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THE ANCIENT VOLCANOES OF BRITAIN.

The Ancient Volcanoes of Britain. By Sir Archibald Geikie, F.R.S., Director-General of the Geological Survey. Vol. I., pp. xxiv. + 477 ; Vol. II., pp. xvi. + 492. (London : Macmillan and Co., Ltd., 1897.)

THE Edinburgh school of geology, when of old it formulated the theory of existing causes of terrestrial change, established the fundamental principle of modern geological science. Thanks to this school, men learnt how rocks were formed, how the strata of the earth's crust were built up, how slow had been the evolution of the continents and oceans, and how important is the conception of time in regard to the past history of the globe. The brilliant representative of this illustrious school who has recently published a history of the volcanoes of Great Britain, sets forth in this remarkable treatise the great features in the volcanic history of the earth, and establishes the principles which will henceforth guide geologists in the study of the massive crystalline rocks.

From the remotest times there have existed on the surface of the globe volcanoes essentially similar to those now active. Such is the doctrine which Sir Archibald Geikie maintains. He has proved the uniformity of the phenomena and of the volcanic products throughout the geological past. He has indicated the cycles of differentiation among the magmas, and their recurrence in successive ages. He has shown how the sequence and structure of ancient eruptive rocks are to be determined.

The geological historian who shall hereafter record the stages in the progress of our knowledge regarding what may be termed fossil volcanoes, will attribute their first discovery to Guettard and Desmarest ; their analysis to Sorby, to the German petrographers, and to Fouqué and Michel Lévy (to whom the present work is dedicated); and their synthesis to Sir Archibald Geikie, who has resuscitated and reconstructed the old dismantled volcanoes, buried under the geological formations of Great Britain.

The author, in a preface dealing with the history of discovery in the domain of volcanic geology, introduces his subject in the following sentences.

"In no department of science is the slow and chequered progress of investigation more conspicuous than in that branch of geology which treats of volcanoes. Although, from the earliest dawn of history, men had been familiar with the stupendous events of volcanic eruptions, they were singularly slow in recognising these phenomena as definite and important parts of the natural history of the earth. Even within the present century, the dominant geological school in Europe taught that volcanoes were mere accidents. A juster appreciation of the nature of the earth's interior was needed, before men could recognise that volcanic action had once been vigorous and prolonged in many countries, where no remains of volcanoes can now be seen."

"To France, belongs the merit of having laid the foundations of the systematic study of ancient volcanoes. As far back as the year 1752, Guettard recognised that the Puys of Auvergne were volcanic cones that had poured forth streams of lava. But it was reserved to Desmarest twelve years later to examine the question in detail, and to establish the investigation of former volcanic action upon a broad and firm basis of careful observation and sagacious inference. He discovered that the volcanoes of Central France were not all of one age, but had made their appearance in a long series, whereof the individual members became less perfect and distinct in proportion to their antiquity." "While these fruitful researches were in progress in France, others of hardly less moment were advancing in Scotland. Hutton, as a part of his immortal 'Theory of the Earth,' had conceived the idea that much molten material had been injected from below into the terrestrial crust, and he had found many proofs of such intrusion among the rocks of his native country. His observations, confirmed and extended by Playfair and Hall, and subsequently by Macculloch, opened up the investigation of the subterranean phases of ancient volcanic action" (Preface, pp. vii.–viii.).

From the peculiarly favourable structure of the country, Britain has been enabled to make many important contributions to the investigation of the subject. De la Beche, Murchison and Sedgwick led the way in recognising, even among the most ancient stratified formations of England and Wales, the records of contemporaneous volcanoes and their subterranean intrusions.

A new stage in the history of volcanic geology was entered when Sorby introduced the method of microscopic examination of rocks by means of thin slices. Petrographical investigation was thereby enabled to keep pace with stratigraphical research. The rocks of the whole globe have been made to pass through the German laboratories, and thus precise knowledge has been obtained regarding the mineralogical composition and structure of the rocks, and light has been thrown on the true principles of their classification. In France, Fouqué and Michel Lévy, studying volcanic rocks both in the field and in thin sections, have been able to reproduce the principal types artificially in their laboratory.

