of students forty years ago should to some extent fail to satisfy the requirements of the present day.

The subject falls naturally under two heads, (1) Formulæ connected with the Spherical Triangle and the Solution of Triangles, (2) Spherical Geometry. In both departments the reviser has used skill and judgment in grafting fresh shoots on the old stock, and has produced a homogeneous and well-balanced volume, double the size of the original and worthy to take its place among the best of our modern text-books. In trigonometry proper, Todhunter's treatment has been rendered very full and thorough. The theory is illustrated by well-selected numerical exercises, fully worked out and presented in the most concise form with due attention to labour-saving devices. Critical and ambiguous cases are carefully considered, discussed and illustrated diagrammatically, while

the practical methods and terminology used in navigation receive some notice.

In the department of spherical geometry more extensive additions have been made. New chapters have been added on Properties of the Spherical Triangle, Properties of Circles on the Sphere, The Principle of Duality, Hart's Theorem, The Generalised Triangle, The Application of Determinants to Spherical Geometry, while some additions and modifications have been introduced elsewhere. The chapter on the principle of duality gives an excellent *résumé* of the subject, illustrated by the exhibition in parallel columns of corresponding properties of a co-axal system of circles on the sphere and its dual a co-lunar system. The principle is also utilised in what the reviser styles, in the preface, a new treatment of Sir Andrew Hart's very striking and fertile theorem that the inscribed and escribed circles of a spherical triangle touch a fourth circle besides the three sides of the triangle. The bearings of the principle of duality on Hart's theorem have, however, been already discussed, and Dr. Leathem's treatment does not seem to add much that is essentially novel. The proof of the theorem, as here presented, appears, indeed, to be open to objection; the proof in § 178 of the condition for the contact of a given circle with the circumcircle of a given triangle assumes that the circles have a *real* limiting point L, while in §§ 203 and 204 all that has been proved is that the cone joining the circle H to the centre of the sphere touches, internally or externally, the inscribed and escribed circles of the triangle—an appeal to the particular case of the equilateral triangle, without further discussion, in order to determine the nature of the contacts hardly carries conviction. The plane analogue of this mode of treatment of Hart's theorem may be found in Lachlan's "Modern Pure Geometry," pp. 206 and 250, where also an adaptation to plane geometry of the theory of duality on the sphere is given at p. 257. Needless to say, the subject admits of wide development.

Among the chapters devoted to spherical geometry, one dealing with inversion, stereographic projection, &c., would have been welcome, but it was possibly excluded by want of space.

In the new chapters admirable judgment is displayed in the selection and arrangement of materials from a wide range of original sources, numerous historical and bibliographical references forming an excellent feature of the work. The style throughout is clear and attractive, and most of the examples which have been added possess the merit of elegance and real scientific interest. A. L.

A CONSUL IN CHINA.

John Chinaman and a Few Others. By E. H. Parker. Pp. xx+380. (London: John Murray, 1901.) Price 8*s.* net.

THIS is an interesting book of personal reminiscences during a long official residence in China. Mr. Parker served in the consular service for many years at a time when our relations with the Flowery Land were even more precarious and uncertain than they are to-day, and it is interesting to observe how under these conditions, and with Sir Harry Parkes as our Minister at Peking, a spirit of self-reliance was engendered among all holding authority at the outlying ports. The riots directed against foreigners which are now occasional were chronic in the 'eighties, and Mr. Parker came into a fair share of them. Being ever ready to accept responsibility, he in most cases undertook the defence of his countrymen during the acute stages of the crises, and when the hurly-burly was over arranged with the local authorities for the necessary punishment of offenders and compensation for the destruction of property. As he remarks, after describing a serious outbreak at Wênchou,

"The moral of this story is that Chinese nerves are so constructed that every Mandarin seems to have in him the makings of a murderer or a saviour, accordingly as the tide in the affairs of men is taken at the flood or on the ebb; that rows are seldom so dangerous or so serious as their noise and appearance is (*sic*) appalling; and that a readiness to make allowances for foolish human nature is commonly appreciated at its full value on the Chinese side. The same missionaries had to take refuge on the island once more dur ng the Boxer riots of 1900, but I see that my sensible and accomplished successor has been able to abstract ample compensation in the same friendly spirit as that evinced sixteen years ago. I see no reason why the whole Chinese question should not be treated on analogous lines."

To the principle here involved we entirely agree, but, unfortunately, the whole Chinese question has to be settled, not by one plain-dealing man, but by a dozen plenipotentiaries whose interests are conflicting, and some of whom find in a disturbed China a prospect of the realisation of their best hopes.

Another source of diplomatic difficulty at the present time is the absence of sound statesmanship at Peking. In the 'sixties, as Mr. Parker points out, there were men like Prince Kung, Wên-Hsiang and Kui-Hsiang, who were giants in comparison with the Prince Chings of the present day. Sir Thomas Wade used to call Wên-Hsiang "the last of the Manchus," and it is difficult to point to another of the race who has risen to anything like the same level of wisdom and knowledge.

But Mr. Parker has much to say of the Chinese and their affairs outside the political arena. He mixed more with the natives and gained a better insight into their characteristics and peculiarities than most Chinese-speaking foreigners, with the result that he has much to say in their favour and many strange peculiarities to note. Among the latter he mentions the curious tendency there is among the people to commit suicide.

"Women are the chief delinquents, or heroines, as they often imagine; it only needs a harsh word or a fit of passion, when down goes an ounce of opium—a most comfortable death. It will be noticed that the recent Boxer troubles are responsible for the suicide of at least a score of prominent statesmen. In some cases whole families have dived head foremost into wells in order to share the master's disgrace or self-sacrifice. In others the Emperor has 'bestowed the cord'; which means that a man sits with his back to a panel and his friends strangle him through two holes. So far from being considered a crime, suicide is under many circumstances regarded as a noble act; rarely as a despicable one, unless done in pure spite, or out of revenge."

The position of women in China is well illustrated by the many stories the author has to tell of native life, and the conclusion at which he arrives is that on which all close

observers are agreed, viz. that they have much more power in their households than is generally supposed, and that their status is universally recognised by all heads of families who desire to lead quiet lives. Mr. Parker quotes the case of a Captain Ch'ên as an illustration of common official domestic affairs.

"He"(Captain Ch'ên) "had a wife—*passée* of course—who ruled the roast in that watchful and relentless way in which capable French women *d'un certain age* rule a busy café. Captain Ch'ên bought, sold, and exchanged concubines freely, this freedom evidently being the common basis upon which agreeable terms had been made between himself and his wife.... Like a sensible man, he always showed formal respect to his wife; and, although he never took her to the various forts, camps, and war junks in or on which he was from time to time employed for months at a stretch, he always consulted her; left the purse strings in her charge; and gave her feminine command over all the concubines and 'slaveys' not actually with him."

Mr. Parker evidently has the gift of tongues, and finds it equally easy to communicate with the natives of Peking, the Hakka people of Canton, and the speakers of half a dozen or more dialects throughout the Empire. In the present work we have the results of this polyglot ability, and in a succession of short chapters, or notes, he throws countless side-lights on the kaleidoscopic aspects of the Chinese question and the social life of the people.

OUR BOOK SHELF.

The Home-Life of Wild Birds. By F. H. Herrick. Pp. xix + 148. (New York and London: G. P. Putnam's Sons, 1901.) Price 10*s.* 6*d.* net.

IN this attractive and beautifully illustrated volume the author lays claim to having invented a new method of studying and photographing birds in their native haunts; and he is certainly to be congratulated on the success of his efforts. Although his method of working is somewhat different, Mr. Herrick may be said to have done for some of the commoner birds of North America what has been effected by the Messrs. Kearton for those of Britain; and higher praise than this it would be difficult to bestow. To the English reader the book will be especially welcome, as throwing a flood of light on the habits of species with which he is necessarily unfamiliar. Among the most successful of the author's efforts are his photographs of cedar-birds, or waxwings, with their nests and young, which illustrate in full detail the mode in which the nestlings are fed and tended by their parents, and the curious postures assumed by the latter in the course of their duties. The attention devoted by these birds to their offspring is well indicated in the following passage, where it is stated that, on one occasion, "with half-spread wings and with back to the sun the mother protected her little ones for a full hour from the broiling sun, while her mate came repeatedly and handed out the cherries."

Instead of photographing from a long distance, or with a camera placed near the nest and worked by the observer from a distance by means of a string, the plan adopted by the author is to bring the nest and its surroundings within a short distance of the observer, who is himself concealed. If the nest be situated on a branch at a considerable height from the ground, the bough is carefully cut off and fixed, with the nest, in its natural position near the ground in a good light. If, on the other hand, the nesting site be a tussock of grass in thick coppice, the whole mass is dug out and transplanted to the open. The photographer takes his station in a green tent, through a hole in the canvas of which the camera can be brought to bear on the nest and its surroundings. When the nest is in a situation to which the tent can be brought near, and where the light is good, its natural position is not interfered with, and only such boughs as obstruct the view are cut away.

It might be thought that the removal of a nest and its surroundings from a height of 40 feet to within a yard or so of the ground, or from the shade of a dense coppice to the glare of sunlight, would seriously disturb the parent birds. This, however, according to the author is not the case if proper precautions be taken. "No injury," writes Mr. Herrick, "is wrought upon old or young. The former nesting conditions are soon forgotten, while the new are quickly adopted and defended with all the boldness of which birds are capable."

The method is at present only in its infancy, but by its aid we may hope in time to have permanent records of the complete life-history of a large number of birds during their nesting-seasons. R. L.

Finishing the Negative. Edited by George E. Brown, F.I.C. Pp. 160. (London: Dawbarn and Ward, Ltd., 1901.)

ALTHOUGH there are many very excellent handbooks on photography in general, there are few which give so much useful and necessary information regarding the treatment of the photographic plate after the negative has been obtained. Many amateurs consider the negative ready for printing after a few spots have been obliterated and perhaps a small retouch here and there; but a glance at this book gives one the idea that the negative is by no means ready for printing, but may be improved (in the case of beginners probably not) by many of the numerous hints here brought together. The separate chapters of this book are devoted to the manipulations of drying, hardening, clearing and removing stains, different methods of intensification and reduction, softening and increasing contrasts, varnishing, stripping, retouching portrait negatives, handwork on back and front of negative, spotting and blocking out, and many other aids to producing a "perfect" picture, concluding with special hints for applying the above processes to the working of celluloid and stripping films.

The editor of the book tells us that in many of the chapters he has had the able help of several workers in these special lines of work, so that the reader will find the hints both practical and instructive.

The book will certainly fill a gap as regards the special branches to which it is devoted, and the many well-chosen illustrations considerably aid the text in showing the reader the "before" and "after" stages of many of the manipulations described.

Text-book of Elementary Botany. By Charlotte L. Laurie. Pp. ix + 142. (London: Allman and Son, Ltd., n.d.) Price 2*s.* 6*d.*

THIS little book supplies the information required for such examinations as the junior Oxford and Cambridge, and is specially adapted to a school curriculum. Despite some defects which are mentioned below, the author is to be congratulated on having written an elementary botany which shows some new features and by its character and conciseness avoids the dull level of most similar works. There is much that calls for favourable comment. The language is simple, and technical words are slipped in easily with derivation or other simple explanation; the illustrations are original, for the most part extremely good and well reproduced, and throughout the book an admirable balance is maintained—no easy matter when the compass is so small. There are three parts to the book, dealing with morphology, classification and physiology respectively. Very wisely, no attempt is made to treat of internal anatomy, so that all exercises can be worked out with the lens and scalpel. In the morphological part, useful summaries pick out at intervals the main data for description or comparison; also numerous ecological references are worked in. One must

regard the use of the terms "sporangium," "macrospore," "microspore" as unnecessary, seeing that the book deals only with the flowering plant; and why "oosphere" and not "ovum"?

In the second part short chapters explain the Linnæan and natural systems of classification, the distribution of plants, and give general directions for field work.

The physiology is the least satisfactory part of the book. The plan adopted of giving experiment, result and conclusions to be deduced therefrom is eminently good. But many of the experiments are open to serious criticism, as in some cases the apparatus is not practical, in others the deductions are unsatisfactory. For instance, apparatus is figured on p. 126 to show that plants take in oxygen. The apparatus shown would certainly allow leakage of air; the potash would not absorb much carbon dioxide, and in so far as it did, this would partly account for the change in the manometer; further, the seedlings shown in the figure would photosynthesise unless placed in the dark. The three subsequent figures also show apparatus which is not workable. Despite these faults and one or two erroneous statements, the book is so vigorous and well compounded that it may be strongly recommended to school teachers as one which is eminently suitable for beginners in botany.

Intuitive Suggestion. By J. W. Thomas. Pp. x + 160. (London: Longmans, Green and Co., 1901.) Price 3*s.* 6*d.* net.

IT is difficult to know how far Mr. Thomas takes himself seriously. His book is called a "New Theory of the Evolution of Mind," and certainly contains some very novel and curious statements both about the past and about the future of mankind. He has, however, no very clear notion of the difference between saying a thing and proving it, and many of his most remarkable assertions are made without any serious attempt of proof. His main thesis appears to be that the processes of the inorganic and organic worlds alike are the consequences of a series of quasi-hypnotic "suggestions" on the part of a "great first cause." He takes, that is, a few unfamiliar and very imperfectly understood facts of experience and makes them the basis of a theory of experience as a whole. Apparently he has never even asked himself whether there is any evidence to show that a creature without a nervous system would be amenable to "suggestion" at all. The argument from the miraculous narratives of the Bible, on which he lays great stress, is deplorable alike from the standpoint of logic and of piety. From the logician's point of view, the alleged facts are insufficient as a basis for a theory of nature, and from that of the believer they lose all their moral significance by being degraded to the level of mediumistic or hypnotic "phenomena." A. E. T

Jahrbuch der Chemie. Herausgegeben von Richard Meyer. Jahrgang, 1900. Pp. xii + 565. (Brunswick: F. Vieweg und Sohn.) Price 15 mk.

THOUGH somewhat later in the time of its appearance, this valuable publication is happily not much thicker than its precursors, and the volume before us gives in reasonable space an excellent summary of the chief advances in chemistry and applied chemistry recorded in the year 1900. The labour of writing is distributed among authorities of the highest competence, and the result is correspondingly satisfactory. It is true that the information is in a highly condensed form, but the present writer is able to say of the subjects on which he is at all qualified to speak that they are dealt with in summaries which bear the impress of informed writers rather than hack abstractors, and that they will continue to serve well the useful purpose of assisting all those who are engaged in the difficult task of keeping themselves moderately well informed of chemical progress. A. S.

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.*]

Earthquake Observations in Strassburg.

DURING the last twelve months, on more than one occasion I have been asked why it is that at the Kaiserlichen Hauptstation für Erdbebenforschung in Strassburg one type of instrument records earthquakes so very much more frequently than other types of instruments give records, although they are all installed in the same building. An answer to this is apparently to be found in an analysis of the Strassburg registers.

For example, in January 1901, a von Rebeur-Ehlert apparatus, which consists of three horizontal pendulums oriented at 120° to each other, which reflect beams of light on to a photographic recording surface at a distance of about three metres, yielded twelve records, only five of which were noted by a single component horizontal pendulum of the type adopted by the British Association and now in use at very many stations round the world. This latter apparatus was therefore quiescent on seven occasions when we should have expected it to have been in action. On looking at the registers, we first observe that these seven disturbances were all exceedingly small, and two of them were only noted in Strassburg. Considering this latter fact, in conjunction with the facts that they are found in the traces from an instrument with a very high multiplication, subject to so-called "Mikroseismische Unruhe" (air tremors?), and that a blur may be formed in the photographic record by a slight flare in the illuminating apparatus, it seems a bold proceeding to enter such records (January 17 and 26) as being earthquakes. I doubt their seismic character and consider that their entry ought to have been accompanied by some qualification. So much for two out of the missing seven. Two others (January 8 and 30), although not recorded by the British Association type of instrument in Strassburg, were recorded by similar instruments in Britain and at stations in other parts of the world. That they were not recorded in Strassburg, but were recorded all round Strassburg, suggests the idea that the instrument as installed at the Hauptstation has not the desired amount of sensibility, and if this is the case it is not remarkable that this form of instrument as used in Strassburg should fail to record very small earthquakes.

As another illustration let us take the month of August, when the Rebeur-Ehlert pendulums gave twenty-four records, out of which the British Association seismograph is advertised as only having responded to four. A glance at the registers for stations in Britain and other countries shows that this number should be increased to seventeen, leaving a balance of seven, which, if they all are earthquakes, are for the most part peculiar to Strassburg, and as such have in my own mind a doubtful character.

Another point connected with the Strassburg registers relates to the determination of origins. To identify a seismogram obtained at Strassburg on September 17 at 4.30 a.m. as connected with an earthquake which shook a small portion of the north of Scotland at about 1.25 a.m. on that morning is asking us to believe more than our reason can accept. Even had the Hauptstation been situated in the south of Scotland itself, it is very doubtful whether its horizontal pendulums would have responded to a local shock originated in the northern part of the same country. JOHN MILNE.

March 3.

Proofs of Euclid I. 5.

SEVERAL writers have lately expressed their opinions in favour of replacing the present proof of this proposition by an alternative proof based on the supposition that the bisector of the vertical angle of the isosceles triangle is drawn, irrespective of the fact that no construction has been given for drawing this bisector. Now there may be some advantage in using a "hypothetical construction" to prove a proposition, where its avoidance necessitates a long and tedious alternative proof. In the present instance the artifice is absolutely unnecessary, as the proof can be simplified in any of the following ways, A being the vertical angle of the isosceles triangle ABC:—

(1) By adopting Euclid's construction of cutting off equal segments AD, AE from the sides and proving as he does that the triangles ABE, ACD are equal in all respects, and then making D, E coincide with A, B respectively. The method of passing to limiting cases is highly instructive, the only question being as to the advisability of trying to introduce it to beginners, except as an experiment.

(2) By drawing a duplicate DEF of the triangle ABC (this operation being only a slight extension of the method of superposition used by Euclid in I. 4), and proving first that $\angle A = \angle E$ and $\angle B = \angle F$, and second that $\angle A = \angle F$ and $\angle B = \angle E$.

(3) By *folding the triangle* so as to bring AB into coincidence with AC. This is *practically* equivalent to bisecting the vertical angle, but it replaces a "hypothetical construction" by an operation which the beginner can easily perform.

The method of folding has many obvious advantages, and much would be gained if beginners could be taught at once to recognise cases in which one half of a figure could be brought into coincidence with the other half by folding. For example, the property that the common chord of two circles is bisected at right angles by the line joining the centres is obvious when it is recognised that one half of the figure is the fold of the other half. The method is, moreover, hardly more artificial than the method of superposition which Euclid himself employs.

It should be noticed that Euclid's proof of I. 4 involves an assumption which I have never seen pointed out, namely, that *two straight lines cannot touch one another*. If this be not assumed, then when the sides DE and AB are brought into coincidence, the sides DF and AC do not necessarily coincide even though they make the same angle with the same straight line and on the same side of it. G. H. BRYAN.

The Zodiacal Light and Sun Pillars.

THE appearance on clear evenings of the zodiacal light *after* sunset at this season of the year in this latitude is usual, and it has been frequent and beautiful to observe in this district for many nights. It would be interesting if the readers of NATURE could detect any definite movement of the arm of light, for much yet remains to be discovered about this phenomenon, and any observer can make this point a study. From a short half-hour after sunset to from 8 to 9 p.m., a straight line drawn from the sun's position at sunset to the Pleiades will not remain the centre line of the zodiacal light. It appears to emanate from the sun and move as the luminous spoke of a wheel which has the sun for centre frequently, but not invariably. What makes the light apparently fade away? Is it that the motion of the earth has drawn with it the arc of volcanic or meteoric particles, which may be the medium of the light, away from the sun? or is it not possible that such a band of dust is lit with a degree of earth-shine? If so, may not this account for that other phenomenon of the Gergershein, which is usually brilliant in proportion to the brilliancy of the zodiacal light? Doubtless these phenomena are always present, but their visibility depends on the magnetic or electric condition of our atmosphere. Irritated by either of these conditions, the belts of dust would alter positions of all the bodies forming them, and so lie at a different angle and be clearer or dimmer accordingly.