In Sir Archibald Geikie's volumes the study of ancient volcanic rocks now emerges from the laboratory, and is prosecuted under the broad sky among the crags, the shores, and the isles. Not that the minute description of internal structure or of chemical and mineralogical composition is neglected by him ; but the rocks are no longer looked at as they are in themselves : their chief value is now sought in their association as parts of a connected volcanic history. A dyke is only noticed when its description allows it to be connected on the one side with a subterranean reservoir, and on the other with its superficial display of lavas or fragmental discharges. The rocks are studied as much from the point of view of their origin as from that of their composition, and their structure is shown to be in relation to some determinate part of a volcanic group. All that has been done, all that has been said in regard to these questions, will be found summed up in Sir Archibald's work, while his masterly exposition of the history of volcanoes from the earliest times down to our own day is enhanced with ingenious conclusions respecting the nature and causes of volcanic action.

The fossil volcanoes reveal no craters. No trace of their original cones has survived to our time, save in some exceptional cases where they have been entombed under lavas, or have been preserved under other accumulations. These and other characteristics con-

stitute difficulties in the study of ancient volcanic action. But they have not proved insuperable. Such has been the progress of this study, that it has already thrown light on the structure and mechanism of the active volcanoes of the present day. Thus a comparison of the pas with the present may enable us to arrive at some adequate conception of the nature and history of volcanoes in the geological history of the globe.

"In this research," as Sir Archibald Geikie remarks, "it is obvious that the presently active volcano must be the basis and starting-point of inquiry. At that channel of communication between the unknown inside and the familiar outside of our globe, we can watch what takes place in times of quiescence or of activity. We can there study each successive phase of an eruption, measure temperatures, photograph passing phenomena, collect gases and vapours, register the fall of ashes or the flow of lavas, and gather a vast body of facts regarding the materials that are ejected from the interior, and the manner of their emission.

"Indispensable as this information is for the comprehension of volcanic action, it obviously affords after all but a superficial glimpse of that action. We cannot see beyond the bottom of the crater. We cannot tell anything about the subterranean ducts, or how the molten and fragmental materials behave in them. All the underground mechanism of volcanoes is necessarily hidden from our eyes. But much of this concealed structure has been revealed in the case of ancient volcanic masses, which have been buried and afterwards upraised and laid bare by denudation.

"In yet another important aspect modern volcanoes do not permit us to obtain full knowledge of the subject. The terrestrial vents, from which we derive our information, by no means represent all the existing points of direct connection between the interior and the exterior of the planet. We know that some volcanic eruptions occur under the sea, and doubtless vast numbers more take place there of which we know nothing. But the conditions under which these submarine discharges are effected, the behaviour of the outflowing lava under a body of oceanic water, and the part played by fragmentary materials in the explosions, can only be surmised. Now and then a submarine volcano pushes its summit above the sea-level, and allows its operations to be seen, but in so doing it becomes practically a terrestrial volcano, and the peculiar submarine phenomena are still effectually concealed from observation.

"The volcanic records of former geological periods, however, are in large measure those of eruptions under the sea. In studying them we are permitted, as it were, to explore the sea-bottom. We can trace how sheets of coral and groves of crinoids were buried under showers of ashes and stones, and how the ooze and silt of the sea-floor were overspread with streams of lava. We are thus, in some degree, enabled to realise what must now happen over many parts of the bed of the existing ocean.

"The geologist who undertakes an investigation into the history of volcanic action within the area of the British Isles during past time, with a view to the better comprehension of this department of terrestrial physics, finds himself in a situation of peculiar advantage. Probably no region on the face of the globe is better fitted than these islands to furnish a large and varied body of evidence regarding the progress of volcanic energy in former ages" (vol. i. pp. 5-6).

Towards the close of his second volume, after adducing in full detail the volcanic records of his native country, the author remarks that

"A review of the geological history of Britain cannot but impress the geologist with a conviction of the essential uniformity of volcanism in its manifestations since the early beginnings of geological time. The composition and structure of the materials erupted from the interior have remained with but little change. The manner in which these materials have been discharged has likewise persisted from the remotest periods. The three modern types of Vesuvian cones, Puys and fissure-eruptions, can be seen to have played their parts in the past as they do to-day."

After an introductory series of chapters dealing with general principles of investigation and interpretation, the work enters upon a detailed description of the volcanic phenomena of the successive geological periods, beginning with the most ancient.

"Among the earliest igneous masses of which the relative geological date can be fixed are the dykes which form so striking a system among the Archæan rocks of the north-west of Scotland, and show how far back the modern type of volcanic fissures and dykes can be traced. No relic, indeed, has survived of any lavas that may have flowed out from these ancient fissures, but so far as regards underground structure, the type is essentially the same as that of the Tertiary and modern Icelandic lava-fields" (vol. ii. pp. 470-471).

The early Palæozoic volcanoes formed cones of lava and tuff comparable to those of such vents as Vesuvius and Etna. As illustrations of the Vesuvian type in the volcanic history of Britain, the author refers to the great Lower Silurian Volcanoes of Cader Idris, Arenig, Snowdon and the Lake District, and to the Old Red Sandstone volcanoes of Central Scotland. In the Lake District the pile of material ejected during Lower Silurian time was at least 8000 or 9000 feet thick. In the Old Red Sandstone basins of Central Scotland there were more than one mass of lavas and tuffs thicker than those of Vesuvius.

The Carboniferous volcanoes were not only abundant and persistent in Scotland, but they attained there a variety and development which give their remains an altogether exceptional interest in the study of volcanic geology. They are referable, from their characters and their age, to two different types, *Plateaux* and *Puys* (vol. i. p. 364).

In the *Plateau-type*, the volcanic materials were discharged over wide tracts of country, so that they now form broad tablelands or ranges of hills, reaching sometimes an extent of many hundreds of square miles and a thickness of more than 1000 feet. Plateaux of this character occur within the British area only in Scotland, where they are the predominant phase of volcanic intercalations in the Carboniferous system, and are eminently characteristic of the earliest portion of that period. This *Plateau* or *Fissure-type* is, among modern volcanoes, best developed in Iceland. In that island, during a volcanic eruption, the ground is rent open by long parallel fissures, only a few feet or yards in width, but traceable sometimes for many miles, and descending to an unknown depth into the interior. From these fissures lava issues—in some cases flowing out tranquilly in broad streams from either side, in other cases issuing with the discharge of slags and blocks of lava which are piled up into small cones set closely together along the line of the rent. By successive discharges of lava from fissures, or from vents opening on lines of fissure, wide plains may be covered with a floor of rock made up of horizontal beds.

The author shows that, after the beginning of the Carboniferous Limestone period, when eruptions of the

plateau-type had generally ceased, volcanic activity showed itself over the area of the British Isles in a different guise, both as regards the nature of its products and the manner and scale of their discharge (vol. i. p. 414). Instead of widely extended lava-sheets and tuffs, piled above each other sometimes to a thickness of many hundred feet, and stretching over hundreds of square miles, another phase of volcanism presented itself, where scattered groups and rows of *Puys*, or small volcanic cones, threw out, in most instances, merely tuffs, and these often only in trifling quantity, though here and there their vents also poured forth lavas, and gradually piled up volcanic ridges which, in a few cases, almost rivalled some of the plateaux. The evidence for these less vigorous manifestations of volcanic activity is furnished (1) by layers of tuff and sheets of basaltic-lavas intercalated among the strata that were being deposited at the time of the eruptions; (2) by necks of tuff, agglomerate, or different lava-form rocks that mark the positions of the orifices of discharge; and (3) by sills, bosses, and dykes that indicate the subterranean efforts of the volcanoes. The comparatively small thickness of the accumulations usually formed by these vents, heir extremely local character, the numerous distinct horizons on which they appear, and the intimate way in which they mingle and alternate with the ordinary Carboniferous strata, are features which at once arrest the attention of the geologist, presenting, as they do, so striking a contrast to those of the plateaux.

In a vast number of ancient volcanic vents, no trace can be discovered of their connection with any fissure in the earth's crust (vol. i. p. 53). Such fissures may, indeed, exist underneath, and may have served as passages for the ascent of lava to within a greater or less distance from the surface. But it is established in these volumes that volcanic energy has the power of blowing out an opening for itself through the upper part of the crust without the existence of any visible fissure there. What may be the limits of depth at which this mode of communication with the outer air is possible we do not yet know. They must obviously vary greatly according to the structure of the terrestrial crust on the one hand, and the amount and persistence of volcanic energy on the other. But where the thickness of rock above the end of the fissure is not too great, the expansive energy of the vapours absorbed in the magma may overcome the resistance of that cover, and blow out an orifice by which the volcanic materials can reach the surface. In an ordinary volcanic orifice the ground-plan of the neck is usually irregularly circular or elliptical.