The very remarkable sunset of March 6 has probably been observed by many readers of NATURE. The "fire-finger" left in a perfectly perpendicular position for upwards of fifty minutes after sunset was visibly withdrawn, without losing colour or size or changing from the perpendicular, and was a vivid and beautiful adjunct to a sunset afterglow strangely reminding one of the "Krakatoa sunsets" of years ago. This finger of fire the writer has only observed once before, after a similar-coloured sunset over the estuaries of the Medway and Thames last summer, but London smoke dimmed the effect. This rare appearance seemed on March 6 to resolve or be replaced by five vivid *white* rays with slight wheel motions from north to south, the largest of which eventually seemed the zodiacal light itself.

GUY J. BRIDGES.

Sutton Mandeville Rectory, Salisbury.

A PHENOMENON was visible here this evening which I think deserves to be recorded. We have an uninterrupted view of the western sky, and about a hundred pairs of sharp eyes are available, so that any unusual sunset is pretty certain to be noticed. Solar halos are comparatively common occurrences, and I have come to the conclusion that lunar rainbows are not so rare as is believed, but the "pillar of fire" which has been visible here for at least forty minutes is the most brilliant sight I or any of my oldest friends have ever witnessed. It was first observed at 6 p.m. just after the sun had disappeared, and was exactly *vertical* over the sun. The colour was at first silvery (resembling a searchlight) and later a golden yellow, the width equal to the sun's diameter, and the length 18° to 20°. A few light clouds seemed to pass *behind* it. Some observers noted a flickering and also a swaying motion, but this may have been an optical effect. At about 6.30 the colour had changed by gradations into a deep crimson-red, and for the next ten minutes it gradually became deeper in colour and shorter, disappearing at 6.40.

I may add that on February 20, 1901, I observed a very faint trace of a similar phenomenon.

Can any of your readers direct me to any literature bearing on the matter? WM. A. KNIGHT.

Sexey's Trade School, Bruton, Somerset, March 6.

The Quadrantid Meteors.

MR. JOHN R. HENRY, according to his letters in NATURE of January 2 and 23, unfortunately looked out too late for the Quadrantids, owing to having miscalculated the time of maximum, the approximate probable time of which might also have been obtained from the British Astronomical Association. He is right in saying that the date of the shower is advancing into the year, but the advance is slower than he thinks. Taking the data he gives, which, however, are only very rough, and also a consideration of the sun's longitude as given in the "Nautical Almanac," there is an advance of only five hours in the thirty-seven years 1825 to 1862. It would appear that in the forty years from then a further advance of probably about eight hours has taken place. It is unfortunate that Prof. A. S. Herschel has not published the exact number of meteors he saw from hour to hour on January 2, 1900, when he watched from 11h. to 16h. 30m. He, however, states that the frequency continued about the same during the whole period, and seeing the radiant point was rising all that period, this would mean that the maximum was near the beginning of his watch.

Mr. Henry may be right in saying that the period of maximum fluctuates somewhat from year to year, though the data he gives are not sufficiently accurate to prove this; but I fail to see what ground he had for expecting the maximum so late as he did this year. Taking all the data into consideration, we might have expected the maximum to be about 23h. on the 2nd. I see no reason to doubt that this expectation was fulfilled; but as the maximum would occur in the daytime, observations in other countries would be necessary to prove this. The Quadrantids as seen here were most numerous on that morning.

It seems probable, therefore, that the time of the next maximum will be about 5h. on January 3, 1903. T. W. BACKHOUSE.

West Hendon House, Sunderland, March 5.

Elementary Mathematics.

I WAS very glad to read in NATURE of January 30 (p. 297) the letter of Mr. J. W. Marshall on elementary mathematics, because all his suggestions referring to elementary algebra have already been realised in my book, "Applied Algebra," published in 1900 at St. Petersburg, in Russian.

I send, therefore, two copies of my book, one for the editor, the other for Mr. Marshall. The algebraical characters will permit every mathematician to judge somewhat of the character of a mathematical book without a knowledge of the Russian language. My compatriots have already condemned my heresy; but I hope that my ex-compatriots (our family is of Scottish origin, derived from Lehrmouth) will judge more liberally my attempt to improve the old method of teaching the prolific science of algebra.

The peculiarities of my exposition are explained by the fact that I wished to say all that was needed, and only what was needed. For that purpose it was necessary to put in the first place the systematical exposition of all the most fundamental methods of algebra which are sufficient for ordinary applications, and to postpone to a supplement all complicated questions that are usually combined with fundamental notions in the existing manuals, only producing a confusion in the minds of the pupils.

Before attempting to expound a new section, I endeavour to explain the purpose which this section serves, for as King Solomon stated: "A fool hath no delight in understanding, but that his heart may discover itself." (Prov. xviii. 2.)

In small type I have given many of the explanations that a good teacher requires with his pupils in the class room, but never includes in his printed manual. This peculiarity makes my book useful for self-instruction.

The beginning of all mathematical study is easy. The difficulty begins later, because it is indispensable to know what has already been studied for the understanding of what follows. Therefore my arrangement permits even the youngest pupils to learn something applicable to the practice of calculation.

WALDEMAR LERMANTOFF.

University of St. Petersburg, Russia.

THE NATIVE QUESTION IN SOUTH AFRICA.[1]

IT cannot be too often repeated or too strongly impressed on the public mind of this country that by far the most difficult problem of South Africa is, not that of the relations of the white populations to one another, but that of the relations of the white population to the "Natives," and of the Natives to one another. It involves questions not to be solved by any process of patching. The ordinary "short view" recommended by European statesmen in treating European problems will not do. To deal with these questions effectually, considerations of a far-reaching economic and anthropological character are necessary. We must understand the Native mind, we must endeavour to see things from the Native point of view, we must consider the Native prejudices and aspirations as well as what we, from our point of view, regard as the Natives' best interests, and we must take into account their physiological and mental condition, and the influence upon it of the changes which have begun and the further changes impending.

It is thus evident that, before any final steps can be taken, a full inquiry into these matters must be held. Until the end of the war such an inquiry would be difficult. Consequently, all that can be done at present is to legislate on the most urgent points, so as to obtain a temporary *modus vivendi* on the labour contracts and the liquor laws. This is all that Lord Milner has yet attempted. But his despatches to the Colonial Secretary, and the important memorandum by Sir Godfrey Lagden, comprised in the papers recently presented to Parliament, though relating chiefly to the proclamations on the two subjects just mentioned, disclose the fact that the authorities are not insensible to the wider principles which must underlie our future policy. Lord Milner fully recognises the need of uniformity throughout British South Africa, and looks forward to a Native code to be framed by a Federal Parliament. It is satisfactory to learn from him that "the best colonial sentiment" as to our treatment of the Natives "is not far removed from the best home sentiment, as represented, for instance, by temperate and reasonable advocates of Native rights," such as the authors of "The Natives in South Africa," reviewed in these columns last May. What is wanted is that such sentiment should be controlled and directed by full and accurate information.

The Anthropological Institute and the Folklore Society have already petitioned Mr. Chamberlain to order a full and systematic inquiry into the Native laws and customs in our new colonies at the earliest possible moment. The authors of the book just referred to, whom Lord Milner mentions with so much approval, speak of the want of such an inquiry as "urgent." It is the only satisfactory way to provide the information required for the guidance of public sentiment, and of the administration; and if the example of Cape Colony be of value, it must precede any comprehensive attempt at legislation. The readers of NATURE are primarily interested in its scientific aspect. It is needless to reproduce the arguments they have had before them more than once. Those arguments are reinforced by Lord Milner's protests against some of the statements made on behalf of the Anti-Slavery Society and the Aborigines Protection Society in these papers, and by Sir Godfrey Lagden's admission that "there is much yet to be learnt by those who are vested with the control of Native affairs." And, though there is no allusion to the matter in the despatches now printed, we may be allowed to indulge the hope that it will not be overlooked as soon as the country is sufficiently pacified to enable the Government to arrange for it. Meanwhile, every opportunity should be taken by scientific anthropologists and jurists to bring their views before ministers and members of Parliament.

[1] "Transvaal. Papers relating to Legislation affecting Natives in the Transvaal." Presented to Parliament, January 1902.

THE JUBILEE OF THE AUSTRIAN METEOROLOGICAL CENTRALANSTALT.

TO celebrate the fiftieth year of the existence of the Central Institute for Meteorology and Earth's Magnetism, the Vienna Academy has published a jubilee volume,[1] the contents of which form a very valuable contribution to science and an appropriate publication for this important celebration. This Central Institute, which is now the hub of all the meteorological and magnetic work carried on in the Austrian Empire, came into existence on July 23 in the year 1851, and it was founded with the object, first, of coordinating a number of stations all over the country and making them work on a uniform plan, and, second, of collecting such observations. How well these two objects have been carried out is familiar to every meteorologist of to-day, and so successful an issue of this organisation has been due to the consecutive labours of such directors as Kreil, Jelinek, Hann and Pernter, who have kept the Institute in such an excellent state of efficiency.

In the present volume we are first made acquainted with a brief history of the events which led up to the formation of the Institute, and the progress made during the period of office of each director. This is written in the form of an introductory chapter by the present director, Prof. Pernter. It is interesting to read that in the year 1851 Director Kreil had only forty stations working on a uniform plan carefully prepared by the Institute, but eleven years later he had increased the number nearly threefold. At this early stage there was a great amount of work to be accomplished, and Kreil, among other things, brought out the useful and valuable year book which was considered at the time a "modèle a suivre." The collection of old observations formed an important duty at this period of the Institute's history, and the first few volumes published contained long series of valuable observations made at Wien (1775–1850), Mailand (1763–1850), Prag (1775–1851), Kremsmünster (1763–1851), Salzburg (1842–1851), Udine (1803–1842), Fünfkirchen (1819–1832), Stanislau (1839–1850), and several other stations.

As time went on, the Institute, like many others, began rapidly to accumulate more work than it could accomplish, and this necessitated an increase in the staff and a greater output of publications. By the year 1877, 238 stations were sending in their results, while twenty years later this number had increased to 447; last year the number of first, second and third class stations together was 420.

To come now to the series of valuable articles which form the substance of this large volume, it may, in the

[1] "Denkschriften der kaiserlichen Akademie der Wissenschaften." *Mathematisch-Naturwissenschaftliche Classe*, vol. lxxiii.

first place, be remarked that as these cover no less than 600 pages, only a very brief reference can be made to each of them.

The first contribution, by the distinguished late director of the Institute, Hofrath Julius Hann, is a masterly discussion of the meteorological observations made at the Institute during the years 1852–1900. This paper brings together the monthly and yearly means of each of the meteorological elements during this period, and in two cases—namely temperature and rainfall—the data given extend back to 1775 and 1845 respectively. Such a long series of temperature observations has enabled him to investigate them for secular variations, with the result that he has found the anomalies to conform to a variation having a period of thirty-five years. It may be of interest here to mention that quite recently Hann has shown (*Kais. Akad. d. Wiss.* Jahrg. 1902, No. 1, p. 5) that the rainfalls of Mailand, Padua and Klagenfurt have also a secular variation of thirty-five years, the years of maxima and minima corresponding with Bruckner's epochs.

Next follow two papers relative to the "Föhn." The first is by Dr. Paul Czermack, in which he describes some experiments that serve to illustrate details in the behaviour and appearance of these currents. The second communication, by Dr. Robert Klein, deals with the daily variation of the meteorological elements at Tragoss due to the occurrence of the "Nordföhn," and he finds that all the elements are regularly disturbed by it, and offers an explanation for these variations.

The influence of the "Bora" on the daily period of some of the meteorological elements is discussed by Herr Eduard Mazelle. The observations were made during the years 1886–1895 at the astro-meteorological observatory in Trieste, and the results indicated that the elements changed definitely on these occasions.

A comparatively short paper, by Dr. Victor Conrad, describes the experiments and observations that he has made to investigate the water capacity of clouds and mists. In the first instance he devoted his time to the study of the "aspirationsmethode," producing artificial mists by means of a small boiler. The author then applied this method to natural clouds and mists, making his observations at elevated stations such as Schneeberg, Waxriegel (1884m.), Schafberg (1798m.), and Hohen Sonnblick (3106m.). The results are a distinct advance on earlier determinations, and, in addition, serve to explain some anomalies previously observed by other workers; thus, to take one case, the curve illustrating the relation of the water capacity to the "seeing distance" (in the mist) in metres shows clearly the difficulty of measurement of the water capacity when the seeing distance reaches about 150 metres.

We come now to two papers dealing with the daily variation of the temperatures in Austria and at Vienna (Hohe Warte), by Drs. J. Valentin and Stanislav Kostlivy respectively. Both these communications are exhaustive investigations on these meteorological elements, but even a brief reference to them must be omitted.

Dr. J. Pircher is the author of an important memoir on the hair-hygrometer. He first discusses the hair from the point of view of a hygroscopic substance, and describes in detail the features and peculiarities of different hair-hygrometers. This is next followed by a minute experimental investigation of the hair-hygrometer and its capability of indicating efficiently the phenomena it is intended to record. Comparisons of the hair-hygrometer with the condensation hygrometer of Alluard, with the psychrometer, the aspiration psychrometer of Assman, &c., are then given, concluding with deductions as to the sensitiveness of the hair-hygrometer and the influence of the action of direct sunlight upon it.

Some of the results at which the author has arrived, to put them in a few words, are, that the relative humidity can under all circumstances be measured to within five per cent., but in most cases to three per cent.; that the efficiency of the instrument is considerably decreased if it be allowed to stand for a long period of time in a room of constant humidity, it being pointed out that it is not only advisable, but necessary, to occasionally moisten the hair; and, finally, that temperature (with the exception of direct sunlight) and wind velocity have no effect on the instrument, while no variation was observed in the case of pressure.

A valuable paper by Prof. J. M. Pernter gives the results of some interesting experiments on the polarisation of light in cloudy media and their connection with the present explanation of the blueness of the sky. This investigation was undertaken to answer, if possible, the question whether the light of the sky (Himmelslicht) considered as scattered light of a cloudy medium, and the blue of the sky (Himmelsblau) as the colour of a true medium, could be more easily and, perhaps, also finally answered by the behaviour of light in relation to polarisation than by measurements of the intensity of single colours, since the latter, both with artificial cloudy media and with skylight, are connected with great experimental difficulties. Prof. Pernter used for the media different percentages of liquids coloured in such a way that he could employ all gradations of colour from the finest blue to a tone of milky white. Through these liquids he allowed rays of different colours to pass, and examined them after transmission by means of a polarimeter. In the summary of the results arrived at it will be seen that an important step in advance has been made from the experimental standpoint, and the observed facts are in harmony with the well-known theory of Lord Rayleigh.

The last two papers in the volume, which can here only be referred to by their titles, are written by Drs. Max Margules and Wilhelm Traberto, and are on "The Value of Work (Arbeitswert) of a Pressure Distribution and on the Preservation of Pressure Differences" and "Isotherms of Austria" respectively. In the latter the author has used, whenever possible, the fifty-year means of temperature, and has employed the values obtained from 773 stations in Austria and 142 outlying places; the maps accompanying the paper illustrate the isotherms for the months of January, April, July and October, the isotherms for the whole year, together with four other maps showing the isotherms for special regions.

In bringing this necessarily brief digest of the contents of this important volume to a conclusion, one cannot but call to mind the very valuable service this Central Institute of Meteorology has rendered to meteorological science in general. The numerous voluminous publications which have issued from its doors, and the very able help it has provided and still provides in many directions, are sufficiently well known to indicate the great activity that is displayed in its various departments. The publication of the volume before us is not only a fitting outcome of such labours, but is a worthy tribute to the memory of those who have striven to place the Institute in the first rank, in which it stands to-day.

W. J. S. L.

THE OWENS COLLEGE JUBILEE.

ON March 12, 1851, the Owens College began its existence in a modest house in the centre of Manchester which had formerly been inhabited by Richard Cobden. The College was removed to its present site in Oxford Street in 1873; since that date one addition after another has been made to the buildings, which now cover an irregular area of some 240,000 square feet.

The chemical laboratories have been twice enlarged,

notably in 1895 by the addition of the Schorlemmer laboratory; the engineering laboratory was opened in 1887 and has been greatly enlarged since; the large Beyer biological laboratories and the museum buildings were completed in the same year; the medical school was extended in 1883 and doubled in size in 1894; the Christie library was opened in 1898, the new physical laboratories (on a separate site) in 1900.

The Prince of Wales inaugurated the jubilee ceremonies of the College yesterday by opening the noble Whitworth Hall, which completes the large quadrangle of the College. It will be remembered that the late Sir Joseph Whitworth left the bulk of his fortune to Lady Whitworth, Mr. R. C. Christie and Mr. R. D. Darbishire, with absolute discretion as to the disposal of the money; of this more than 120,000*l.* has been given to Owens College by the legatees, jointly or severally. The late Mr. Christie, himself for many years a professor at Owens, after presenting the College with a beautiful library building from his private purse, gave in 1897 the residue of his share of the Whitworth bequest, amounting to about 50,000*l.*, for the building of a college hall, to be named after Whitworth. This hall, designed like the rest of the main buildings of the College by Messrs. Waterhouse and Son, is in the Gothic style, and is 120 feet long and 50 feet wide. It has a beautiful and elaborate high-pitched oak roof, of which the apex is 56 feet from the floor. The principals are supported on columns of granite. The sides of the hall are of polished stone with a panelling of polished oak. At the north end is an organ (the gift of Mrs. Rylands), encased in a fine screen of carved oak, and on a level with the organ loft, and adjoining it, are galleries for a choir. Immediately in front of the organ is a daïs, a few feet above the level of the floor. The hall is lighted by a series of stained glass windows on either side, and by a great window, in the perpendicular style, at the south end, in which the arms of the founder of the College and its chief benefactors have been inserted. The floor slopes slightly upwards from north to south, and at the extreme end of the hall there is a raised platform so that all can see the north daïs. Two small galleries are placed across the south corners of the hall, each adjoined by a short lateral gallery. The hall itself seats between nine hundred and a thousand persons. It forms the first story of the Whitworth building, of which the basement contains smaller rooms, destined for university offices, &c. There are exits into the museum and library, and also three exits on to Oxford Street and Burlington Street.

The order for the proceedings for the jubilee was as follows:—

Wednesday, March 12, 11.30, commemoration of the foundation of the College and opening of the Whitworth Hall, by H.R.H. the Prince of Wales (accompanied by H.R.H. the Princess of Wales); 2.15, luncheon at the Town Hall by invitation of the Lord Mayor of Manchester, and at the College by invitation of the College authorities; 8.30, reception at the College, by the president, the Duke of Devonshire, K.G., and council.

Thursday, March 13, 11.0, presentation of addresses of congratulation from universities and learned societies in the Whitworth Hall and conferring of honorary degrees by the chancellor of the Victoria University, Earl Spencer, K.G.; 7.30, dinner given by the College to delegates and to the governor and staff of the College.

Representatives from a number of foreign and colonial universities and learned societies arranged to be present, among them being the following:—Foreign universities and societies: Paris, Prof. A. Espinas; Lille, Prof. A. Angellier; Académie des Sciences (Institut de France), Prof. H. Becquerel; Munich, Prof. Hermann Breymann and Prof. K. Goebel; Göttingen, Prof. Walther Nernst; Göttingen (Royal Academy of Sciences), Prof. Voigt; Lund, Mr. Vice-Consul H. Ehrenborg; Geneva, Prof. Chodat; California, Prof. F. Slate; Western Reserve (Ohio), Prof. H. E. Bourne; Zürich Polytechnic, Dr. E. Knecht. Indian, Colonial universities and learned societies: McGill (Montreal), Lord Strathcona, G.C.M.G. (High Commissioner for Canada); Calcutta, Dr. William Booth; Bombay, Sir J. Jardine, K.C.I.E.; Madras, Mr. J. B. Bilderbeck; Cape of Good Hope, Mr. T. E. Fuller (Agent-General for Cape Colony); Adelaide, Prof. Hudson Beare. In addition delegates were sent by the universities of the United Kingdom, university colleges, and most of the learned societies.

It may be mentioned that at the opening of the College among the members of the staff, which consisted of a principal, four other professors and two teachers, were Archibald Sandeman, professor of mathematics; Dr. Edward Frankland, professor of chemistry; and W. C. Williamson, professor of natural history, botany and geology. There were sixty-two students in the first session. The staff now consists of the principal, Dr. Alfred Hopkinson, and thirty-one other professors and eighty lecturers and assistant lecturers; and the College has between a thousand and eleven hundred students in its various departments of arts, science, law and medicine.

NOTES.

WE regret to see the announcement of the death of Prof. Maxwell Simpson, F.R.S., formerly professor of chemistry in Queen's College, Cork, at the age of eighty-seven; and also of Mr. Bryan Donkin, a vice-president of the Institution of Mechanical Engineers, at the age of sixty-seven.

PROF. J. KUEHN, professor of agriculture in the University of Halle, has been elected a correspondant of the Paris Academy of Sciences, in the section of rural economy.

THE Racult memorial lecture of the Chemical Society will be delivered by Prof. van 't Hoff on Wednesday, March 26, in the lecture theatre of the Royal Institution. The annual general meeting of the Society will be held on the afternoon of the same day.

AN interesting Easter excursion to the Gower Peninsula, South Wales, has been arranged by the Geologists' Association. The party will leave London on Thursday, March 27, and will return on Wednesday, April 2. The district is rich in fine rock scenery, instructive exposures and cliff sections, and splendid views, so that those who are able to take part in the excursion may be assured of a pleasant holiday.

THE Paris Natural History Museum celebrated on Sunday last the fiftieth anniversary of the publication of the first scientific memoirs of one of the most distinguished members of its staff, M. Albert Gaudry. He was honoured, says the Paris correspondent of the *Times*, as one of the most eminent evolutionists in France, in many respects a precursor of Darwin. It is he, in the words of M. Edmond Perrier, the director of the museum, who has virtually emancipated palæontology from the swaddling clothes in which its mother science, comparative anatomy, had endeavoured so long to keep it.

PROF. MELDOLA'S address on the coming of age of the Essex Field Club, which will be given at the twenty-second annual meeting, to be held in the Essex Museum, Stratford, on Saturday, March 22, should be worth the attention of those interested in naturalists' societies or desiring to encourage their efforts. A carefully digested record of the *local* scientific work carried on by the

Club and its members will be of great value. Since its foundation in 1880, the Society has published about 5000 pages of matter, three-fourths of which relates to the natural history, in the widest sense, of the county of Essex, and much of it is wholly original in character. Any reader desiring to attend the meeting should communicate with the hon. secretary, Mr. W. Cole, Buckhurst Hill, Essex.

A MEETING of the American Philosophical Society will be held at Philadelphia on April 3–5. Among the subjects of papers included in the preliminary programme are :—The International Catalogue of Scientific Literature, Dr. Cyrus Adler; recent progress in the lunar theory, Prof. E. W. Brown, F.R.S.; systematic geography, Prof. W. M. Davis; results of observation with the zenith telescope at the Sayre Observatory, Prof. C. L. Doolittle; the advancement of knowledge by the aid of the Carnegie Institution, President D. C. Gilman; the continuity of protoplasm, Prof. H. Kraemer; further experiments on the physiological action of ions, Dr. Jacques Loeb; wireless telegraphy, Mr. Guglielmo Marconi (if in America); distribution of fresh water decapods and its bearing upon ancient geography, Dr. Arnold E. Ortmann; evolution and distribution of the Proboscidea in America, Prof. H. F. Osborn; the relation of the American University to science, President H. S. Pritchett; South American mammals, Prof. W. B. Scott; historical investigation of the supposed changes in the colour of Sirius since the epoch of the Greeks and Romans, Dr. T. J. J. See; and biological heredity and organic evolution, Prof. Giuseppe Sergi.

THE ninth meeting of the Australasian Association for the Advancement of Science was held at Hobart on January 8–16, under the presidency of Captain F. W. Hutton, F.R.S., whose address on evolution and its teaching was abridged in last week's NATURE. The presidents of the sections and the subjects of their addresses were as follows :—Mr. R. W. Chapman (astronomy, mathematics, physics and mechanics), tidal theory and its application; Prof. A. M. A. Mica-Smith (chemistry and mineralogy), the study of the chemistry of the air, and whither it has led; Prof. T. S. Hall (geology and palæontology), the possibility of detailed correlation of Australian formations with those of the mother hemisphere; Prof. W. B. Benham (biology), earthworms and palæo-geography; Rev. Geo. Brown (geography), the Pacific, east and west; Mr. T. A. Coghlan (economic and social science and statistics), the statistical question; Dr. W. E. Roth (ethnology and anthropology), on the games, sports and amusements of the North Queensland aboriginals; Sir T. Fitzgerald (sanitary science and hygiene), the nature of diseases; Prof. A. Wall (mental science and education), poetry as a factor in education; Mr. P. Oakden (architecture and engineering), no title announced. Many papers were read in each of the sections, and from the titles in the official programme we judge that a large proportion was of wide scientific interest. The handbook prepared for the use of the members contains a short historical sketch of Tasmania, and essays on the natural history of the country. These signs of scientific activity at the antipodes are of interest to those who regard contributions to natural knowledge as essential to the development of national character and progress.

PROF. W. R. DUNSTAN, F.R.S., director of the scientific department of the Imperial Institute, presided on March 4 at the first of a series of six lectures and demonstrations which are being given at the Institute by Mr. R. Hedger Wallace, formerly of the Victorian Agricultural Department, on "The Commercial Products and Agricultural Resources of the Crown Colonies." In his introductory remarks, the chairman explained the object of the course. The Imperial Institute contains magnificent collections of products, illustrative of the natural resources of the colonies, and it is hoped that by lectures and demonstrations such as these the interest and utility of the collections to the general public will be much increased. Following each lecture, Mr. Wallace will give a demonstration in the particular court containing the products of the colony described. A large and increasing number of schools throughout the United Kingdom have applied to the Imperial Institute for small collections of various colonial products, and it is therefore hoped that this course will attract both teachers and pupils. Mr. Wallace began by directing attention to the fact that the value of the imports and exports of Great Britain last year was 522,000,000*l.* and 280,000,000*l.* respectively. It is a matter of importance, therefore, to ascertain whether this adverse balance of 242,000,000*l.* passes to the British planter and manufacturer, and remains within the Empire, or goes to foreign countries. Hence also the desirability of ascertaining what can most profitably be grown in our various colonies. From this point of view England has much to learn from Germany. That country has recently sent out scientific experts to report on the natural resources of its colonies and to ascertain by practical experiment how capital can be most profitably invested. In England, on the other hand, this matter is left largely to private enterprise.

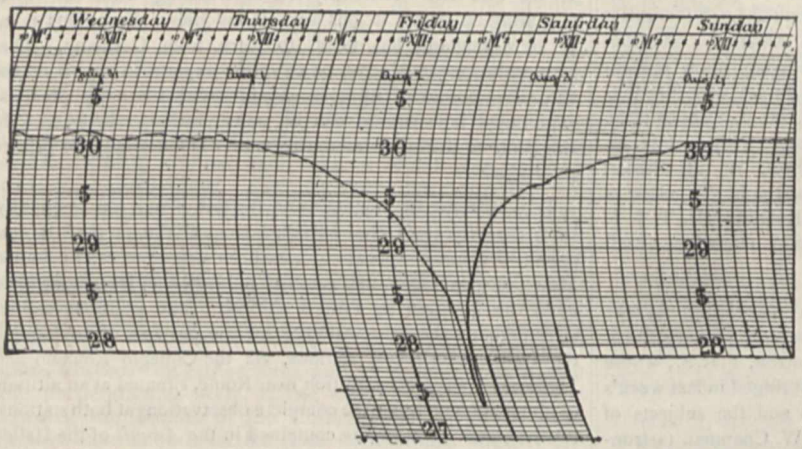
THE influence of mountains on the fall of hail has frequently been the subject of controversy, but up to the present time no certain conclusion appears to have been arrived at. The Italian Meteorological Office has recently published an interesting note upon the question by Prof. V. Monti. The positions chosen were perhaps the most suitable for the purpose of any among the Italian network of stations, viz. the Collegio Romano and Montecavo, an isolated station near Rome, situated at an altitude of about 1000 metres; the complete observations at both stations, for the years 1880–87, are contained in the *Annals* of the Italian Meteorological Office. During this period, forty-one days of hail were recorded at Rome against eighty at Montecavo; the monthly values show two maxima, in April and October, and two minima, in July and December, as regards the excess of days of hail at the mountain station. A comparison of days of thunderstorm shows, on the other hand, that there were 176 such storms at Rome, against 129 at Montecavo. This seems to show that the excess of hail at the mountain station is not attributable to a greater intensity of atmospheric electricity. The author gives a table showing that the monthly mean temperature at Rome is at times about 10° higher than at Montecavo, and suggests that the fusion of the hail in traversing a warmer stratum of air may to some extent account for the smaller amount at the lower station.

PROF. TINE TAMMES describes in the *Zeitschrift für wissenschaftliche Mikroskopie*, xviii. p. 280, a convenient form of electrical lamp for use with the microscope, which has been introduced into the Botanical Laboratory at Groningen. The lamp itself is an incandescent lamp of about 4 cm. diameter, and is enclosed in an iron box the weight of which adds to its steadiness. This box is open at the front and back, the back opening letting out the heat while the front opening is furnished with grooves for inserting glass plates. The front plate is of ground glass, specially chosen for its low absorbing power and absence of coarse grain, and this gives a uniformly bright area as source of illumination. Behind this is a screen of cobalt or other coloured glass for absorbing the superfluous yellow rays.

A PAPER on the metallography or photomicrography of iron and steel is communicated to the *Journal* of the Royal Microscopical Society for February by Mr. William H. Merrett.

The subject is one of recent development, and among other workers the names of Dr. Sorby, Profs. Marten and Wedding, and M. Osmond, of Paris, are mentioned. The paper deals with the analogy between the transformations occurring in steel and in frozen saline solutions, taking as illustrations Sir W. C. Roberts-Austen's diagrams of equilibrium curves. The methods of preparing and polishing steel for opaque examination are described, including Prof. Le Chatelier's method of obtaining sufficiently fine polishing powders. The paper is illustrated by several photographs of the different constituents of iron and steel under a magnification of 850 diameters. Although metallography was originally of scientific interest only, it has now become of the greatest commercial importance.

A VERY remarkable barograph trace obtained during a typhoon on August 2-3, 1901, is given in the *Quarterly Journal* of the Royal Meteorological Society (January), and is here reproduced



Barograph trace during typhoon, August 2-3, 1901.

with the permission of the Society. The barograph was on the steamer *Laisang*, which encountered the typhoon somewhere to the northward of the Formosa Channel, in about lat. 25° N., long. 122° E. or thereabouts. The fall and rise of the barometer were most rapid, the range being no less than two inches in eight hours. The chart shows the minimum reading to have been as low as 27·35 in. at 9 p.m. on August 2. Such a low barometer reading is said in the note from which these particulars are derived to have been rarely recorded. It was, however, exceeded on the following occasions:—27·33 in., February 5, 1870, on board H.M.S. *Tarifa*, 500 miles west of Ireland. 27·332 in., January 26, 1884, Ochtertyre, near Crieff, Scotland (*Quarterly Journal* Royal Meteorological Society, vol. x. p. 114). 27·135 in., September 22, 1885, False Point, Orissa, India (NATURE, vol. xxxv. p. 344). 27·38 in., December 8, 1886, Belfast; probably about 27·28 in. over the north of Ireland (*Quarterly Journal* Royal Meteorological Society, vol. xiii. p. 211).

IN the *Irish Naturalist* for March, Dr. R. F. Scharff records the stranding in Dublin Bay of a specimen of the white-beaked dolphin (*Lagenorhynchus albirostris*). The specimen, which is a male, seems of unusually large size, measuring 12 feet in length, the species being stated in text-books not to exceed 9 feet.

STUDENTS of "distribution" will be interested in a paper by Dr. D. Sharp on Oriental beetles which appears in the March number of the *Entomologists' Monthly Magazine*. The author states that in the group Limnichini—the members of which are remarkable for their death-feigning instinct—he finds a remarkable similarity between the Central American and Oriental forms, amounting in one instance to generic identity.

WE have received the second number of the *Nature-Study Journal*, published by the South-Eastern Agricultural College, Wye, Kent. It contains a description of a country walk through a fossiliferous district in autumn, in which attention is directed to the objects of natural history met with, and also samples of "nature-lessons" for children. The editor asks for outlines of a series of lessons suitable for the same purpose.

IN their eleventh annual report, the Society for the Protection of Birds record an increase in the number of their associates, although they have to deplore a falling-off in subscriptions. With the aid of the Royal Society for the Prevention of Cruelty to Animals, the Society has succeeded in obtaining several convictions during the past year, one of the most satisfactory being in the case of a gamekeeper charged with shooting two of the bustards introduced by Lord Walsingham into Norfolk. Some—although not a great—effect appears to have been made upon the plume-trade by the efforts of the Society; but the recent fashion for the skins of entire terns and the wings of gulls as decorations for ladies' hats is a cause for much regret. So great is the demand for these objects that in Yorkshire alone a single dealer is stated to have contracted to supply 10,000 skins to a London firm. The subject of the Society's second essay competition was "the best means of introducing Bird and Arbor Day into England"; and now that the prizes have been awarded, the Society is hopeful that Coronation year may mark the institution of such a day in all the schools of the country.

THE accompanying diffraction effect is reproduced from a plate contributed by Prof. W. S. Franklin to the January number of the *Physical Review*, and represents one of a number of photographs of shadows cast upon a photographic plate from a monochromatic point of light distant about sixteen metres from the plate. The objects casting the shadows were about three metres from the plate, which was in each case at right angles to the incident light. The

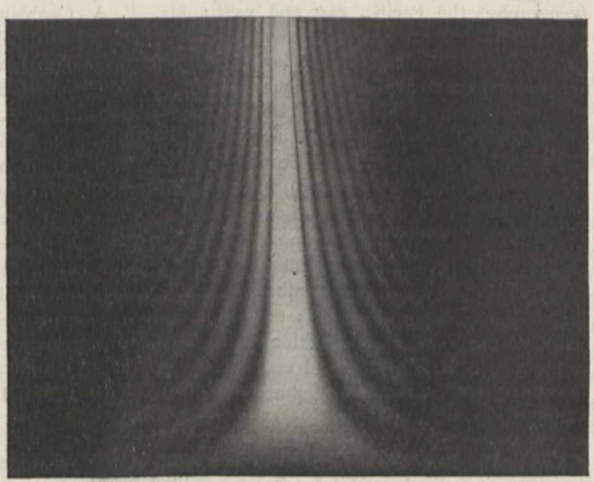


FIG. 1.—Diffraction Shadows of a Tapering Slit.

photograph here reproduced shows the shadow of a slit between very carefully worked edges of brass. The slit was about fifteen centimetres in length, tapering from a width of 0·05 centimetre at one end to nearly zero at the other.

IN a recent issue of the *Actes* of the Scientific Society of Chili (vol. xi. part 3), Señor F. Albert publishes an account of the different species of seals frequenting the coasts of that country, together with a summary of the legislation for their protection. It is satisfactory to learn that the Government are fully alive to the necessity for such protection and are doing all they can to see that the various enactments are duly carried out. The regulations forbid any but Chilian subjects to shoot seals or otters at all, while they establish a close time lasting from the beginning of November till the end of February.

TO shake about 200,000 peach trees and 50,000 plum trees for the purpose of dislodging injurious insects is a formidable task, yet it was successfully accomplished several times between April 18 and June 1, 1901, by the Hale Georgia Orchard Company at Fort Valley, Georgia, U.S.A. The insect against which this action was taken was the curculio beetle. The San Jose scale, so prevalent in south Georgia, is thoroughly controlled by the kerosene-water treatment, the beach-tree borer is held in abeyance by the cutting-out method, and the brown rot is fairly well controlled by the Bordeaux treatment, but the curculio baffles all contrivances for its destruction except the

Gang at work catching beetles shaken off fruit trees in Georgia.

tedious method of shaking the trees on which they occur and catching the beetles as they fall. The accompanying illustration from a paper by Messrs. W. M. Scott and W. F. Fiske, in the *Proceedings* of the thirteenth annual meeting of the Association of Economic Entomologists, shows a gang at work catching beetles on sheets stretched upon frames, as they are shaken off the trees. With eleven pairs of sheets, about 40,000 trees were treated in the course of a day. About 137,000 of the beetles were caught and killed during the season, and as a large proportion must have been females capable of depositing eggs, an immense amount of damage was prevented by the work.

TO Mr. O. Voges, of Buenos Ayres, is due the credit of having discovered the smallest bacillus which has yet been identified. It is much smaller than the influenza bacillus, and is only just discernible when magnified about 1500 times. These very minute rods were obtained from abscesses which cattle suffer from in South America, producing a disease known as manquea amongst other names. It is usually found in quite young cattle, and is easily recognisable by the characteristic lameness of one leg which it produces. The bacillus is an anærobe, and produces in artificial cultures the same highly offensive odour which is associated with it in the abscess. Mice, rats and rabbits are quite immune to its action, but guinea-pigs succumb in from 24–48 hours, and the bacilli are found in the heart's blood and all internal organs. Inasmuch as the action of such well-known anærobic pathogenic bacteria as those of tetanus and symptomatic anthrax is due to their toxic products, filtrates of liquid cultures of this bacillus were tested for their toxicity, but even guinea-pigs did not react to such injections, and therefore Voges concludes that the pathogenic action is due to the bacilli themselves and not to their products. An interesting fact noted by Voges is that the animals he inoculated only succumbed when the weather was hot; not once in the winter could he successfully infect one animal. This is also true of the disease in its ordinary course, as the hotter the climate the more fatal are the results. If the abscess is opened in its early stages the disease is arrested and the animal recovers. This simple remedy is recommended by Voges.

THE fourth and concluding number of the second volume of the *West Indian Bulletin* contains several interesting articles. One on the Jamaica fruit trade is a reprint of an account given by a special correspondent in the *Times*, and deals mainly with the successful inauguration of the shipping of bananas to England last year. Mr. A. R. Gilzean contributes a sketch of the history of rice-growing in British Guiana. As a very large proportion of the population of the country is composed of East Indian coolies well acquainted with rice cultivation, there can be no doubt that in time rice will become an important article of commerce, the local conditions being described as ideal. An account is given of recent experiments with sweet potatoes, the cultivation of different varieties in various islands, methods of storage, preparation of meal, &c. Sweet potatoes form a staple food in the islands, and the Imperial Department of Agriculture is endeavouring to induce English people to cultivate a taste for the vegetable by sending fortnightly supplies to London, printed information being given to purchasers as to fifteen different ways of preparing for table. Mr. Maxwell-Lefroy has a lengthy article on suggestions for insect control in the West Indies. He proposes five principal ways of attacking the problems—measures to prevent the introduction of new diseases (such as quarantine or the regulation of plant importation); the adoption of preventive measures; also of remedial measures; the encouragement of useful native birds and other organisms; and the introduction of new insectivorous birds, insects, &c., and the regulation of the importation of new animals. Other papers relate to bee-keeping, "thrips" and "witch-broom" diseases on cacao, methods for destroying land crabs, treatment of imported plants at Jamaica, citrate of lime and concentrated lime juice, &c. The number includes the index to the volume.

THERE are several indications in various islands of the Indo-Pacific region that the fact of being tattooed is thought to be beneficial when the soul passes into the next world. The last example of this belief is an account in *Globus* (Bd. lxxxi. p. 46), by Prof. G. Thilenius, of the tattooing of women in the Laughlan Islands, or Nada, a small group of islands east of the southern end of New Guinea. A considerable surface of the women is tattooed with angled designs, but concentric circles are tattooed on the legs. The belief is that between the Laughlan Islands and the island of Vatum in the Trobriand group, to which their souls should go, there is a great snake over which they must pass. The snake asks each soul for her tattooing. The soul takes off her tattooing and gives it to the snake, who covers itself with it. The snake then becomes broad and flat and the soul passes over, as on a bridge. If the soul is not tattooed the snake shrinks, becomes very narrow, and the soul falls into the sea and cannot reach Vatum. These wretched souls become fish.