The discharge of explosive vapours was sometimes the first and only effort of volcanic energy. Generally, however, fragmentary volcanic materials were ejected, and cones of tuff were formed; or, if the eruption was more vigorous, lava was poured out. Towards the close of a volcanic period, the vents were gradually choked up with the fragmentary materials that were ejected from, and fell back into them. When the vents were plugged up by the consolidation of fragmentary matter, or the uprise of lava in them, the final efforts of the volcanoes led to the intrusion of *sills* and *dykes*, not only into the rocks beneath the volcanic sheets, but also, in many instances, into at least the older parts of these sheets themselves. The size and extent of the *sills* may thus be a record of the intensity of this latest phase of the volcanic eruptions.

The chief products of the Carboniferous volcanoes are basic rocks, dolerites, and basalts, with andesites; they are somewhat more acid in the necks, where are found diabases, trachytes, and phonolites. The Puy lavas are generally more basic than the lavas of the plateaux.

The Permian volcanoes were the last of the long Palæozoic series, and, so far as we yet know, the whole of the Mesozoic periods, within the area of Britain, were absolutely unbroken by a single volcanic eruption. It was an era of geological calm, during which the Triassic, Jurassic and Cretaceous formations were slowly accumulated over the larger part of Europe. The stratigraphical quietude was not, indeed, unbroken. The widespread subsidence of the sea-bottom was interrupted here and there by important upheavals, and considerable geographical changes were in process of time accomplished. But, save in one or two widely separated areas of Europe, there were no active volcanoes over the whole continent.

After the enormous interval represented by the whole of the Mesozoic and the earlier part of the Tertiary formations, a time of disturbance arose once more, and a surface of 40,000 square miles was covered in the north-west of Britain by great basalt-floods. The whole of these latest volcanic manifestations were comprised within the earlier (Oligocene and, perhaps, early Miocene) part of older Tertiary time.

The first indications of Tertiary volcanic energy in the north-west of Europe were displayed in the formation of numerous parallel fissures extending in the British Isles in a general north-westerly direction. Between the walls of these opened fissures a basic magma rose and solidified, thus constituting the innumerable dykes of the region. Sometimes the magma reached the surface of the ground, and streaming forth there formed the successive sheets of basalt in the great plateaux. In some instances, as in modern Icelandic eruptions, the lava may have issued immediately from the fissures; in others its rise has been accompanied with the formation of small cones along the line of a chasm. During a tolerably protracted period, basic and intermediate lavas (basalts, dolerites, andesites, and trachytes) continued to be poured out, together with possibly an occasional outflow of rhyolite. These eruptions took place from many points, and not from great central volcanoes like Vesuvius. The result of their operations was to bury under more than 3000 feet of volcanic materials the broad valley between the mainland of Scotland and the chain of the Outer Hebrides. This long series of eruptions is shown to have been subaerial by the terrestrial relics—plants, insects, river-beds and lake-bottoms preserved under and between the lavas. Gradually, as the pile of volcanic material grew in thickness, the magma was less frequently ejected to the surface, but it insinuated itself underneath to form there sills or intrusive sheets.

The second stage in the Tertiary volcanic history is revealed by the great bodies of amorphous and banded gabbro which form so prominent a feature in the Inner Hebrides. These eruptive masses have disrupted the

lavas of the plateaux which are more or less metamorphosed around them, and are traversed by a fringe of finer-grained sills and veins of dolerite, gabbro, troctolite, picrite, &c., which have often insinuated themselves between the sheets of the plateau-basalts. The coarse-grained and banded gabbros may have consolidated at some depth; at least nothing is yet certainly known of their superficial equivalents.

The third stage of activity, probably long posterior to the second, likewise furnishes no evidence of any superficial ejection. It is recorded by a series of markedly acid rocks—obsidians, felsites, rhyolites, porphyries, granophyres, and granites. These rocks form huge conical hills, which in outward aspect recall the trachytic Puys of Auvergne. They traverse alike the plateau-basalts and the bosses of gabbro, into which they send many dykes and veins. They also project numerous thick sills into the formations lying underneath. The rocks around these acid protrusions have been greatly metamorphosed, while the granophyres and granites have in turn undergone considerable change in composition from having caught up and assimilated sometimes a fourth of their bulk of basalt or gabbro.

After the uprise of the granophyres with their surrounding network of felsitic dykes and veins, a new ascent of basic material manifested itself, recalling that of the earliest basalt-dykes, but on a minor scale. The dykes then formed cut all the other members of the volcanic series, including the granophyres. No trace remains of any superficial discharges connected with these latest dykes. If they ever gave rise to outflows of lava, these have long since disappeared in the vast denudation which the Tertiary volcanic rocks have undergone.

The latest eruptions of North-Western Europe, forming the Tertiary volcanic series, are shown by Sir Archibald Geikie to have far exceeded in area, and possibly also in bulk of material discharged, all the eruptions that had preceded them in the geological record.

We learn further that neither in their forms or products, nor by their extent and vigour, did the volcanic manifestations of the successive ages of the geological past materially differ from those of the present time. There is assuredly no evidence that volcanic energy has gradually waned since the dawn of geological history.

A consideration of the distribution of the volcanic rocks in time shows not only how singularly uniform the course of volcanic activity has been, but that there is no evidence of the cessation of any of the broader petrographical types during geological history. Quite as much variety may be observed among the erupted materials of Tertiary time in Britain as among those of the early ages, when the earth was younger and its volcanic vigour might be supposed to have been greater and more varied than it is now.

From the evidence detailed in these volumes, it appears that the sequence from basic to acid discharges was on the whole characteristic of each eruptive period. It is obvious however, the author observes, that as the protrusions of successive periods took place within the same limited geographical area, the internal magma during the interval between two such periods must in some way have been renewed as regards its constitution, for when, after long quiescence, eruptions began once more, basic lavas appeared first, and were eventually followed by acid kinds.

Various opinions have been propounded as to the cause or causes of the differentiation observable in erupted masses, but none of them are entirely satisfactory. We must await the results of further exploration in the field and of continued research in the laboratory.

What appears to have taken place within a subterranean molten magma which has been propelled into the earth's crust as a boss or laccolite, with or without a connected system of dykes, may possibly be made to throw some light on the remarkable changes in the characters of lavas successively erupted from the same vent during the continuance of a volcanic cycle. Whether or not any such process of differentiation can be proved to take place within a subterranean volcanic reservoir, the sequence of erupted lavas bears a curious resemblance to the order in which the constituents of some large bosses succeed each other from margin to centre (vol. i. p. 92).

Sir Archibald Geikie has written the history of the ancient volcanoes of Britain in a series of attractive chapters, which he has illustrated with more than four hundred sketches, photographs and maps. But the fine work with which he has enriched science is much more than a detailed description of the crystalline rocks of his own country. He elucidates their structure and arrangement, and explains thereby their history. He rises from a consideration of facts to a discussion of the cause of volcanic phenomena. He makes the extinct volcanoes bear their testimony in favour of the uniformity and unity of the laws of nature. His work will remain one of the monuments of our time, establishing for the future the conception of the continuity of volcanic phenomena from the earliest periods, and, so far as the geological records go, demonstrating that the interior of our planet has reacted on its exterior in the same way and with the same results. CHAS. BARROIS.

AMERICAN MATHEMATICS.

Higher Mathematics: a Text-book for Classical and Engineering Colleges. Edited by Mansfield Merriman and Robert S. Woodward. Pp. xi + 576. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

THIS is a style of mathematical treatise to which we are not accustomed in this country, from the luxury of the print and size of page, as well as for the refreshing novelty and interest of the contents.

Till recently, it was thought that the study of mathematics was not likely to flourish in America, as *trop vieux jeu* by the side of the new physical and biological sciences. To-day, however, it is the American student who is the most enthusiastic follower of recent mathematical development, while we in this country are being left far behind.

The words on the title-page—A Text-book for Classical and Engineering Colleges—the equivalent of our own—For Schools and Colleges—is not, however, taken, as with us, to be the rendering of *In usum Delphini;* all human interest arising from the application of theory has not been carefully eliminated from the pages, as

likely to confuse or excite the mind of the student; on the contrary, the various contributors insert carefully chosen appropriate illustrations as the best means of elucidating the difficulties of the abstract theory. With us the spirit of the schoolmaster is too much abroad in our mathematical writings; it has even been objected that these illustrations tend to obscure a subject, as it were, with the smoke of its own guns: a musty simile in these days of smokeless gunpowder.