PROF. A. TARENETSKY, in an elaborate work, "Beiträge zur Skelet und Schaedelkunde der Aleuten, Konaegen, Kena

und Koljuschen, mit vergleichend anthropologischen Bemerkungen," published by the Russian Academy of Sciences, has come to very interesting conclusions concerning the still problematic origin of these hyperboreans. His researches are based upon thirty-five skulls and two complete Aleutian skeletons of the museum of the Academy, skulls of other East Asian natives, borrowed from the Medical Academy Museum, having been used for comparison. The conclusions of the author are as follows:—The Aleute skulls represent a strongly pronounced type and offer few traces of mixture with other tribes; notwithstanding some secondary differences, the skulls of both the western and the eastern Aleutes are similar to each other. As to the Konyag skulls, although they mostly are artificially deformed, they are nevertheless very similar to those of the American Indians on the one side and to those of the Aleutes on the other side. They also sharply differ from the skulls of both the western and the eastern Eskimos. Between the Kenais and the Koloshes there is no difference as regards their skulls, which are very near to the skulls of the Aleutes and the Konyags, representing the same type, which is only slightly altered with the Konyags by artificial deformation and by admixture of foreign blood. Consequently, the author makes the supposition that all the four stems have a common origin and are descendants of an Indian stem which belonged, not to the Eskimos, but to the American Red Indians. As to the skeletons of the Aleutes, they are very typical, especially on account of the structure of the very long extremities, and these peculiarities are not known in skeletons of other tribes. Only a few bones, unearthed a couple of years ago in Mongolia and belonging to some probably Turkish stem, offered some likeness with the Aleute skeletons. This find induces the author to believe that the populations of north-west America and Asia may have had a common origin, as they communicated across the Bering Strait. Only part of the Aleute and Konyag skulls had been described by Baer, the remainder being now described for the first time.

DR. T. K. ROSE'S treatise on "The Metallurgy of Gold," the fourth edition of which has just been published by Messrs. C. Griffin and Co., provides students of metallurgy and managers of gold mines and smelting works with a concise and valuable statement of the existing conditions of the industry in which they are interested. As an Associate of the Royal School of Mines, Dr. Rose has been able to obtain particulars of practical developments of the metallurgy of gold in many parts of the world. His book has been revised and extended in order to keep it in touch with recent progress, and the changes will enable it to retain its position as a standard work on the subject with which it deals.

THE Hampstead Scientific Society appears to be in a flourishing condition, judging from the Report for 1901, just received. Among the subjects of lectures delivered before the Society during the session covered by the report are curious fish, lodestone lore, a glimpse at the work of Lord Kelvin, the amœba and its allies, the form of the earth, and the human eye. There is an astronomical section; and, as the Society possesses a telescope, observations can be made of celestial objects discussed at the class meetings. The natural history section has in preparation an account of the fauna and flora of Hampstead and its neighbourhood, which it is hoped will be sufficiently advanced for the first part to appear in the autumn of this year. The report points out that a natural history museum would greatly add to the scientific welfare of Hampstead; so that support should be given to the Hampstead Borough Council's scheme for a public museum and art gallery.

SOME time since, MM. Sabatier and Senderens discovered that metallic nickel, reduced from its oxide at as low a temperature as possible, possessed extraordinary catalytic power with regard to the addition of hydrogen, and from time to time they have published numerous syntheses carried out in this way. In the current number of the *Comptes rendus* is given an extremely elegant synthesis of methane based upon the same reaction. It was found that if either carbon monoxide or dioxide mixed with a slight excess of hydrogen is passed over reduced nickel at temperatures between 250° and 300° C., the oxide is reduced and methane is quantatitively produced. In spite of the fundamental importance of the synthesis of methane in organic chemistry, none of the syntheses realised up to the present are of sufficient simplicity and directness to be realised on the lecture table. The new method allows of the preparation of methane from its elements in two steps only, and will doubtless take its place as a standard lecture experiment.

THE additions to the Zoological Society's Gardens during the past week include two Martinican Doves (*Zenaida aurita*), a White-winged Zenaida Dove (*Melopelia leucoptera*) from the West Indies, presented by Mr. D. Seth Smith; a Black-backed Piping Crow (*Gymnorhina tibicen*) from Australia, presented by Mrs. J. Rose; three Derbian Zonures (*Zonurus giganteus*) from South Africa, presented by Captain H. M. Tristram, 12th Lancers; a Slow Loris (*Nycticebus tardigradus*) from Borneo, four Derbian Zonures (*Zonurus giganteus*) from South Africa, six Dark-green Snakes (*Zamenis gemonensis*) European, deposited; a Panda (*Ælurus fulgens*) from Nepal, a Green Bittern (*Butorides virescens*) from America, purchased.

OUR ASTRONOMICAL COLUMN.

NEW ANNUAL TERM IN THE VARIATION OF LATITUDE.—In the *Astronomical Journal*, vol. xxii. pp. 107-108, Prof. H. Kimura announces that from a detailed examination of the observations taken for variation of latitude he has detected a periodicity in the residuals obtained, which appears to indicate the existence of a hitherto unrecognised annual component. Most of the observations were collected in Prof. Albrecht's report in the *Astronomische Nachrichten*, No. 3734. The maximum amplitude of the new term is about 0″·03. At present it is impossible to examine the dependence of this element on geographical position, as the materials have been combined from all stations between $\phi = 60°$ N. and $\phi = 21°$ N., and the term as found would correspond to a mean latitude 42° N. A future series of observations in different parallels will possibly settle if the new component is a function of the latitude. From the variation curve it appears that the new term has zero values at 0·33 and 0·85, maximum at 0·0 and minimum at 0·57; a noticeable feature of this is that the zeroes lie near the equinoxes, the maxima and minima near the solstices.

OBSERVATIONS OF JUPITER.

JUPITER is now conspicuously visible as a morning star. During the ensuing spring and summer, observers of this planet will have some interesting features to reexamine, though his position, about 19 degrees south of the equator, cannot be regarded as favouring telescopic study. At the time of opposition on August 5 next he will, however, be placed 5 degrees further north than last year, and this will make a sufficient difference in his altitude to improve markedly the general definition of the markings. During the seven months from May to November, 1901, the writer, with a 10-inch reflecting telescope, secured observations of Jupiter on 76 nights, but the image was usually very indistinct and unsteady, and it was only on two or three occasions that the disc was sufficiently sharp to present the more delicate features satisfactorily.

This planet is always interesting from the large number and frequently conspicuous character of the details shown on his surface. These details consist of spots or patches of various tints, forms and sizes situated either on the dusky belts or on the alternating bright zones. The proper motions which affect these markings and displace their relative positions from day to day furnish a mass of material for prolonged study, while the oft-recurring and sometimes rapid changes taking place in their visible aspect provide an attractive field for the draughtsman.

During the present year, observational research in reference to this object is likely to prove of an unusually interesting character, as there are several features which deserve (and will doubtless receive) special attention. During 1901, the red spot exhibited a singular acceleration of motion when compared with its rate in previous years, for it maintained a longitude of 45°, consistently with a rotation period of 9h. 55m. 40s.·6, upon which system II. of Mr. Crommelin's ephemerides is based. It will therefore be most important to trace the position of the spot in ensuing months, as it seems probable that this curiously durable marking, after a constantly increasing retardation between about 1878 and 1900 which augmented its rotation period from 9h. 55m. 34s.·5 to 9h. 55m. 41s.·8, will now travel with greater celerity and give a period becoming shorter with the time until the minimum is reached. If these oscillations in velocity are developed at regular intervals, it will soon be possible to determine the length of the cycle for observations of the red spot or of the hollow in the great southern belt date from 1831. There is some significant evidence in support of the conjecture that the motion of certain markings as well as the apparition of particular spots in various latitudes are recurrent on the planet, and some of the reappearances appear to take place at periods not differing materially from the time of Jupiter's revolution round the sun. The red spot may be looked for near mid-transit on March 13 at 18h. 7m., on March 25 at 18h. 4m., on March 30 at 17h. 13m., on April 6 at 18h. 0m., and on April 11 at 17h. 9m.

Observers should now endeavour to redetect the rapidly moving dark spots which appeared in the north temperate belt of Jupiter in 1880 and 1891. There were a number of spots visible in this latitude in 1901, but the writer found their mean rate of rotation 9h. 55m. 50s. This is nearly 8 minutes in excess of the rotation period found for certain irregular markings in approximately the same latitude in the autumn of 1880 which gave a rate of 9h. 48m. It is a very singular circumstance that in a similar latitude of Jupiter spots are developed showing respectively the shortest and longest rotation periods of any which have ever been observed.

In 1901, a large dark spot was often seen in the south or tropical [1] zone of the planet, and this may prove a repetition of the object observed in the same latitude in 1889–91. This spot exhibits a rotation period of 9h. 55m. 18s.·5, and its more rapid movement will enable it to overtake the red spot in about June, 1902, should both the markings remain visible until that month. The longitude of the south temperate or tropical spot will be as follows during the next three months, and it will follow the red spot at the time-intervals stated if the latter object retains the same longitude (=45°) as in 1901 :—

1902	Longitude	Follows Red spot. h.	m.
March 17	110·5	1	48
April 17	94·1	1	21
May 17	77·7	0	54

The writer obtained an observation of this marking on February 27, when it appeared to be central at 18h. 40m., which would make its longitude 123°·8, but it was very imperfectly seen. The instrument used was a 4-inch Cooke refractor, power 175.

Another important feature for reobservation in 1902 will be the white and dark spots plentifully grouped along the equatorial region of the planet. In the three years 1898, 1899 and 1900, the rotation period of the equatorial current differed very little, the mean value from a large number of spots being 9h. 50m. 24s., or 5m. 17s.·7 less than the rate of the red spot. But in 1901 the mean rotation period of 28 equatorial spots observed at Bristol was 9h. 50m. 29s., or 5m. 12s. less than that of the red spot.

When further observations of these variations have been pursued during many oppositions, the outcome may be both interesting and important as affording a good clue to the physical condition and phenomena of the planet. That great atmospheric changes are in progress on the disc is evident, and it is the facility with which they may be observed and compared which renders this object a singularly attractive one to the possessors of telescopes. W. F. DENNING.

[1] This interesting marking exhibited a motion coinciding with that of objects placed in the planet's south temperate zone, though its position encroached on the south tropical as well as the south temperate region.

MAGIC SQUARES AND OTHER PROBLEMS UPON A CHESS-BOARD.[1]

THE construction of magic squares is an amusement of great antiquity; we hear of them being constructed in India and in China before the Christian era, whilst they appear to have been introduced into Europe by Moschopulus, who flourished at Constantinople early in the fifteenth century. On the diagram you see a simple example of a magic square, one celebrated as being drawn by Albert Dürer in his picture of "Melancholy," painted about the year 1500 (Fig. 1). It is one of the fourth order, involving 16 compartments or cells. In describing such squares, the horizontal lines of cells are called "rows," the vertical lines "columns," and the oblique lines going from corner to corner

1	15	14	4
12	6	7	9
8	10	11	5
13	3	2	16

FIG. 1.

"diagonals." In the 16 compartments are placed the first 16 numbers, 1, 2, 3, . . . 16, and the magic property consists in this, that the numbers are placed in such wise that the sum of the numbers in every row, column and diagonal is the same, viz., in this case, 34.

It is probable that magic squares were so called because the properties they possessed seemed to be extraordinary and wonderful; they were, indeed, regarded with superstitious reverence and employed as talismans. Cornelius Agrippa constructed magic squares of orders 3, 4, 5, 6, 7, 8, 9, and associated them with the seven heavenly bodies, Saturn, Jupiter, Mars, the Sun, Venus, Mercury and the Moon. A magic square engraved on a silver plate was regarded as a charm against the plague, and to this day such charms are worn in the east.

However, what was at first merely a practice of magicians and talisman makers has now for a long time become a serious

17	24	1	8	15
23	5	7	14	16
4	6	13	20	22
10	12	19	21	3
11	18	25	2	9

FIG. 2.

study for mathematicians. Not that they have imagined that it would lead them to anything of solid advantage, but because the theory of such squares was seen to be fraught with difficulty, and it was considered possible that some new properties of numbers might be discovered which mathematicians could turn to account. This has, in fact, proved to be the case; for from a certain point of view the subject has been found to be algebraical rather than arithmetical, and to be intimately connected with great departments of science, such as the "infinitesimal calculus," "the calculus of operations" and the "theory of groups."

In the next diagram (Fig. 2) I show you a magic square of order 5, the sum of the numbers in each row, column and

[1] A discourse delivered at the Royal Institution on Friday evening, February 14, by Major P. A. MacMahon, F.R.S.

diagonal being 65. This number 65 is obtained by multiplying 25, the number of cells, by the next higher number, 26, and then dividing by twice the order of the square, viz., 10. A similar rule applies in the case of a magic square of any order. The formation of these squares has a fascination for many persons, and, as a consequence, a large amount of ingenuity has been expended in forming particular examples and in discovering general principles of formation. As an example of the amount of labour that some have expended on this matter, it may be mentioned that in 1693 Frénicle, a Frenchman, published a work of more than 500 pages upon magic squares. In this work he showed that 880 magic squares of the fourth order could be constructed, and in an appendix he gave the actual diagrams of the whole of them. The number of magic squares of the order 5 has not been exactly determined, but it has been shown that the number certainly exceeds 60,000.

As a consequence it is not very difficult to compose particular specimens, and, for the most part, the fascinated individuals, to whom I have alluded, have devoted their energies to the discovery of principles of formation. Of such principles I will give a few, remarking that the cases of squares of uneven order 1, 3, 5 . . . are more simple than those of even order 4, 6, . . . and that no magic square of order 2 exists at all. The simplest of all methods for an uneven order is shown in the diagram (Fig. 3), where certain additional cells are added to the square, the numbers written as shown in natural order diagonally, and then the numbers which are outside the square

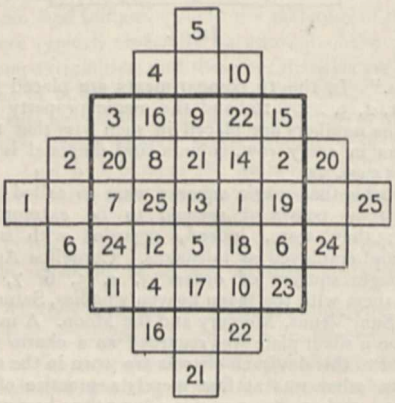


FIG. 3.

projected into the empty compartments according to an easily understood law. The second method is associated with the name of De la Loubère, though it is stated that he learnt it during a visit to Siam in 1687. The number 1 (see Fig. 2) is placed in the middle cell of the top row, and the successive numbers placed in their natural order in a diagonal line sloping upwards to the right subject to the laws :—

(1) When the top row is reached, the next number is written at the bottom of the next column.

(2) When the right-hand column is reached, the next number is written on the left of the row above.

(3) When it is impossible to proceed according to the above rules, the number is placed in the cell immediately below the last number written.

If we commence by writing the number 1 in any cell except that above indicated, a square is reached which is magic in regard to rows and columns, but not in regard to diagonals.

Subsequent writers have shown that starting with the left-hand bottom cell and using the move of the knight instead of that of the bishop, the general principle of De la Loubère will also lead to a magic square (Fig. 4). The next method is that of De la Hire, and dates from 1705. Two subsidiary squares are constructed as shown, the one involving five numbers 1, 2, 3, 4, 5, and the other five numbers 0, 5, 10, 15, 20. When these squares are properly formed and a third square constructed by adding together the numbers in corresponding cells, this third square is magic (Fig. 5). Time does not permit me to enter into the exact method of forming the subsidiary squares, and I will merely mention that each of them possesses a particular property, viz., only five different numbers are involved, and all five appear in each column and in each row ; in other words, no row and no column contains two numbers of the same kind, but no diagonal property is necessarily involved. Such squares are of a great scientific importance, and have been termed by Euler and subsequent writers "Latin squares," for a reason that will presently appear. From a scientific point of view, the chief interest of all arrangements such as I consider this evening lies, not in their actual formation, but in the enumeration of all possible ways of forming them, and in this respect very little has been hitherto

7	20	3	11	24
13	21	9	17	5
19	2	15	23	6
25	8	16	4	12
1	14	22	10	18

FIG. 4.

achieved by mathematicians. No person living knows in how many ways it is possible to form a magic square of any order exceeding 4. The fact is, that before we can attempt to enumerate magic squares we must see our way to solve problems of a far more simple character. For example, before we can enumerate the squares that can be formed by De la Hire's method we must take a first step by finding out how many Latin squares can be formed of the different orders. For the order 5 the question is, "In how many ways can five different objects be placed in the cells so that each column and each

3	4	1	5	2
2	3	4	1	5
5	2	3	4	1
1	5	2	3	4
4	1	5	2	3

15	0	20	5	10
0	20	5	10	15
20	5	10	15	0
5	10	15	0	20
10	15	0	20	5

18	4	21	10	12
2	23	9	11	20
25	7	13	19	1
6	15	17	3	24
14	16	5	22	8

FIG. 5.

row contains each object?" It may occur to some here this evening that such a discussion might be interesting or curious, but could not possibly be of any scientific value. But such is not the case. A department of mathematics that is universally acknowledged to be of fundamental importance is the "theory of groups." Operations of this theory and those connected with logical and other algebras possess what is termed a "multiplication table," which denotes the laws to which the operations are subject. In Fig. 6 you see such a table of order 6 slightly modified from Burnside's "Treatise on the Theory of Groups"; it is, as you see, a Latin square, and the chief problem that awaits solution is the enumeration of such tables ; the

questions are not parallel because *all* Latin squares do not give rise to tables in the theory of groups; but still, we must walk before we can run, and a step in the right direction is the enumeration of *all* Latin squares. When I call to mind that the theory of groups has an important bearing upon many branches of physical science, notably upon dynamics, I consider that I have made good my point.

I now concentrate attention on these Latin squares, and observe that the theory of the enumeration has nothing to do with the particular numbers that occupy the compartments; the only essential is that the numbers shall be different one from another. My attention was first called to the subject of the Latin square by a work of the renowned mathematician Euler, written in 1782, entitled "Recherches sur une nouvelle espèce de Quarrés Magiques." I may say that Euler seems to have been the first to grasp the necessity of considering squares possessing what may be termed a magical property of a far less recondite character than that possessed by the magic squares of the ancients, and, as we shall see presently, he might have gone a

I	A	B	C	D	E
A	B	I	D	E	C
B	I	A	E	C	D
C	E	D	I	B	A
D	C	E	A	I	B
E	D	C	B	A	I

FIG. 6.

step further in the same direction with advantage and have commenced with arrangements of a more simple character than that of the Latin square, with arrangements, in fact, which present no difficulties of enumeration, but which supply the key to the unlocking of the secrets of which we are in search. He commences by remarking that a curious problem had been exercising the wits of many persons. He describes it as follows:—There

$a\alpha$	$a\beta$	$a\gamma$	$a\delta$	$a\varepsilon$	$a\theta$
$b\alpha$	$b\beta$	$b\gamma$	$b\delta$	$b\varepsilon$	$b\theta$
$c\alpha$	$c\beta$	$c\gamma$	$c\delta$	$c\varepsilon$	$c\theta$
$d\alpha$	$d\beta$	$d\gamma$	$d\delta$	$d\varepsilon$	$d\theta$
$e\alpha$	$e\beta$	$e\gamma$	$e\delta$	$e\varepsilon$	$e\theta$
$f\alpha$	$f\beta$	$f\gamma$	$f\delta$	$f\varepsilon$	$f\theta$

FIG. 7.

are 36 officers of six different ranks drawn from six different regiments, and the problem is to arrange them in a square of order 6, one officer in each compartment, in such wise that in each row, as well as in each column, there appears an officer of each rank and also an officer of each regiment. Of a single regiment we have, suppose, a colonel, lieutenant-colonel, major, captain, first lieutenant and second lieutenant, and similarly for five other regiments, so that there are in all 36 officers who must be so placed that in each row and in each column each rank is represented, and also each regiment. Euler denotes the six regiments by the Latin letters a, b, c, d, e, f, and the six ranks by the Greek letters $\alpha, \beta, \gamma, \delta, \epsilon, \theta$, and observes that the character of an officer is determined by a combination of two letters, the one Latin and the other Greek; there are 36 such combinations, and the problem consists in placing these combinations in the 36 compartments in such wise that every row and every column contains the 6 Latin letters and also the 6 Greek letters (Fig. 7). Euler found no solution of this problem in the case of a square of order 6, and since Euler's time no one has succeeded either in finding a solution or in proving that no solution exists. Anyone interested has, therefore, this question before him at the present moment, and I recommend it to any-

$a\alpha$	$b\gamma$	$c\beta$
$b\beta$	$c\alpha$	$a\gamma$
$c\gamma$	$a\beta$	$b\alpha$

FIG. 8.

one present who desires an exercise of his wits and a trial of his patience and ingenuity. It is easy to prove that when the square is of order 2, viz. the case of 4 officers of two different ranks drawn from two different regiments, there is no solution; Euler gave his opinion to the effect that no solution is possible whenever the order of the square is two greater than a multiple of four. In other simple cases he obtained solutions; for example, for the order 3, the problem of 9 officers of three different ranks drawn from three different regiments, it is easy to discover the solution shown in the diagram (Fig. 8), and, as demonstrated by Euler, whenever one solution has been constructed there is a simple process by which a certain number of others can be derived from it. Now if you look at that diagram and suppose the Greek letters obliterated, you will see that the Latin letters are arranged so that each of the letters occurs in each row and in each column, the magical property mentioned above, and for this reason Euler termed such arrangements Latin squares and stated that the first step in the solution of the problem is to enumerate the Latin squares of a given order. As showing the intimate connection between the Græco-Latin square of Euler and ordinary magic squares, it should be noticed that the method of De la Hire, by employing Latin and Greek letters for the elements in his two subsidiary Latin squares, gives rise immediately to the Græco-Latin square of Euler. Euler says in regard to the problem of the Latin square, "The complete enumeration of the Latin squares of a given order is a very important question, but seems to me of extreme difficulty, the more so as all known methods of the doctrine of combinations appear to give us no help," and again, "the enumeration appears to be beyond the bounds of possibility when the order exceeds 5." Moreover, Cayley, in 1890, that is 108 years later, gave a *résumé* of what had been done in the matter, but did not see his way to a solution of the question. Under these circumstances, you will see how futile it is to expect a solution of the magic-square problem when the far simpler question of the Latin square has for so long proved such a tough nut to crack. The problem of the Latin square has eventually been completely solved, and in order to lead you up gradually to an understanding of the method that has proved successful, I ask you to look at the Latin square of order 5 that you see in the diagram (Fig. 9). The first row of letters can be written in any order, but not so the second row, for each column when the second row is written must contain two different

a	b	c	d	e
b	d	e	a	c
c	e	d	b	a
d	c	a	e	b
e	a	b	c	d

FIG. 9.

letters. We must, therefore, be able to solve the comparatively simple question of the number of possible arrangements of the first two rows. For a given order of the letters in the first row, in how many ways can we write the

letters in the second row so that each column contains a pair of different letters? This is a famous question, of which the solution is well known; it is known to mathematicians as the "problème des rencontres." It may be stated in a variety of ways; one of the most interesting is as follows:—A person writes a number of letters and addresses the corresponding envelopes; if he now put the letters at random into the envelopes, what is the probability that not a single letter is in the right envelope?

Passing on to the problem of determining the number of ways of arranging the first three rows so that each column contains three different letters, it may be stated that up to 1898 no solution of it had been given; while it is obvious that as the number of the rows is increased the resulting problems will be of enhanced difficulty. A particular case of the three-row problem had, however, been considered under the title "problème des ménages" and a solution obtained. It may be stated as follows:—

A given number of married ladies take their seats at a round table in given positions; in how many ways can their husbands be seated so that each is between two ladies, but not next to his own wife? For order 5, that is 5 ladies, the question comes to this:—Write down 5 letters and underneath them the same letters shifted one place to the left; in how many ways can the third row be written so that each column contains three different letters? This particular case of the three-row problem for any order presents no real difficulty. The results are that in the cases of 3, 4, 5, 6 . . . married couples there are 1, 2, 13, 80, &c., ways.

Since the year 1890, the problem of the Latin square has been completely solved by an entirely new method, which has also proved successful in solving similar questions of a far more recondite character, and I am here this evening to attempt to give you some notion of the method and some account of the series of problems to which that method has been found to be applicable.

There is, as viewed mathematically, a fundamental difference between arithmetic and algebra; the former may be regarded as an algebra in which the numerical magnitudes under consideration are restricted to be integers; the two branches contemplate discontinuous and continuous magnitude respectively. Similarly, in geometry we have the continuous theory, which contemplates figures generated by points moving from one place to another and in doing so passing over an infinite succession of points, tracing a line in a plane or in space, and also a discontinuous theory, in which the position of a point varies suddenly, *per saltum*, and we are not concerned with any continuously varying motion or position. The present problems are concerned sometimes with this discontinuous geometry and sometimes with an additional discontinuity in regard to numerical magnitude, and the object is to count and not to measure. Far removed as these questions are, apparently, from the subject-matter of a calculus of infinitely small quantities and the variation of quantities by infinitesimal increments, my purpose is to show that they are intimately connected with them and that success is a necessary consequence of the relationship. I must first take you to a much simpler problem than that of the Latin square, to one which in a variety of ways is very easy of solution, but which happens to be perhaps the simplest illustration of the method. In the game of chess a castle can move either horizontally or vertically, and it is easy to place 8 castles on the board so that no piece can be taken by any other piece. One such arrangement is shown in Fig. 10. The condition is simply that one castle must be in each row and also in each column. Every such arrangement is a diagrammatic representation of a certain mathematical process performed upon a certain algebraical function. For consider the process of differentiating x^8; it may be performed as follows:—Write down x^8 as the product of 8 x's,

$$x\ x\ x\ x\ x\ x\ x\ x,$$

and now substitute unity for x in all possible ways and add the results; the substitution can take place in eight different ways, and the addition results in $8x^7$, which will be recognised as the differential coefficient. Observe that the process of differentiation is thus broken up into eight minor processes, each of which may be diagrammatically represented on the first row of the chess-board by a unit placed in the compartment corresponding to the particular x for which unity has been substituted. If we now perform differentiation a second time, we may take the results of the above minor processes and in each of them again substitute unity for x in all possible ways; since in each the substitution can take place in seven different ways, it is seen that we can regard the process of differentiating twice as composed of $8 \times 7 = 56$ minor processes, each of which can be diagrammatically represented by two units, one in each of the first two rows of the chess-board, in positions corresponding to the substitutions of unity for x that have been carried out. Proceeding in this manner in regular order up to the eighth differentiation, we find that the whole process of differentiating x^8 eight times in succession can be decomposed into $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 40{,}320$ minor processes, each of which is denoted by a diagram which slight reflection shows is a solution of the castle problem (Fig. 11). There are, in fact, no more solutions, and the whole series of 40,320 diagrams

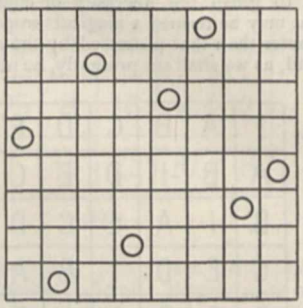


FIG. 10.

constitutes a picture in detail of the differentiations. Simple differentiations of integral powers thus yield the enumerative solutions of the castle problem on chess-boards of any size.

We have here a clue to a method for the investigation of these chess-board problems; it is the grain of mustard seed which has grown up into a tree of vigorous growth, throwing out branches and roots in all sorts of unexpected directions. The above illustrations of differentiation gave birth to the idea that it might be possible to design pairs of mathematical processes and functions which would yield the solution of chess-board problems of a more difficult character. Two plans of operation present themselves. In the first place we may take up a particular question, the Latin square for instance, and attempt to design, on the one hand, a process, and, on the

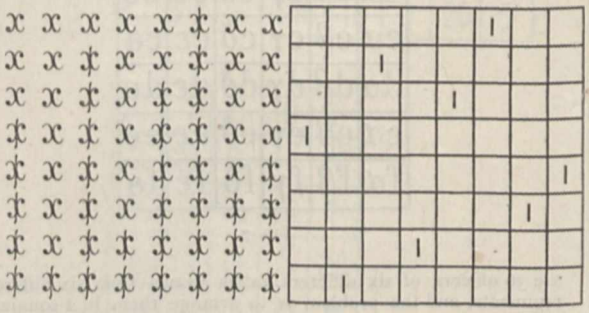


FIG. 11.

other hand, a function the combination of which will lead to the series of diagrams. In the second place, we may have no particular problem in view, but simply start by designing a process and a function, and examine the properties of the series of diagrams to which the combination leads. The first of these plans is the more difficult, but was actually accomplished in the case of the Latin square and some other questions; but the second plan, which is the proper method of investigation, met with great success, and the Latin square was one of its first victims, a solution of a more elegant nature being obtained than that which had resulted from the first plan of operations. There is such an extensive choice of processes and functions that many solutions are obtainable of any particular problem. I will now

give you an idea of a solution of the Latin square, which is not the most elegant that has been found, but which is the most suitable to explain to an audience. Suppose we have five collections of objects, each collection containing the same five different objects, *a*, *b*, *c*, *d*, *e* (Fig. 12). I suppose the objects distributed amongst five different persons in the following manner:—The first person takes one object from each collection, so as to obtain each of the five objects; he can do this in 120 different ways; we will suppose that he takes *a* from the first, *b* from the second, *c* from the third, *d* from the fourth, *e* from the fifth; the collections then become as you see in Fig. 12, second row. Now suppose the second man to advance with the intention of taking one object from each collection and obtaining each of the five objects, he has not the same liberty of choice as had the first, because he cannot take *a* from the first collection or *b* from the second, &c. However, he has a good choice in his selection, and we will suppose him to take *b* from the first collection, *d* from the second, *e* from the third,

(*abcde*)	(*abcde*)	(*abcde*)	(*abcde*)	(*abcde*)
(.*bcde*)	(*a*.*cde*)	(*ab*.*de*)	(*abc*.*e*)	(*abcd*.)
(..*cde*)	(*a*.*c*.*e*)	(*ab*.*d*.)	(.*bc*.*e*)	(*ab*.*d*.)
(...*de*)	(*a*.*c*..)	(*ab*...)	(..*c*.*e*)	(.*b*.*d*.)
(....*e*)	(*a*....)	(.*b*...)	(..*c*..)	(...*d*.)

FIG. 12.

a from the fourth, *c* from the fifth. The collections then become as you see in the third row. The third man who has the same task finds his choice more restricted, but he elects to take *c* from the first, *e* from the second, *d* from the third, *b* from the fourth and *a* from the fifth. The fourth man finds he can take *d*, *c*, *a*, *e*, *b*, and this leaves *e*, *a*, *b*, *c*, *d* for the last man. If we plot the selections that have been made by the five men, we find the Latin square shown in Fig. 9.

Every division of the objects that can be made on this plan gives rise to a Latin square, and all possible distributions give rise to the whole of the Latin squares. Now it happens that a mathematical process exists (connected with algebraical symmetric functions) that acts towards a function representing the five collections in exactly the same way as I have supposed the men to act, and when the process is performed five times in succession, an integer results which denotes exactly the number of Latin squares of order 5 that can be constructed. Moreover, *en route* the "problème des rencontres" and the problems connected with any definite number of rows of the space are also solved.

I will now mention some questions of a more difficult character that are readily solved by the method. In the

a a b c	*a a b b*	*a a a b*
a b c a	*a b a b*	*a a b a*
b c a a	*b b a a*	*a b a a*
c a a b	*b a b a*	*b a a a*

FIG. 13.

"problème des ménages" you will recollect that the condition was that no man must sit next to his wife. If the condition be that there must be at least four (or any even number) persons between him and his wife, the question is just as easily solved. Latin squares where the letters are not all different in each row and column are easily counted. Illustrations of these are shown in Fig. 13. One of these extended to order 8 gives the solution of the problem of placing 16 castles on a chess-board, 8 black and 8 white, so that no castle can take another of its own colour.

Theoretically, the Græco-Latin squares of Euler can be counted, but I am bound to say that the most laborious calculations are necessary to arrive at a numerical result or even to establish that in certain cases the number sought is zero.

Next consider a square of any size and any number of different letters, each of which must appear in each row and in each column, while there is no restriction as to the number that may appear in any one compartment. In this case the result is very simple; suppose the square of order 4 (Fig. 14), and that there are seven different letters that must appear in each row and column; the number of arrangements is $(4!)^7$, viz., 4, the order of the square, must be multiplied by each lower number and the number thus reached multiplied seven times by itself.

Finally, if there be given for each row and for each column a different assemblage of letters and no restriction be placed upon the contents of any compartment, the number of squares in which all these conditions are satisfied can be counted. This, of course, is a far more recondite question than that of the Latin square, and cannot be attacked at all by any other method.

I now pass to certain purely numerical problems. Suppose we have a square lattice of any size and are told that numbers are to be placed in the compartments in such wise that the sums of the numbers in the different rows and columns are to have any given values the same or different. This very general question, hitherto regarded as unassailable, is solved quite easily. The solution is not more difficult when the lattice is rectangular instead of square and when any desired limitation is imposed upon the magnitude of the numbers.

Up to this point, the solutions obtained depend upon processes of the differential calculus. A whole series of other problems, similar in general character, but in one respect essentially different, arises from the processes of the calculus of finite differences. Into these time does not permit me to enter. In the case of magic squares as generally understood, the method brought forward marks a distinct advance in connection with De la Hire's method of formation by means of a pair of Latin squares, but apart from this a great difficulty is involved in the condition

abcd		ef	g
e	abc	dg	f
f	deg	ab	c
g	f	c	abde

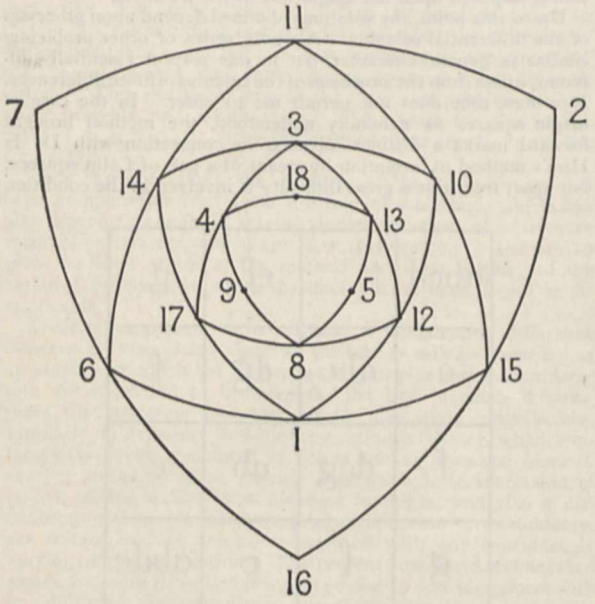
FIG. 14.

that no two numbers must be the same. Still, a statement can be made as to a succession of mathematical processes which result in a number which enumerates the magic squares of a given order. In any cases except those of the first few orders, the processes involve an absolutely prohibitive amount of labour, so that it cannot yet be said that a practical solution of the question has been obtained.

Scientifically speaking, it is the assignment of the processes and not the actual performance of them that is interesting; it is the method involved rather than the results flowing from the method that is attractive; it is the connecting link between two, to all appearance, widely separated departments of mathematics that it has been fascinating to forge and to strengthen. Of all the subjects that for hundreds of years past have from time to time engaged the attention of mathematicians, perhaps the most isolated has been the subject of these chess-board arrangements. This isolation does not, I believe, any longer exist. The whole series of diagrams formed according to any given laws must be regarded as a pictorial representation, in greatest detail, of the manner in which a certain process is performed. We have to exercise our wits to discover what this process is. To say and to establish that problems of the general nature of the magic square are intimately connected with the infinitesimal calculus and the calculus of finite differences is to sum the matter up. Much, however, remains to be done. The present method is not able to deal with diagonal properties, or with arrangements which depend upon the knight's move. The subject is only in its infancy at present. More workers

are required who will, without doubt, introduce new ideas and obtain results far transcending those we are in possession of now. The latest work has shown that the method is applicable to boards of triangular and trapezoidal shapes, and also to solid boards in three dimensions, so that the remote ground occupied by magic and Nasik cubes will soon be invaded.

In conclusion, I bring before you an interesting example of magic arrangement that I found whilst engaged in rummaging amongst the books and documents of the old Mathematical Society of Spitalfields (1717–1845) for the purpose of extracting something which might interest or amuse, if it might not instruct, the audience I addressed in Section A of the British Association for the Advancement of Science at Glasgow last autumn. It is an arrangement of the first eighteen numbers on five connected triangles; the magical property consists in the circumstance that the numbers 19, 38 and 57 appear as sums in a variety of ways. The number 19 appears nine times, 38 twelve times and 57 fourteen times (Fig. 15).



9= 7+12=14+ 5= 4+15
= 6+13=17+ 2= 9+10
=16+ 3= 1+18= 8+11
38= 7+11+14+ 6=11+ 2+15+10=15+16+ 6+ 1
=11+10+ 3+14=10+15+ 1+12= 1+ 6+14+17
=14+ 3+ 4+17= 3+10+12+13=12+ 1+17+ 8
= 3+13+18+ 4=13+12+ 8+ 5= 8+17+ 4+ 9
57= 7+14+ 4+ 5+12+15= 6+17+ 9+13+10+ 2=16+ 1+ 8+18+ 3+11
= 7+11+ 2+15+16+ 6=11+10+15+ 1+ 6+14=14+ 3+10+12+ 1+17
= 3+13+12+ 8+17+ 4= 4+18+13+ 5+ 8+ 9
= 9+ 4+ 3+10+15+16=18+13+12+ 1+ 6+ 7= 5+ 8+17+14+11+ 2
= 9+ 8+12+10+11+ 7=18+ 4+17+ 1+15+ 2= 5+13+ 3+14+ 6+16

FIG. 15.

I should say that I feel conscious that I have not been able to introduce the subject of my lecture without occasional and, perhaps, in the circumstances, unavoidable obscurity. For the rest, I have felt somewhat doubtful as to the interest I might arouse in these problems, but the managers honoured me by inviting me to display to you some of the chips from a pure mathematician's workshop, and I felt no hesitation in accepting.

FORTHCOMING BOOKS OF SCIENCE.

Mr. Felix Alcan (Paris) promises:—"Les Bases scientifiques de l'Éducation physique," by Démeny; "Les Grands Phénomènes géologiques," by Prof. S. Meunier; "Manuel d'Electrothéropie," by A. Weill; "Traité d'Intubation du Larynx," by Bonain; "Manuel d'Histologie pathologique," tome ii., by MM. Durante, Dominici, &c.

Mr. Edward Arnold gives notice of:—"Elementary Principles in Statistical Mechanics, by Dr. J. W. Gibbs, and "The Elements of Experimental Phonetics," by Dr. E. W. Scripture.

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. Tylor has resigned the office of keeper of the University Museum, which he has held since the death of Prof. Henry Smith in 1883. He will retain his leadership in anthropology. Prof. Tylor's magnificent gifts of totemistic objects to the Museum will remain as tokens of the great interest which he has taken in the welfare of the institution with which his more immediate connection will now cease.

At a meeting of the Junior Scientific Club on Wednesday, March 5, papers were read by Mr. H. D. Davis (Balliol) on snake poisons, and by Mr. J. Phelps (Trinity) on the boiling points of solutions.

CAMBRIDGE.—Mr. T. H. Havelock, of St. John's College, has been elected to the Isaac Newton studentship in physical astronomy. Mr. Havelock and Mr. J. E. Wright (senior wrangler 1900), of Trinity, are the Smith's prizemen of the year.

The Allen studentship is awarded to Mr. F. N. Hales, Trinity, for research in psychophysics.