Thus, for instance, the solution of a quintic equation is presented as required for the determination of the supply of a water-main (p. 13); very vulgar this, our college professor will say. So, too, the intuitive reasoning of a graphical procedure with an appropriate diagram has been freely employed to replace the tedious and unconvincing procession of formulas which impede the progress of our own students. A mention of M. Félix Lucas's electrical determination of the roots, real and imaginary, might well have found a place here.

Each of the eleven chapters of the book is undertaken by a different writer—Chapter i., on the Solution of Equations, by Mansfield Merriman; and Chapter ii., on Determinants, by Laenas Gifford Weld; both complete and original in their way.

The treatment, in Chapter iii., of Projective Geometry, by George Bruce Halsted, is very bright and stimulating; this is a subject ignored in our own mathematical curriculum.

The two forms of spelling "centre" and "center," appear on the same page (95); the second is, of course, phonetically correct, as the English pronunciation always inverts the liquid and the vowel in the French spelling, here and in all similar words.

Chapter iv. is on Hyperbolic Functions, by James McMahon. Our scholastics look upon this subject as a temporary fad, which has not come to stay; however, electricians find them indispensable, and many elegant electrical applications, among others equally important, of mechanical and astronomical interest, such as catenaries, loxodromes, charts, conjugate functions, will be found collected here.

The long form of these functions, cosh, sinh, tanh, . . . has been retained, with a suggestion that the ugly sounds they suggest should be avoided by pronouncing them *h*-cosine, *h*-sine, *h*-tangent, &c. But the modern continental practice is to abbreviate the symbols to ch, sh, th, pronouncing only the letters *c-h*, *s-h*, *t-h*, as with the Elliptic Functions; so also for their inverse functions, ch^{-1}, sh^{-1}, th^{-1}, employed here, for their obvious advantages in integration. A well-arranged table concludes this chapter; we miss, however, Bernoulli's numbers in their proper place in the expression of tan x, th x. . . .

Prof. Byerley, of Harvard, contributes Chapter v., on Harmonic Functions. When his genial treatise on Fourier's Series and Harmonic Analysis made its appearance, some four years ago, it was welcomed by all physicists as the long-desired manual, which placed this subject before them in an intelligible manner, devoid of artificial obstacles and impediments. Unfortunately the treatise fell into the hands of mathematical critics, who could see little merit in the book, because it passed over in silence the tedious, and useless, arguments concerning the legitimacy of the expansions. If an electrician is to employ a Fourier Series, he will content himself with the first two or three terms of the series; just as the calculator of mathematical tables will not, for practical purposes, employ more than three, or four terms at most, in Taylor's Series. But where the applicability becomes doubtful, by reason of the neighbourhood of a discontinuity, he will assure himself, by a diagram such as those on p. 199, of the limits of the divergence.

These difficulties concerning the discontinuity of functions is very properly relegated to another chapter, number vii., on Functions of Complex Variables, by Thomas S. Fiske, which gives us a very clear account of the most recent manner, of the school of Weierstrass, of approaching such refinements of argument. We are pleased to find the name "one-valued function" instead of "uniform function," which is misleading to the beginner.

Prof. Woolsey Johnson, of the U.S. Naval Academy, contributes Chapter vii., on Differential Equations. His own formal treatise on the subject is well known and highly popular; and the present chapter incorporates the essential, or what Maxwell called the "gentlemanly," knowledge of the subject.

The next two chapters—Chapter viii., on Grassmann's Space Analysis, by Edward W. Hyde, and Chapter ix., on Vector Analysis and Quaternions, by Alexander Macfarlane—seem to us by comparison to be of the nature of luxuries, appealing to the purely analytical spirit; although even here electrical applications are introduced to show how the theories may be usefully applied.

Chapter x. is a short and useful *résumé*, by R. S. Woodward, of the principal parts of Probability and the Method of Least Squares, with which every physical student should now be familiar; and the volume concludes with Chapter xi., on the History of Modern Mathematics, by David Eugene Smith, in which the author is compelled to apologise for the incompleteness imposed upon him by the exigencies of room, but which, nevertheless, provides the most important details required for reference.