The Balfour studentship in animal morphology is awarded to Mr. J. S. Budgett, Trinity.

The General Board of Studies propose to re-establish the office of assistant to the superintendent of the Museum of Zoology with a view to the arrangement of the collections.

MR. R. A. S. REDMAYNE has been appointed professor of mining in the University of Birmingham, and Mr. Thomas Turner professor of metallurgy. Mr. Redmayne is resident manager of the Seaton Delaval Collieries in Northumberland, and Mr. Turner has for several years been director of technical instruction to the Staffordshire County Council.

THE sum of 25,000*l.* has been given by Mr. William Johnston, shipowner of Liverpool, for furthering the university movement in that city. The money will be devoted, in accordance with the wishes of the donor, to promote research in pathology and physiology. The 25,000*l.* is divided as follows:—10,000*l.* is allocated to found a chair of chemical biology, 6000*l.* at 5 per cent. interest to endow permanently three research fellowships of 100*l.* a year each. Of these fellowships one is held by a medical graduate of a colonial university, a second by a graduate of medicine of the United States, and a third by a research student in gynæcology. The remaining 9000*l.* is to be spent in building a laboratory adjoining the Thompson Yates laboratories, to accommodate the tropical school, the professor of chemical biology, experimental medicine, comparative pathology, and serum research department.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 6.—"The Density and Coefficient of Cubical Expansion of Ice." By J. H. Vincent, D.Sc., B.A., St. John's College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

February 20.—"Note on the Anomalous Dispersion of Sodium Vapour." By W. H. Julius, Professor of Physics in the University of Utrecht. Communicated by C. Vernon Boys, F.R.S.

"On the Physics and Physiology of the Protoplasmic Streaming in Plants." By Alfred J. Ewart, B.Sc. (Oxon), D.Sc. (Lond.), Ph.D., F.L.S., Lecturer on Botany in the Birmingham Technical Institute. Communicated by Francis Gotch, D.Sc., F.R.S.

February 27.—"Note on the Discovery of a New Trypanosoma." By D. Bruce, F.R.S., Lieut.-Colonel, R.A.M.C.

The author received from South Africa specimens of blood taken from cattle which contain a new species of Trypanosoma.

This new species can be at once distinguished from the Trypanosomas of Surra, tse-tse fly disease, or rat by its larger size, it being almost twice as large as any of the others. In general appearance it conforms closely to the others in possessing an oval protoplasmic body, a longitudinal fin-like membrane, and a single flagellum.

This new Trypanosoma was lately discovered by Dr. A. Theiler, who is in charge of the bacteriological laboratory of the Medical Officer of Health, Pretoria, Transvaal.

He states that at first he was under the impression that he had merely hit against the familiar Trypanosama of tse-tse fly disease. He, however, was struck by its larger size, and tried a few inoculation experiments. He found that the new Trypanosoma only infects cattle. Horses, dogs, goats, rabbits and guinea-pigs are all immune, neither showing symptoms nor the presence of the parasites in the blood. With the same blood he infected two calves, which showed distinct febrile reaction, and at the same time the parasites appeared in the blood.

He found the parasite for the first time in the blood of a young ox which had just recovered from an attack of rinderpest, and since then has successfully inoculated calves from two other cattle.

He describes the disease as an acute pernicious anæmia with grave blood changes, a general anæmia without deformation of the elements of the blood, or, lastly, only a slight fever, and that there exists a natural immunity in cattle against this Trypanosoma.

He is of opinion that this disease is the same as that attributed by Dr. Kolle—who studied rinderpest in South Africa with Koch during the last outbreak—to bovine malaria. Dr. Kolle overlooked the Trypanosoma, saw that the disease was infectious, and thought he observed endoglobular parasites and pigment in the red blood corpuscles.

As this discovery seems to be an interesting one, and as

Dr. Theiler deserves great credit for the observation, it is proposed that this Trypanosoma be named after the discoverer *Trypanosoma Theileri*.

Royal Microscopical Society, February 19.—Mr. W. Carruthers, F.R.S., vice-president, in the chair.—The chairman directed attention to an interesting exhibition, by Mr. Conrad Beck, of typical bacteria.—The secretary, in the absence of the author, read a paper by Mr. Nelson on polarising with the microscope, wherein the use of tourmalines was advocated. One tourmaline, of a smoky tint, with the slightest dash of pink, free from veins or specks, and not less than ¼-inch in diameter, should be mounted in a cap to fit over the eye-piece. The other tourmaline might be of the ordinary yellow-green variety, but larger, about $\frac{4}{10} \times \frac{6}{10}$ inch, mounted in a metal screen, $2\frac{3}{4} \times 3\frac{1}{2}$ inches, so as to exclude all light not passing through the tourmaline. This screen is to be placed in front of and close to the lamp chimney. Any form of substage condenser can be used with this new arrangement of tourmalines, with the exception of apochromatic condensers, which should not be used in polariscope work because the fluorite used in their construction itself polarises. The images obtained by this new method will be just as critical as those in a microscope where no polariscope is used. The paper concluded with an explanation of the advantages obtained in the adoption of the arrangement in the investigation of phenomena due to the interference of polarised light. Mr. Karop thought it would be a great advantage if a tourmaline prism could be rendered effective, as Nicol's prisms were expensive; he thought, however, that a sufficiently large piece of flawless tourmaline would be as expensive as a Nicol's prism.

PARIS.

Academy of Sciences, March 3.—M. Bouquet de la Grye in the chair.—On an antique vase found at Abou-Roach, by M. Berthelot. Contrary to expectation, this vase proved to be not metallic, but appears to have been prepared by the reaction between a fine sand and a mixture of litharge and common salt.—Researches on the silicide of calcium, by MM. H. Moissan and W. Dilthey. As the accounts of the properties of calcium silicide given by Wöhler, Chalmot and Jacobs are contradictory, the authors undertook its reinvestigation. It is obtained by the reaction of lime and silicon at the temperature of the electric furnace, but since calcium silicide is readily oxidised by fused lime it is necessary to keep the silicon in excess. The silicide obtained in this way contained only silicon as impurity, and in one case this amounted to only 1 per cent. Calcium silicide acts very slowly upon water, the reaction being complete only after some months. Hydrogen is the only gas evolved, no gaseous compound of silicon being produced. Hydrochloric acid attacks it more rapidly, hydrogen again being the only gas produced.—On the crystallisation of iron peroxide, by M. Alfred Ditte. The conversion of oxide of iron into the crystallised form by ignition of sulphate of iron with salt is due to the combined action of the vapours of ferric chloride, hydrochloric acid and sodium chloride. The action takes place still more readily in the presence of fluorides, but in this case the oxide is liable to be contaminated by traces of insoluble fluorine compounds.—On a new Trypanosoma of the Bovidæ, by M. A. Laveran. The new species is classified as *Tr. Theileri*, and is clearly distinguished from *Tr. Brucei* by the fact that the latter is inoculable into a large number of mammals, whilst the new species appears to be special to the Bovidæ. It is pathogenic, producing anæmia either with or without fever. During the course of the fever the parasites may be found in the blood for some weeks. Occasionally there is pernicious anæmia with a rapid destruction of the red corpuscles, leading quickly to a fatal issue.—New syntheses of methane, by MM. Paul Sabatier and J. B. Senderens. (see p. 446).—Methane is produced by the action of reduced nickel upon mixtures of hydrogen with carbon monoxide or dioxide.—On the lines of maximum decrease of moduli and algebraic or transcendental equations, by M. Edmond Maillet.—On entire functions and the transcendental meromorphs discovered by M. Painléve, by M. Pierre Boutroux.—The cooling power of air at high pressures and of air in motion, by M. P. Compan. The formula expressing the law of cooling as given by Dulong and Petit has been verified for pressures below atmospheric. The author proposed to see how far this formula was valid when the pressures are higher than atmospheric, when the hot body cools in a chamber of indefinite shape, and when the air is in motion. The constants of Dulong and Petit were found to hold up to pressures of six atmospheres, and were also found to remain unchanged when the cooling took place in the open instead of inside a spherical envelope. The cooling effect of air in motion was found to be represented by the formula $kt\sqrt{u}$, where u is the velocity of translation of the air and t the excess of temperature.—On an electrostatic relay, by M. V. Crémieu. A description of a relay which is capable of automatically regulating the potential of the charge on a condenser.—On the use of the capillary electrometer for measuring the true differences of potential at the contact of amalgams and electrolytes, by M. Lucien Poincaré. A reclamation of priority against M. P. Boley.—On the search for a Hertzian radiation emanating from the sun, by MM. H. Deslandres and Décombe. A discussion as to the best mode of attacking the problem of determining whether any of the Hertzian radiations from the sun reach the lower regions of the earth's atmosphere. The conclusion is drawn that the apparatus for this purpose should be set up in observatories devoted to physical astronomy, side by side with the apparatus for the study of the sun and its atmosphere. A lengthy series of observations will probably be necessary before the question can be finally decided.—The explanation of some celestial phenomena by means of the Hertzian waves, by M. Charles Nordmann. The author draws the conclusion that the sun must emit Hertzian waves, this emission being particularly intense in the regions where violent superficial eruptions are produced and at those times when the intensity of the eruptions is at a maximum, that is to say, in the region of the spots and faculæ and at the moment of maximum solar activity. This view is then applied to the explanation of the form of the solar corona and the spectra of comets. It is claimed for this theory that it is contradicted by no facts, and renders a complete account of many different and otherwise inexplicable phenomena.—On the recombination of the ions in gases, by M. P. Langevin. In a previous note a theory has been given of a method permitting of the direct measurement of the coefficient of recombination of positive and negative ions. The experimental part of the work is given in the present paper. It is shown that the thickness of the gaseous layer and the strength of field may be varied within wide limits without affecting the constancy of this coefficient, which remains between 0·26 and 0·28, a value which coincides with the determination of the same coefficient by Townsend made by an entirely different method. From this it would appear that in air at the ordinary pressure there is about one recombination for every four collisions between ions of opposite signs.—The magnetostriction of nickel steels, by MM. H. Nagaoka and K. Honda.—Remarks on the researches of MM. Nagaoka and Honda, by M. C. E. Guillaume.—On the expansion of steels at high temperatures, by MM. Georges Charpy and Louis Grenet. The coefficients of expansion, which increase with temperature, remain almost exactly equal for the different steels, the percentage of carbon in which varies from 0·03 to 3·5.—The specific heat and atomic weight of vanadium, by MM. C. Matignon and E. Monnet. A crystalline compound of aluminium and vanadium, AlVa, was prepared, and the mean specific heat as determined in this and in a ferro-vanadium was 0·1245, which gives an atomic heat of 6·35 if the atomic weight be taken as 51.—On some thallium combinations, by M. V. Thomas.—On dioxytariric and ketotariric acids, by M. Arnaud.—On the products of condensation of tetramethyldiamidobenzhydrol with some primary aromatic amines in which the para-position is occupied, by MM. A. Guyot and M. Granderye.—New reactions of organometallic derivatives, by M. E. E. Blaise. If the crude product of the reaction of magnesium upon an ethereal solution of an alkyl iodide is treated with ethylene oxide, the splitting of the magnesium compound takes place for the most part in a different manner from the syntheses already published, the main product being ethylene bromhydrin. At the same time, a small quantity of the expected primary alcohol containing two atoms of carbon more than the original alkyl group is also obtained.—The action of sulphides, sulphites and hyposulphites upon nitro-derivatives of azo-colouring matters, by MM. Rosenstiehl and Suais.—Compounds of alcohol with the chlorides of manganese and cobalt, by M. F. Bourion.—Some facts in opposition to the application without reserve of the laws of osmosis to red blood corpuscles, by MM. H. Stassano and F. Billon. It is generally admitted without question, as a consequence of the laws of osmosis, that the volume of a red corpuscle varies inversely with the

concentration of the solution. Observations are given showing that this principle does not completely express the actual phenomena.—Volume in urology, by M. J. Winter.—The employment of the electric arc in iron in phototherapy, by MM. André Broca and Alfred Chatin.—*Pachypodium Rutenbergianum*, a Madagascan textile plant, by M. Henri Jumelle.—On some rocky veins which traverse the dunite ground mass of Koswinsky, by M. L. Duparc.

DIARY OF SOCIETIES.

THURSDAY, MARCH 13.

ROYAL SOCIETY, at 4.30.—Croonian Lecture, on Certain Chemical and Physical Properties of Hæmoglobin: Prof. A. Gamgee, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Adjourned discussion on the following papers:—Electric Shock and Legislation thereon: Major-General C. E. Webber, C.B., R.E.—Electric Shocks: F. B. Aspinall.—Electric Shocks at 500 volts: A. P. Trotter.

MATHEMATICAL SOCIETY, at 5.30.—The Theory of Cauchy's Principal values (III.): Mr. G. H. Hardy.—The Solutions of a System of Linear Congruences: Rev. J. Cullen.—Algebraical Connection between Zonal Harmonics of Orders differing by an Integer: R. Hargreaves.—On Quadrature Formulæ: J. Buchanan.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Indian Famine of 1899, and the Measures taken to meet It: T. W. Holderness.

FRIDAY, MARCH 14.

ROYAL INSTITUTION, at 9.—Magnetism in Transitu: Prof. S. P. Thompson, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Note on the Green Flash: T. W. Backhouse.—The Flash Spectrum, Sumatra Eclipse, 1901: S. A. Mitchell.—Observations of Nova Cygni (1876) made with the 40-inch Refractor of the Yerkes Observatory: E. E. Barnard.—Anomalous Occultations of Stars by the Moon: G. W. Hough.—The Duration of Totality at Naval-moral, 1900: C. T. Whitmell.—Note on Prof. Turner's Recent Paper on Photographic Surveying: H. G. Fourcade.—The Magnitude of η-Argûs, 1900-1902: R. T. A. Innes.—On the Variation of S. Carinæ: A. W. Roberts.—Σ 484 and 485, and two pairs: Rev. T. E. Espin.—Double Star Observations, 1899-1901: W. H. Maw.—New Variable Stars found during the Measurements for the Astrographic Catalogue: Royal Observatory, Greenwich.—Results of Micrometer Measures of Double Stars made with the 28-inch refractor: Royal Observatory, Greenwich.—*Promised papers.*—Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1901: Royal Observatory, Greenwich.—Proper Motion of Nova Persei: Royal Observatory, Greenwich.—On the Images formed by a Parabolic Mirror. First paper:—The Geometrical Theory: H. C. Plummer.

MALACOLOGICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Use of Long Steel Wires in Surveying: H. J. Deane.

PHYSICAL SOCIETY, at 5.—The Thermal Expansion of Porcelain: A. E. Tutton, F.R.S.—On the Temperature Variation of the Electrical Resistance of Pure Metals, and Allied Matters: W. Williams.—A Suspected Case of the Electrical Resonance of Minute Metal Particles for Light Waves. A New Type of Absorption: Prof. R. W. Wood.

SATURDAY, MARCH 15.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

MONDAY, MARCH 17.

VICTORIA INSTITUTE, at 4.30.—Adaptation and Selection in Nature, and their Bearing on the Evidence of Design: Dr. W. Kidd.

SOCIETY OF ARTS, at 8.—Photography applied to Illustration and Printing: J. D. Geddes.

TUESDAY, MARCH 18.

ROYAL INSTITUTION, at 3.—Recent Researches on Protective Resemblance, Warning Colours and Mimicry in Insects: Prof. E. B. Poulton, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*:—Electrical Traction on Railways: W. M. Mordey and B. M. Jenkin. Papers will be read:—The Greenwich Footway-Tunnel: W. Copperthwaite.—Subaqueous Tunnelling through the Thames Gravel, Baker Street and Waterloo Railway: A. H. Haigh.

ZOOLOGICAL SOCIETY, at 8.30.—The Evolution of Horns and Antlers: Dr. Hans Gadow, F.R.S.—Notes on the Transformations of some South-African Lepidoptera: Lt.-Col. J. M. Fawcett.—On a new Stridulating Organ in a Scorpion: R. I. Pocock.

ROYAL STATISTICAL SOCIETY, at 5.

WEDNESDAY, MARCH 19.

CHEMICAL SOCIETY, at 5.30.—The Absorption Spectra of Metallic Nitrates. Part I.: W. N. Hartley.—A Method of Determining the Ratio of Distribution of a Base between Two Acids: H. M. Dawson and F. E. Grant.—On the Molecular Complexity of Acetic Acid in Chloroform Solution: H. M. Dawson.—On the Existence of Polyiodides in Nitrobenzene Solution: H. M. Dawson and R. Gawler.—Nitrogen Chlorides containing the Propionyl Groups: F. D. Chattaway.—Derivatives of *a*-Aminocamphoroxime: A. Lapworth and A. W. Harvey.—Preparation of Sulphamide from Ammonium Amidosulphite: E. Divers and M. Ogawa.—Hypoiodous Acid: R. L. Taylor.

SOCIETY OF ARTS, at 8. Electric Traction. London's Tubes, Trams, and Trains: J. C. Robinson.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Foraminifera: A. Earland.

ENTOMOLOGICAL SOCIETY, at 8.—Notes on Some Cases of Seasonal Dimorphism in Butterflies; with an Account of Experiments made by Mr. Guy A. K. Marshall: Dr. F. A. Dixey.—Mimicry illustrated by the Sanger Shepherd Three Colour Process: Prof. E. B. Poulton, F.R.S.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—La Lune mange les Nuages. A Note on the Thermal Relations of Floating Clouds: W. N. Shaw, F.R.S.—The Prevalence of Gales on the Coasts of the British Islands during the Thirty Years 1871-1900: F. J. Brodie.

THURSDAY, MARCH 20.

ROYAL SOCIETY, at 4.30.—*Probable papers*:—Development of the Layers of the Retina in the Chick after the Formation of the Optic Cup: J. Cameron.—On a Peculiarity of the Cerebral Commissures in certain Marsupialia, not hitherto recognised as a Distinctive Feature of the Diprotodontia: Prof. G. Elliot Smith.—The Classification of the Elements: Prof. H. E. Armstrong, F.R.S.—On a Throw-Testing Machine for Reversals of Mean Stress: Prof. Osborne Reynolds, F.R.S., and J. H. Smith.—On the Equilibrium of Rotating Liquid Cylinders: J. H. Jeans.—A Portable Telemeter, or Range-finder: Prof. G. Forbes, F.R.S.

LINNEAN SOCIETY, at 8.—Electric Response in Ordinary Plants under Mechanical Stimulus: Prof. J. C. Bose.—On the Fruit of *Melocarina bambusoides*, Trin., an Exalbuminous Grass: Dr. O. Stapf.—On Malacostraca from the Red Sea Collected by Dr. H. O. Forbes: Messrs. Alfred O. Walker and Andrew Scott.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper.

FRIDAY, MARCH 21.

ROYAL INSTITUTION, at 9.—Recent Developments in Colouring Matters. (In English): Prof. Otto N. Witt.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Fencing of Steam and Gas-Engines: H. D. Marshall.—Fencing or Guarding Machinery used in Textile Factories: S. R. Platt.—Protection of Lift-shafts, and Safety Devices in connection with Lift-Doors and Controlling Gear: H. C. Walker.—Guarding Machine Tools: W. H. Johnson.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Infantile Mortality in the Tropics Dr. Daniels.

SATURDAY, MARCH 22.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (Essex Museum of Natural History, Stratford), at 6.30.—Annual Meeting. The Presidential Address will be delivered by Prof. Meldola, F.R.S., on The Coming of Age of the Essex Field Club, a Record of Local Scientific Work, 1880-1901.

CONTENTS.

SUPPLEMENT.

SUPPLEMENT TO "NATURE."

THE PRESENT JUDGED BY THE FUTURE.

Anticipations of the Reaction of Mechanical and Scientific Progress upon Human Life and Thought. By H. G. Wells. Pp. 318. (London: Chapman and Hall. Ltd., 1902.) Price 7*s.* 6*d.*

THIS is a profoundly interesting and suggestive book by a very remarkable man. Mr. Wells was educated at the Royal College of Science; he has a thorough knowledge of, and considerable training in, the great branches of science—physics, chemistry, astronomy, geology and biology. This course of study operated, in the case of Mr. Wells, upon a mind naturally gifted with an extraordinarily vivid imagination and the aptitude for true literary art. In one of his latest works, "Love and Mr. Lewisham," Mr. Wells has told us the story of the struggle for life of a South Kensington student, and for the first time given the Royal College of Science the dignity of literary recognition. But it is by his audacious and fascinating "imaginings" as to the arrival on our planet of the inhabitants of Mars, the strange evolution and changes in the nature of men and the earth's surface as seen a million years hence, the morphology and habits of the inhabitants of the moon, the nocturnal freezing and solidification of its atmosphere, and as to other such topics that Mr. H. G. Wells is best known. The really wonderful range of knowledge shown in these stories, the scientific accuracy of the abundant details, the absolute restraint of the weird histories recounted, within the limits of what scientific criticism must admit as possible—nay, even probable, given the one initial miracle of any-one having and recording experiences of such things—lend a special charm to Mr. Wells' writings wanting in those of all other masters of this kind of literary craft from Swift to Jules Verne. One of his shorter stories, "The Star"—calmly recording in the words of a survivor the approach and passage of a huge meteor which causes the ocean to sweep the land-surface of the earth in all parts to a depth of two hundred feet—is written with such faithful adherence to scientific possibility and such convincing art in narrative that I, for one, am haunted by the conviction that the thing has occurred in past epochs more than once, and may at any time occur again.

The character which Mr. Wells has thus established for himself will necessarily tend to a misunderstanding of the nature of his work recently published under the title "Anticipations." In this book the author is not seeking to amuse us by far-reaching speculation as to remote possibilities. Under the guise of prophecy as to the future, Mr. Wells criticises the present. He imagines that before a hundred years are out (we must all wish this forecast to be realised) there will gradually come into existence

"a naturally and informally organised, educated class, an unprecedented sort of people, a New Republic dominating the world. . . . a new social Hercules that will strangle the serpents of war and national animosity in his cradle . . . a conscious organisation of intelligent and, quite possibly in some cases, wealthy men."

Mr. Wells hopes great things from the cosmopolitanism and intelligence of this coming power. He tells us what the men of this new group will think on various subjects and do in regard to many things, and thus he makes them the vehicle for conveying his righteous indignation and just contempt for a large part of the present ways and beliefs of mankind. It is impossible to do justice in a brief review to a book which deals with nearly every subject under the sun—from motor-cars and cooperative cookery to the struggle for domination among the nations and the essence of religion. Mr. Wells commences his far-reaching survey with a comparatively comfortable chapter on "Locomotion in the Twentieth Century." Special motor tracks and individual motor-cars will to a large extent replace railways. This leads on to the consideration of the "Diffusion of Great Cities." The country will cease to come into the town; the town will spread into the country in proportion as the facilities for locomotion enable a larger and larger area to be in easy touch with the great centres. Then follow chapters on the domestic economy and the relations of class to class—the natural history or bionomics of the social organism in the past, the present and the immediate future of the twentieth century. "War in the Twentieth Century," "The Conflict of Languages" and "Faith, Morals and Public Policy in the Twentieth Century" are the titles of subsequent chapters.

I shall best enable the reader to judge of the manner in which these subjects are treated, and stimulate, I hope, his desire to read Mr. Wells' book by a few quotations.

"The facies of the social fabric has," he says, "changed and—as I hope to make clear—is still changing in a direction from which, without a total destruction and re-birth of that fabric, there can never be any return. The most striking of the new classes to emerge is certainly the share-holding class, the owners of a sort of property new in the world's history. . . . Share property is property that can be owned at any distance and that yields its revenue without thought or care on the part of its proprietor; it is, indeed, absolutely irresponsible property, a thing that no old world property ever was. . . . The shareholder owns the world *de jure*, by the common recognition of the rights of property; and the incumbency of knowledge, management and toil fall entirely to others. He toils not, neither does he spin; he is mechanically released from the penalty of the Fall, he reaps in a still sinful world all the practical benefits of the millennium—without any of its moral limitations."

Among many other ways and habits which are pointed out for improvement in the nascent century, those of house-builders are criticised at some length. Here is a good sample:—

"I find it incredible that there will not be a sweeping revolution in the methods of building during the next century. The erection of a house-wall, come to think of it, is an astonishingly tedious and complex business, the final result exceedingly unsatisfactory. . . . I fail to see the necessity of (and, accordingly, I resent bitterly) all these coral-reef methods. Better walls than this and less life-wasting ways of making them are surely possible. . . . I can dream at last of much more revolutionary affairs, of a thing running to and fro along a temporary rail, that will squeeze out wall as one squeezes paint from a tube, and form its surface with a pat or two as it sets. Moreover, I do not see at all why the walls of small dwelling-houses should be so solid as they are. There still hangs about us the monumental tradition of the

pyramids. It ought to be possible to build sound, portable and habitable houses of felted wire-netting and weather-proofed paper upon a light framework."

Mr. Wells would improve the British workman.

"The average sanitary plumber of to-day in England," he says, "insists upon his position as a mere labourer as though it were some precious thing; he guards himself from improvement as a virtuous woman guards her honour; he works for specifically limited hours and by the hour with specific limitations in the practice of his trade, on the fairly sound assumption that but for that restriction any fool might do plumbing as well as he; whatever he learns he learns from some other plumber during his apprenticeship years—after which he devotes himself to doing the minimum of work in the maximum of time until his brief excursion into this mysterious universe is over."

He has not much respect for the House of Commons.

"Even the physical conditions under which the House of Commons meets and plays at Government are ridiculously obsolete. Every disputable point is settled by a division; a bell rings, there is shouting and running, the members come blundering into the chamber and sort themselves with much loutish shuffling and shoving into the division lobbies. They are counted, as illiterate farmers count sheep; amidst much fuss and confusion they return to their places and the tellers vociferate the result. The waste of time over these antics is enormous, and they are often repeated many times in an evening."

Our author traces the origin of the modern democracy or democratic quasi-monarchy. He has a wholesome contempt for the mode of Government it has produced and the conduct of affairs by party representatives. Every such Government conducts its affairs, he says,

"as though there were no such thing as special knowledge or practical education. The utmost recognition it affords to the man who has taken the pains to know, and specifically to do, is occasionally to consult him upon specific points and override his councils in its ampler wisdom, or to entrust to him some otherwise impossible duty under circumstances of extreme limitation. The man of special equipment is treated always as if he were some sort of curious performing animal."

Of war, Mr. Wells has much to say which is very important and, indeed, should be read, side by side, with the passionate appeal of a similar tendency recently made by Mr. Rudyard Kipling in his "Islanders."

"War," he tells us, "in the past was a thing of days and heroisms; battles and campaigns rested in the hand of the great commander; he stood out against the sky, picturesquely on horseback, visibly controlling it all. War in the future will be a question of preparation, of long years of foresight and disciplined imagination."

The picture given below is a fine sample of Mr. Wells' style and matter:—

"There will be first of all the coming of the war, the wave of excitement, the belligerent shouting of the unemployed inefficients, the flag-waving, the secret doubts, the eagerness for hopeful news, the impatience of the warning voice. I seem to see, almost as if he were symbolic, the grey old general—the general who learnt his art of war away in the vanished nineteenth century, the altogether too elderly general with his epaulettes and decorations, his uniform that has still its historical value, his spurs and his sword—riding along on his obsolete horse by the side of his doomed column. Above all things he is a gentleman—and the column looks at him lovingly with its countless boys' faces, and the boys' eyes are infinitely trustful, for he has won battles in the old time. They will believe in him to the end. They have been brought up in their schools to believe in him and his class, their mothers have mingled respect for the gentlefolk with the simple doctrines of their faith, their first lesson on entering the army was the salute. The 'smart' helmets His Majesty, or some such unqualified person, chose for them lie hotly on their young brows, and over their shoulders slope their obsolete carelessly-sighted guns. Tramp, tramp, they march, doing what they have been told to do; Religion and the Ratepayer and the Rights of the Parent working through the instrumentality of the Best Club in the world have kept their souls and minds, if not untainted, at least only harmlessly veneered, with the thinnest sham of training or knowledge. Tramp, tramp, they go, boys who will never be men, rejoicing patriotically in the nation that has thus sent them forth, badly armed, badly clothed, badly led to be killed in some avoidable quarrel by men unseen. And beside them, an absolute stranger to them, a stranger even in habits of speech and thought, and at any rate to be shot with them fairly and squarely, marches the subaltern—the son of the school-burking shareholding class—a slightly taller sort of boy, as ill taught as they are in all that concerns the realities of life, ignorant of how to get food, how to get water, how to keep fever down and strength up, ignorant of his practical equality with the men beside him, carefully trained under a clerical headmaster to use a crib, play cricket rather nicely, look all right whatever happens, believe in his gentility and avoid talking 'shop.' . . . So the gentlemanly old general—the polished drover to the shambles—rides, and his doomed column march by, in this vision that haunts my mind. I cannot foresee what such a force will even attempt to do, against modern weapons. Nothing can happen but the needless and most wasteful and pitiful killing of these poor lads, who make up the infantry battalions, the main class of all European armies to-day, whenever they come against a sanely organised army. There is nowhere they can come in, there is nothing they can do. The scattered invisible marksmen with their supporting guns will shatter their masses, pick them off individually, cover their line of retreat and force them into wholesale surrenders. It will be more like herding sheep than actual fighting. Yet the bitterest and cruellest things will have to happen, thousands and thousands of poor boys will be smashed in all sorts of dreadful ways and given over to every conceivable form of avoidable hardship and painful disease, before the obvious fact that war is no longer a business for half-trained lads in uniform, led by parson-bred sixth form boys and men of pleasure and old men, but an exhaustive demand upon very carefully educated adults for the most strenuous best that is in them, will get its practical recognition."

Our author proceeds to emphasise

"the inexorable tendency in things to make a soldier a skilled and educated man and to link him, in sympathy and organisation, with the engineer and the doctor, and all the continually developing mass of scientifically educated men that the advance of science and mechanism is producing."

He is led to think it not improbable that the present military hierarchy will be left in this country as a sort of ornamental court attendants, and that an entirely new and independent army will be raised and organised on sound business principles.

"Already," he says, "recruiting is falling off. . . . Elementary education has at last raised the intelligence of the British lower classes to a point when the prospect of fighting in distant lands under unsuitably educated British officers of means and gentility with a defective War Office equipment and inferior weapons has lost much of its romantic glamour."

As to education, Mr. Wells holds, and very many, like myself, will agree with him, that "it is increasingly evident that to organise and control public education is beyond the power of a democratic Government."

"Schools alone are of no avail, universities are merely dens of the higher cramming. . . . At present, in Great Britain at least, the headmasters entrusted with the education of the bulk of the influential men of the next decades are conspicuously second-rate men, forced and etiolated creatures, scholarship boys manured with annotated editions, and brought up under and protected from all current illumination by the Kale-pot of the Thirty-nine Articles. Many of them are less capable teachers and even less intelligent men than many Board School teachers."

There is need, Mr. Wells declares, of a new type of school and also of a new type of university,

"something other than a happy fastness for those precociously brilliant creatures—creatures whose brilliance is too often the hectic indication of a constitutional unsoundness of mind—who can 'get in' before the portcullis of the nineteenth birthday falls."

The coming men, those whom Mr. Wells calls the New Republic, will do away with

"the half-educated, unskilled pretenders, professing impossible creeds and propounding ridiculous curricula, to whom the unhappy parents of to-day must needs entrust the intelligences of their children. . . . The windy pretences of 'forming character,' supplying moral training and so forth, under which the educationalist of to-day conceals the fact that he is incapable of his proper task of training, developing and equipping the mind, will no longer be made by the teacher. Nor will the teacher be permitted to subordinate his duties to the entirely irrelevant business of his pupils' sports." Hereafter "the school and college will probably give only the keys and apparatus of thought, a necessary language or so, a sound mathematical training, drawing, a wide and reasoned view of philosophy, some good exercises in dialectics, a training in the use of those stores of fact that science has made. So equipped the young man and young woman will go on to the technical school of their chosen profession and to the criticism of contemporary practice for their special efficiency and to the literature of contemporary thought for their general development."

The value of literature and the great question of the exclusive study of Greek and Latin writers are alluded to thus:—

"After all, in spite of the pretentious impostors who trade upon the claim, literature, contemporary literature, is the breath of civilised life, and those who sincerely think and write the salt of the social body. To mumble over the past, to live on the classics, however splendid, is senility.'

Many readers will find the final chapter the most interesting in this uncompromising book, where religion, morals and philosophy are briefly but frankly touched. The men of the New Republic will be, says Mr. Wells, "religious" men, and we gather that he is one, a forerunner so to speak, of those new men. They will find "an effect of purpose in the totality of things." That is the essence of being "religious" and amounts to "belief in God." They will "presume to no possibility of knowledge of the real being of God." They will reject the conception of God as an omniscient mind as being as impossible as that which presents Him as an omnipresent moving body.

"They will regard the whole of being, within themselves and without, as the sufficient revelation of God to their souls." "The same spacious faith that will render the idea of airing their egotisms in God's presence, through prayer, or of any such quite personal intimacy, absurd, will render the idea of an irascible and punitive Deity ridiculous and incredible." "To believe completely in God" (as these men will believe) "is to believe in the final rightness of all being." "If" (and this is said in comment on Huxley's Romanes lecture) "the universe is non-ethical by our present standards, we must reconsider these standards and reconstruct our ethics."

Mr. Wells declares that no more "shattering" book than the "Essay on Population" by Malthus has ever been or ever will be written. Darwinism, as one outcome of it, has destroyed the basis of old-fashioned doctrines. An outline is given of the religion of the men of the New Republic. They will not seek to discover the final object of the struggle among existences; they will have abandoned the search for ultimates. They will seek God's purpose in the sphere of their activities and desire no more. They will find in themselves a desire, a passion almost, to create and organise, to put in order, to get the maximum result from certain possibilities. These men will hold life to be a privilege and a responsibility, "not a sort of night refuge for base spirits out of the void." They will, accordingly, not punish criminals by inflicting pain, but will apply Nature's own method of improving her stock—the method of killing. And equally they will not encourage or applaud or support by charity (as many persons do at present)

"a mean-spirited, under-sized, diseased little man, quite incapable of earning a decent living even for himself, married to some underfed, ignorant, ill-shaped, plain and diseased little woman and guilty of the lives of ten or twelve ugly ailing children." "All Christian States of to-day are, as a matter of fact, engaged in slave-breeding. It is a result that endears religion and purity to the sweating employer, and leads unimaginative bishops, who have never missed a meal in their lives, and who know nothing of the indescribable bitterness of a handicapped entry into this world, to draw a complacent contrast with irreligious France."

It seems to me that this book should have—even for those whom it cannot fail to offend—more than the interest which attaches to clever fault-finding. It is, truly enough, an unsparing indictment of existing government, society, education, religion and morality, but it contains also a confession of faith and is full of a spirit of hope and a belief in future development. It is a truthful statement of the outlook of a man who has grasped thoroughly the teachings of modern science and who still keeps hope alive in his breast.

E. Ray Lankester.

MOTOR VEHICLES.

Motor Vehicles and Motors. By W. Worby Beaumont. (Westminster: A. Constable and Co., Ltd., 1900.)

IT is difficult within the limits of an ordinary notice to deal adequately with this huge work of 618 quarto pages. Mr. Beaumont has attempted to give a complete history of all the applications of mechanical methods of propulsion to vehicles running on the highway, and has described almost every motor vehicle of importance which has been put on the road during the past seventy-five years.

He first deals with that part of the history of self-propelled carriages which is prior to the date when Daimler, by his introduction of the internal combustion petroleum spirit-worked motor, enabled designers for the first time to dispense with the complication of a steam boiler. The author considers Daimler's invention marked an entirely new departure, and he is undoubtedly justified in holding this opinion, as within a few years after Daimler's engine had been applied to motor cars they developed so rapidly and were so commonly used in France and Germany that even in England, the country *par excellence* of restrictive legislation, Parliament was compelled during the year 1896 by sheer force of public opinion to pass an Act removing some of the absurd provisions which had up to that time prohibited any attempt to use motor vehicles on highways or in our streets.

This early historical portion, which occupies the first forty-eight pages, is useful, as it brings clearly before us the great success obtained by the early engineers, such as Hancock, Gurney and others, fully seventy-five years ago. We are apt to forget that the adaptation of steam power to road vehicles was made so successful by these men that it is beyond doubt that if they had been left unharassed by interested opposition and legislation the methods of traffic which now prevail would have been greatly modified; that is to say, that instead of the railways being, as they are at present, practically the sole routes along which traffic is carried, there is no doubt that if Hancock and those of his time had been allowed to continue their work, the highways of England would have carried their share of the traffic, the factories of England would not have been concentrated as they are, all of them close to lines of railway, and many other modifications wholly beneficial would have taken place affecting the distribution, health and happiness of our industrial population.

Designers of modern vehicles learn much from the history of the early attempts. It is interesting, for instance, to notice from the illustrations of the early boilers used by Gurney, Summers and Ogle how closely they approached to the instantaneous generator or flash boiler, as it is called, which was reintroduced by Serpollet in 1889.

Mr. Beaumont has introduced a few chapters on the general questions affecting locomotion on highways; he gives comparatively short descriptions of modern steam vehicles and electrically driven vehicles, but the bulk of his work is occupied by a carefully written history of the modern motor car driven by the internal combustion engine which has been developed from Daimler's discovery in 1885. This history, which occupies more than half of the book, commences with Daimler's work and goes on to describe the important modifications introduced by him and by the various French engineers, Panhard, Levassor, Peugeot, De Dion, Mors and others and by the Daimler Co. themselves at their works at Cammstadt. He also describes very fully the alternative line of discovery followed up by Benz which also commenced in 1885.

This description of the development of the modern motor car is so complete and so profusely illustrated by reproductions of photographs, as well as by scale drawings and diagrams, that it ought to be of considerable value to everyone interested in this matter, whether they be engineer designers, patent agents, or a general reader attempting to post himself in this interesting matter. But the value of the work as a book of reference on the motor car is greatly diminished by the very confused arrangement of this descriptive history. The author could have either described the whole of the successive developments in their strict chronological order or he could have described in turn each inventor's line of development, giving dates so as to enable us to know to whom we owe the initiative in each successful step. Instead of this he has commenced by describing the work of Daimler in 1885 and the next succeeding years, and from thence jumped to a description of the Daimler motors as manufactured in 1899. He then describes the work of the French engineers, without stating when or how they took up Daimler's work, and then goes back to Benz and treats his discoveries in fair chronological order, so that it is very difficult for the average reader of Mr. Beaumont to learn how much is due to Daimler and how much to Benz.

As we have said above, the work is magnificently illustrated; as a rule the author gives an illustration reproduced from a photograph showing the external appearance of each vehicle described. This is followed in most cases by a sectional drawing showing the general arrangement and by detailed drawings to scale of the important internal organs. Some of the drawings, the credit of which we learn from the preface must be given to Mr. d'Esterre, such as those of the general arrangements, Figs. 99 and 100, which are the sectional and plan views of the Panhard and Levassor Daimler motor carriage of 6 h.-p. racing type, are marvellous examples of correct draughtsmanship, and it is a pity that these drawings are confined to the limits of a quarto page, as they would well bear enlargement to double their present scale.

The author has made some attempt to group together his descriptions of certain important features of the engine, such as the carburettors and cylinder-cooling arrangements. He here also gives us a kind of essay on driving and steering wheel axles, although these are common to all classes of mechanically propelled vehicles. He completes his survey of the motor vehicle driven by the internal combustion engine by several pages of tables of the economic performances of these engines when using petrol as fuel. We are inclined to believe with him that many of the French tests of the power given out by these motors are not trustworthy, as the duration of the tests was quite insufficient to enable one

to judge whether the cylinder-cooling devices, wearing surfaces, and other matters which ought to be proportionate to the power developed, were in these cases sufficient for their purpose. He further points out that none of the tests given by him give any fair comparison as to the relative power obtainable from motors using light petrol of the specific gravity of 0·68 as compared with the heavy oils having a specific gravity of 0·88. Apart from the increased difficulty of vaporising the heavy oil, the efficiency obtained ought to be proportionate to the weight, and when these oils are used as heating agents, tested by the amount of water evaporated for a given weight of fuel, it is found in practice that this is so, and that the evaporative efficiency does vary with the weight.