The account given by the Editors, in the preface, of the work expected of the average American student, shows that the standard of requirement is much higher than in this country, and not hampered by traditional prejudice.

A. G. GREENHILL.

OSTEOLOGY.

The Vertebrate Skeleton. By Sidney H. Reynolds, M.A. Pp. xvi + 559. (Cambridge: University Press, 1897.)

THIS most recent addition to the Biological Series of the Cambridge Natural Science Manuals edited by Mr. A. E. Shipley, is an attractive-looking volume, well printed, and with the monotony of the text agreeably broken by a judicious use of small capitals, italics, and clarendon type. The numerous illustrations, which are probably accountable for the high price (12*s.* 6*d.*) of the book, though simple in execution are clear in detail, and, on the whole, chosen with discretion. The majority of the figures have not been published before, and are based on specimens contained in the Cambridge University Museum and the Natural History Museum, London. The text is remarkably free from typographical errors, but is frequently bald in style and irritating from

unnecessary iteration. This repetition, it is true, is apologised for in the preface, but it could have been avoided by altering the plan of the book, which as it stands is rather confusing.

What strikes one most on glancing through the pages is the disproportionate treatment of the subject. To devote one-third of the whole book to the mammalian skeleton shows that the author has allowed himself a free hand where the facilities for compilation are greatest—and his indebtedness to the "Osteology of the Mammalia" is admitted in the preface. Where, however, it has been necessary to collect the detailed statements from scattered sources, as, for instance, in Fishes and Amphibia, the results are very far from satisfactory. The parts relating to the Cyclostomi, Ganoid fishes, the shoulder-girdle of Anura, and the hyoid of Reptilia are especially poor. The classifactory scheme (pp. 30-49), including as it does extinct as well as living vertebrates, should prove of considerable service to the student. It is well up to date, and, on the whole, trustworthy, although ichthyologists will probably gird at the inclusion of a physoclistous form like *Exocœtus* among the Clupeidæ. It would have been well if the generic and specific names of the borrowed figures had been checked by reference to some modern catalogue, instead of relying so implicitly upon those used by the original authors. *Galeus*, for instance (Fig. 15), should read *Galeocerdo*, and *Docidophryne gigantea* (Fig. 30), *Bufo marinus;* while the Figs. 16 and 17 of the seven-gilled shark should, in the student's interests, be given the same generic name, either *Notidanus* or *Heptanchus*. The specimen in the Natural History Museum, on which Fig. 16 is based, is marked *Notidanus*, while Gegenbaur's figure, which is reproduced in Fig. 17, is labelled *Heptanchus*, and Mr. Reynolds has, regardless of uniformity, adopted the two names as he found them.

The want of cohesion throughout the text detracts seriously from the value of the book. The various sections, culled from different sources, are not blended together, so that the product is indigestible and difficult of assimilation. The failure to treat the subject from a consistent morphological point of view is, in fact, the great flaw in the book. Positive inaccuracies are not common, but the sternum ought not to come under the head "Hyoid apparatus" (p. 162), the epipubic cartilage of *Xenopus* (p. 188) and the horny beaks of *Siren* (p. 168) are not "minute," and auditory ossicles are not as large as Fig. 100 would lead one to believe. The application of the name "branchiostegal rays" to the endoskeletal cartilages of the branchial septum of selachians (p. 120) implies a false homology with the dermal bones attached to the hyoid arch in bony fishes, while the inclusion of the vomer of the dog (p. 395), under the head "Bones in relation to the Olfactory Capsules," fails to impress upon the student the fact that this bone is morphologically an ossification of the mucous membrane of the roof of the mouth.

That great credit is due to Mr. Reynolds for his conscientious industry and honesty of purpose there is abundant internal evidence to show, but the product of his labours is—a book which is just good enough to suggest how valuable it might have been had its compilation been entrusted to a qualified morphologist. At the same time, Mr. Reynolds is to be congratulated on the large amount of information which he has brought together, and on the fact that he has not neglected the extinct forms. And although, in its present form, the book cannot with advantage be used as a book of reference, while its abrupt and disconnected style renders it ill-adapted for continuous reading, there can be little doubt that if, when a second edition is called for, the plan of the book were simplified, the inaccuracies corrected, and the various chapters and sections connected up and coordinated, the book would prove a valuable addition to the student's library.