His chapter on carburettors or vaporisers is somewhat disappointing. After all, the use of the carburettors is one of the main features which distinguish the modern petrol or heavy oil motor from the gas engine. After describing the two classes of carburettors for light oil, *i.e.* the surface vaporiser and the spray-making vaporiser, he describes a number of varieties of these two forms, without, however, giving any information as to their comparative efficiency or successful use. His conclusions as to the difficulties in using vaporisers heated by the exhaust gases or otherwise which are necessary when heavy oils are used are interesting and in the main correct. This part of the subject is of the greatest interest and importance, as an enormous development in the use of internal combustion engines for heavy vehicles would follow on a satisfactory solution of the problem of vaporising the heavy oils. Although for many years past the heavy oil stationary engine has taken its place as a well-known trustworthy commercial article, the use of heavy oil in the same internal combustion engine in motor cars has turned out to be a problem offering so many difficulties that up to the present hardly any maker of internal combustion engines has dealt with heavy oil with any reasonable degree of success.

One of the best-written chapters in Mr. Beaumont's book is that on electric ignition. This somewhat difficult matter is dealt with very exhaustively and so clearly that a reader need not be an electrical engineer to understand it. The various sources of electric energy which are used to give the spark and the sparking plugs and accessories necessary are, as a whole, correctly and clearly set out. I can hardly think, however, that Figs. 277 and 280, giving the diagram of magnetic field of the Bosch inductor generator, are correct. At the same time, they are scarcely necessary far making clear the author's meaning.

The author here gives at considerable length, not only the main features, but most of the details of construction of the vehicles used by the London Electric Cab Co. which had already proved a failure at the time that he wrote his description. Since that time great advances have been made in the construction of electrically driven vehicles, chiefly in the improvement of the accumulators themselves, so that we believe it has now been ascertained that electrically driven vehicles can now be put on the streets and worked at a very reasonable cost for maintenance; in fact, already the cost for maintenance of the accumulators is less than that of the rubber tyres.

Jenatzy's electrical vehicle, "La Jamais Contente," which attained a speed of 65·8 miles an hour, is described as having accomplished the greatest speed ever reached on a high road, but since that time much higher speeds have been recorded by the Mors and other petrol-driven vehicles during the time of the Paris-Bordeaux and other great French races.

Some space is devoted to the consideration of modern steam vehicles as made by Serpollet and by various American firms, such as Stanley and Whitney. It is to be regretted, however, that the descriptions of the flash boiler used by Serpollet are so very meagre, for undoubtedly this steam generator needs very careful study, as it bids fair to bring steam once more into use as a propelling power for light vehicles. Vehicles of the Stanley, or "locomobile" class as they are now called, are so common in the streets of London that everyone has noticed their satisfactory and quiet running. Mr. Beaumont's description of the "Stanley" vehicle is very complete.

A chapter is devoted to the description of the heavier motor vehicles used for transport of goods, and of which we have heard so much in connection with the Liverpool trials and more recently during the War Office motor-wagon trials at Aldershot. Several of these vehicles are described with considerable minuteness, but the author omits to tell us why it is that up to the present internal combustion engines have not come into use at all largely for these vehicles. Quite at the end of the book we find one or two chapters dealing with matters which are common to all classes of mechanically propelled vehicles, such as questions of vibration, balancing motors and pivoted steering axles. The latter chapter contains several errors, the chief of which are due to careless editing. For instance, in discussing the question of the side rub of wheels on the road on p. 570, we find distance H described as a number of degrees, and the proper angle of the outer wheel is called "a tangent to a curve." Again, in a description of the Peugeot float feed carburettor on p. 162, cock H is said to be for emptying the carburettor, whereas it is well known that it is not used for this purpose, but fulfils the rather important function of admitting any required quantity of air to the carburettor.

Apart from these errors, and several others of the same kind which are certain to be found in a work containing so much matter, the whole of the descriptive part and illustrations may be generally described as excellent. The same cannot be said of chapters iv., v. and vi., which deal with the general questions of road resistance, resistance due to gravity, and power required, air and wind resistance. In these the author has got together a number of tables recording the results of several experimenters on road resistances, which are confusing and contradictory, as he makes no attempt to explain them or reconcile them in any way.

The subjects of air and wind resistances, which are of some importance, are summarily dismissed in one page of thirty-six lines containing a formula, *i.e.* that connecting air pressure and velocity, which is most certainly incorrect. Here, however, the author can hardly be blamed, as this question of wind pressure and air resistance is one of great difficulty. Most of those who have experimented

in the matter during the last few years are not satisfied that the square law holds at all speeds, *i.e.* that the air resistance does not vary as the square of the velocity of the vehicle passing through it; that when bodies of irregular outline are moved through the air the resistance is not as the square of the velocity, but below 1000 feet per minute it probably varies at a lower rate than the square, at or near 1000 feet the square law is fairly correct, above 1000 feet per minute at a higher rate. It is probable that there is a point at which the curve turns over, otherwise it would be difficult to account for the small consumption of petrol on the racing vehicles during the French road races at the very high speeds registered.

Mr. Beaumont's work as a whole will be found a valuable one to those interested in these matters.

THE STELLAR UNIVERSE.

The Stars: a Study of the Universe. By Simon Newcomb. Pp. xi + 332. (London: John Murray, 1901.) Price 6*s*.

IN the consideration of a book such as this contribution to "The Progressive Science Series," it is advisable to ascertain the standard by which it is to be judged. For convenience, three classes of scientific books may be distinguished, each with its own criterion. There are, first of all, the text-books of a more or less didactic character, aiming at putting the student in possession of the salient facts of his subject; then we have the reference books, and in the third class we may place all volumes which aim at presenting aspects of a science in terms which may be appreciated by the lay as well as the scientific reader. Prof. Newcomb's book belongs to the third of these types, for it is intended to convey to cultivated minds a view of the state of knowledge of the various bodies in the stellar universe. The stars are considered individually and collectively in many of their characteristics and relationships, with particular reference to their general properties and the structure of the sidereal heavens.

It would be impossible for a man of science of such distinguished eminence as Prof. Newcomb to produce a book of mediocre quality in all its parts. Several of the chapters in the present volume are original contributions to astronomical knowledge and are not likely to be overlooked in future discussion. As instances we may mention the essays on the distribution of the stars and the statistical studies of proper motion. In the treatment of such subjects as these Prof. Newcomb is *facile princeps*, the result being that good material is selected and satisfactory conclusions are reached. But in the realm of astro-physics he wanders about with less definite aim and purpose, partly trusting to the counsel of friends as to the selection of subjects upon which to concentrate his attention. The result of this eclectic survey is not altogether satisfactory. A wide acquaintance with the new astronomy and a perfectly impartial spirit are rare attributes among writers on celestial science, but they are none the less desirable, and when they are not manifest the deficiency should be pointed out. This we propose to do, if only for the purpose of showing that there are other points of view beside those occupied by Prof. Newcomb.

It is easy to show that the outlook described is not only limited, but also often imperfect. Take, for example, the account of nebulæ. About forty lines have been found in the spectra of these bodies, yet Prof. Newcomb gives the impression that only four are known, namely the blue and violet hydrogen lines and the two characteristic nebular lines. Moreover, he makes the astounding remark that "none of these lines can be certainly identified with those of any terrestrial substance. The supposed matter which produces them has, therefore, been called nebulum." This is almost all that is said of the spectra of nebulæ, and it is an incorrect and incomplete statement of the facts. The suggestion that the lines at wavelengths 4341 and 4861 are due to the hypothetical nebulum has nothing to support it and cannot be taken seriously. For the rest, we can only say that astro-physics has progressed much farther in the knowledge of the lines and origins of nebular spectra than is implied in Prof. Newcomb's paragraph upon the subject.

As the whole question of the nature of nebulæ has to be referred to spectroscopy for an answer, a basis so slender as that described is unable to support a satisfactory edifice. If all that is known of nebular spectra were bounded by the remarks mentioned, the statement that "the light of a nebula does not come from solid matter, but from matter of a gaseous or other attenuated form" might pass muster among the uncritical. But, in addition to the lines of hydrogen and helium and the flutings of carbon, we have evidence of the existence in nebulæ of the metals iron, calcium and possibly magnesium, thus showing that we are not dealing merely with the permanent gases. So far as the spectroscopic evidence is concerned, the hypothesis that nebulæ consist of meteoritic and gaseous matter satisfies the facts better than any other; and even the dynamical objections mentioned are by no means "insuperable," as Prof. Newcomb describes them. Of course, "the amount of light produced by the collision of two such objects [meteorites] is only a minute fraction of the energy lost." But the remainder produces heat which may be sufficient to vaporise some of the constituents of the meteorites engaged, and it must be remembered that gases glow at a low temperature as well as at a high one.

The tendency to accept transcendental temperatures as characteristic of celestial phenomena shows itself in connection with new stars. We have as the cause of the new star of 1866 "an outburst of incandescent hydrogen, giving rise to a volume of flame of such magnitude as to be visible at the vast distance of our system." From what is now known of new stars it is probable that the Nova of 1866 had a spectrum of much the same kind as that shown by the new stars which have been observed in recent years. In any case, the "world on fire" theory is obsolescent, if not obsolete. Nova Aurigæ began the reform, for no detailed observations with modern instruments had been made before its day. Prof. Copeland detected and announced the presence of hydrogen in the spectrum on the first night he observed the star after receiving the postcard from Dr. Anderson announcing the discovery of the object. The spectrum was photographed at South Kensington a few days later, and on February 8, 1892, Sir Norman Lockyer announced to the Royal Society that "the bright lines K, H, *h* and G are

accompanied by dark lines on their more refrangible sides." Substantially the same announcement was made by Prof. Pickering about the same time. These are the facts, but they have been overlooked by Prof. Newcomb, who does not mention Sir Norman Lockyer or Prof. Pickering in connection with the Nova, but gives Profs. Campbell and Vogel the credit of the discovery of the double spectrum, and ascribes to the latter the demonstration of the existence of hydrogen a fortnight after the element had been detected in England. The question of priority is a small matter, but the principle involved is important, namely, that care should be taken in the selection of significant observations by whomsoever they are made. It can scarcely be said that Prof. Newcomb has exercised impartial judgment in this case.

Early observations of the occurrence of bright hydrogen lines in the spectrum of Mira Ceti are overlooked in much the same way as with Nova Aurigæ. Bright hydrogen lines were photographed in the spectrum of this variable star so long ago as 1886, and were observed by Mr. Espin about the same time; yet we read "Campbel found that near the time of maximum, the bright hydrogen line Hγ was very strong and overexposed on all the plates." The disregard of observation of Beta Lyræ is even more unsatisfactory. Prof. Myers's mathematical theory of the constitution of the star's system is described, while the numerous spectroscopic researches relating to the star are scarcely mentioned. The South Kensington photographs indicated long ago the presence of two bodies giving dark-line spectra—one like Rigel and the other like Bellatrix. The shifting bright lines are superposed upon the double-absorption spectrum, and the spectroscopic variations which occur bear a constant relation to the period of the star's changes of lucidity. Prof. Belopolsky's measures of the velocity of the star in the line of sight, and his proof that the radial velocity is zero when the star is passing through the primary and secondary minima, have practically proved that the chief cause of variability is eclipse by such bodies as those mentioned. Why, then, should these established facts be left out of consideration while space is given to mathematical inquiries which have yet to receive spectroscopic confirmation?

The study of these binary and multiple spectroscopic systems has already led to results of deep significance, and Prof. Newcomb devotes some attention to them. In connection with the account of Prof. Vogel's investigations of Algol, however, it is worth remark that the eclipse theory of the variability of the star was practically established by Prof. Pickering by observations of spectroscopic changes before precise measures of the radial velocity were made at Potsdam. Algol is a case of May wedded to December—a fervid body linked to one apparently decaying or dead. In true spectroscopic binaries like Zeta Ursæ Majoris (not Xi Ursæ Majoris, as is stated on p. 167), we have the component stars in more or less the same stage of development. From close binaries of this kind with periods of a day or so it is now possible to pass almost without a gap to the double stars with periods reckoned in centuries. Prof. Newcomb gives eleven years as the shortest period of a telescopic binary, but the star β 883 has a period of only half this length, which brings the two classes of binary systems closer together than he supposes.

Breaches of continuity are usually only apparent, and become filled as knowledge increases. We have passed the days of special creations, and are beginning to see a course of evolution in all natural processes. The biologist has adapted himself to this idea more readily than the astronomer, who looks askance at all attempts to discover a spectroscopic order of evolution in celestial bodies. Prof. Newcomb brings together a number of interesting facts concerning the structure of our universe, but he does not show much relationship between them. Why is it that nebulæ which give bright-line spectra, bright-line stars and new stars are almost exclusively confined to the Milky Way? For though it is true that diffuse nebulæ "are least numerous in the Milky Way and increase in number as we go from it in either direction," it is also true that there are more planetary nebulæ near the Milky Way than in any other part of the heavens. It is reasonable to suppose that there is a large amount of dark meteoritic matter in the region of the Galaxy, as well as a greater depth of stars. Sir Norman Lockyer has suggested this in explanation of the overwhelming number of very faint stars which occur in the Milky Way. Such stars may only be faint because of the partial extinction of light caused by fine particles of matter; so that the same stars would appear brighter if they happened to be nearer the galactic poles. Upon this hypothesis it is possible to explain phenomena which otherwise appear inexplicable; at any rate, it is as worthy of analysis as the "grindstone" theory of the structure of the universe.

It is too much to assert that no extinction or modification of light occurs in space. We can only analyse what reaches us, and it is just as logical to assume the existence of an absorbing medium as it is to neglect a possible cause which, while not contrary to any observed facts, facilitates the explanation of related phenomena. The test of any theory is not so much how it explains one group of facts or phenomena, but how far it admits of general application; and it is because the meteoritic hypothesis satisfies this condition that it claims attention. Most of us will agree with Prof. Newcomb in the remark, "So far as we can judge from the enumeration of the stars in all directions, and from the aspect of the Milky Way, our system is near the centre of the stellar universe." But the argument is nevertheless unsound. It would be just as reasonable for a horse tethered to a stake to conclude that the grass he was able to get at represented all there was in the world. We can only sound the depths of space so far as our instruments permit us, and the facts as to the distribution of stars or other celestial bodies must be considered in relation to others of a spectroscopic character before we are justified in assuming that the sun is situated towards the centre of our universe.

There are many other points in Prof. Newcomb's book which invite discussion, but they cannot be dealt with here. It is worth mention that no account is taken of Prof. Perry's reasons for believing that the sun may have radiated heat for much more than twenty million years, and that the results of studies of photographs of stellar spectra taken at South Kensington are entirely neglected. The misprints we have noticed are *Sirs* A. A. Common and Isaac Roberts (p. iv.), telescopic for spectroscopic (p. 12)

Goodrick for Goodricke (p. 102), Tebbut for Tebbutt (p. 126), Edinborough for Edinburgh (p. 139), and meteoritic theory for meteoritic hypothesis (p. 190). As was remarked at the commencement of this notice, the book presents many interesting problems on subjects with which Prof. Newcomb is familiar, but it leaves the reader still to seek a broad-minded statement of the position of spectroscopic work in connection with the study of the stars. R. A. GREGORY.

PRINCIPLES OF GEOGRAPHY.

Tarr and McMurry's Geographies. Second book, *North America.* Third book, *Europe and other Continents.* By R. S. Tarr and Frank M. McMurry. Pp. xix + 469, and xx + 574. (New York: the Macmillan Company. London: Macmillan and Co., Ltd., 1900 and 1901.) Price 4*s.* 6*d.* each.

THE leading idea of this series, of which the first volume only, that on "Home Geography," has been published in England, is that "Geography treats of the relation between man and the earth—a hill or a lake is worthy of mention only because it bears a relation to us, the men upon the earth; considered by itself it is not a part of geography." Without discussing this notable statement on its merits, we confess to finding its application in these volumes somewhat disappointing. It becomes an attempt to extend the methods of the elementary illustrated geographies to more advanced stages, and necessitates a degree of sketchiness which makes some parts of the books almost unintelligible and others misleading. On pp. 27 and 28 of vol. ii., for example, we find pictures of fur-clad Eskimos and half-naked savages of the tropics to illustrate the difference of temperature in these two latitudes, and only fourteen pages further on we are confronted with a vertical section of the atmosphere showing the complete general circulation. The circulation between the horse latitudes is compared to that caused by a stove in a room, and the rest is dismissed in the sentences, "Being cooled on account of its great height, the air of the anti-trades slowly settles, some of it coming to the surface at about a third of the distance to the poles. There it spreads out, a part continuing on toward the poles, a part returning to the equator as the trade winds." Given the analogy of the stove, what is the intelligent pupil to make of the "part continuing on towards the poles"?

Again, in connection with oceanic circulation, we find drift currents satisfactorily accounted for, but the cause of the many currents which cannot be thus explained is simply passed over. In describing the relation of ocean currents to climate, the authors fall into serious error, and the old story of the "Gulf Stream" carrying "one-half as much heat into the Arctic as reaches it from the direct rays of the sun" reappears once more. All the explanation given of the tides is, "When the sun and moon pull upon the earth, the ocean, being a liquid that can be moved, is drawn slightly out of shape."

The descriptive parts of these books are admirable; in the volume on the United States especially, the physical features, climate, means of transport, industries and commerce are treated with unfailing interest and clearness, and there is abundance of illustration and good maps; but the "physiographic basis" as here set forth—the attempt to account for modern distribution directly from first principles—must suggest to the boy who "sees difficulties" so many questions of which we do not know the answers that he will be apt to distrust the "principles" altogether, while the boy who accepts everything will receive a fatal impression of the simplicity of the universe. It is one of the advantages of geography that continual reference can be made, in teaching, to first principles, but the science is still a long way from the point at which a satisfactory text-book of the kind proposed by the authors can be written.

ELEMENTARY ZOOLOGY.

A Text-book of Zoology. By G. P. Mudge, A.R.C.Sc. Lond. Pp. viii + 416; 100 figures and 2 coloured plates. (London: Edward Arnold, 1901.) Price 7*s.* 6*d.*

THIS aid to the study of zoology differs in plan from most books of similar purpose. After a general introduction on the scope of biology, which will prove, we fear, a heavy meal for beginners, the author discusses (1) the comparative morphology of vertebrates, illustrated by dogfish, frog and rabbit, and by the lancelet (which has naturally a chapter to itself); (2) the morphology of cœlomate invertebrates, illustrated by crayfish, cockroach, freshwater mussel and earthworm; (3) the structure of Hydra as a type of acœlomate diploblastic invertebrates; and (4) the structure of Paramœcium and Amœba as types of Protozoa. Then follow chapters on reproduction and development, heredity and variation.

Mr. Mudge's exposition is clear and accurate, and his terseness is a feat in itself. Perhaps this striving after conciseness has inhibited the author, for while the chapters on heredity and variation, for instance, are vivid and interesting, there are too many pages in the body of the book which read like dull summaries and show no individuality of treatment or expression. Surely some individuality was needed to justify the repetition for the *n*th time of much that may be found in many other books.

We do not think that Mr. Mudge was wise in his choice of a title—"A Text-book of Zoology"—for this ticket is too big for his wares. A text-book of zoology cannot afford to leave out of consideration birds and reptiles, and half of the classes of invertebrates, or to deal so slightly with bionomics. And while we recognise the value of this new aid to the study of zoology in so far as it forces the student to realise what comparative anatomy means, we doubt whether this lesson is rightly learned when only a few types are compared. Thus, to be frank, is there more than practical convenience to justify the time-honoured position of the frog in schemes of comparative morphological study? As a cheap *corpus vile* on which the student may learn to dissect, the frog is useful—almost indispensable—but as a type for the study of the comparative morphology of vertebrates it is one of the most difficult. The figures in the book are clear and useful, but the prominence given to the coloured diagrams of various circulatory systems seems out of perspective.