OUR BOOK SHELF.

Studien über Dampfspannkraftmessungen. By Georg W. A. Kahlbaum; with the co-operation of C. G. von Wirkner and others. Part ii. 1st half. Pp. x + 221. (Basel: Benno Schwabe, 1897.)

IN the first part of this work (NATURE, March 8, 1894, p. 436), measurements of the vapour pressures of a number of substances were given. The method used in the determinations was also fully described, and its accuracy discussed. The author's intention was to devote the second part of the book to a discussion of the theoretical bearing of the experimental material collected. Further experiments with substances belonging to chemical groups other than those previously examined revealed, however, the necessity of first enlarging this experimental material; the present volume contains the results of these additional measurements. The experimental method employed is the same as before, and the results are given in the form of numerical tables and of curves. Every precaution appears to have been taken to secure accuracy. Where previous observations exist, the results are compared together, and the satisfactory agreement found between the results obtained by Ramsay and Young, for example, by the statical, and by the authors by the dynamical method, may be regarded as further evidence of the trustworthiness of the latter. In this volume the measurements extend from about 0 to 760 mm., except in cases where the solidification of the substance prevented the measurements at lower pressures. The substances for which new experimental results are given are benzene, brom-benzene, benzaldehyde, phenol, aniline, benzonitrile, benzyl alcohol, nitrobenzene, benzoic acid, ethyl alcohol, propionic, normal butyric, valeric, heptylic, isobutyric and isocaproic acids, methyl-, dimethyl-, ethyl- and diethyl-aniline, phenylmethyl ketone, methyl benzoate and benzoyl chloride.

In connection with the fatty acids, the accuracy of Dühring's rule is discussed. The rule states that the difference between the boiling-points of a liquid at some standard pressure and at any other pressure divided by the corresponding difference for some other liquid is a constant quantity for that pair of liquids. This, it appears, is sufficiently accurate only when the liquids belong to a group of closely related substances, such as the fatty acids.

In conclusion, it is hardly necessary to point out the great value, scientific and practical, of careful determinations, such as those before us, of the vapour pressures of liquids.

The Induction Coil in Practical Work, including Röntgen Rays. By Lewis Wright. Pp. vi + 172. (London: Macmillan and Co., Ltd., 1897.)

THE discovery of the Röntgen rays has created a revived interest in many of the beautiful experiments that can be performed with the aid of the Ruhmkorff induction coil, and is thus indirectly a sufficient justification for the appearance of this treatise of 172 pages. More especially

written for those who, without much previous acquaintance with electrical apparatus, are for purposes of practical utility or scientific recreation anxious for theoretical and practical knowledge on the subject, this little book is also replete with useful information and suggestive hints that will not fail to prove of service to more experienced electricians. The volume is methodically arranged and well illustrated; and if there are omissions which might with advantage have been supplied, these are no doubt largely due to the author having been confined to a limited amount of space. So many experiments connected with the electrical discharge in rarefied and dense gases can be performed not only with an induction coil, but equally efficiently with a Wimshurst or other form of electrostatic influence machine, that one cannot but regret that the author has so rigidly confined himself to the application of coils alone. For a similar reason, it seems a pity not to have included some detailed information as to the so-called high frequency coils of Tesla and Elihu Thomson, which, even as an adjunct to induction coils, are not quite so completely abandoned for X-ray work as the author appears to imagine, while they afford a means for many other instructive experiments of comparative novelty and great beauty. It is necessary to say, moreover, that the brief references that do appear in the book to such coils, as also to the use of alternating currents generally, are scarcely as accurate and as lucid as might be desired.

It is to be regretted that the author uses the word *current* in a loose and, sometimes, in a very misleading manner. Notwithstanding these defects, which it is to be hoped the author may be able to remedy in subsequent editions, the book is undoubtedly the best popular and practical work that has yet appeared on the subject of which it treats.

The Calculus for Engineers and Physicists. By Prof. Robert H. Smith. Pp. xi + 176. (London: Charles Griffin and Co., Ltd., 1897.)

NOT only is "Integration more useful than Differentiation," the author's opening statement, but the conception of Integration is more tangible and easy to grasp than that of Differentiation, a far more abstract idea.

We recognise the growth of a tree after a few years, although the actual rate of growth is infinitesimal.

For purposes of application, a knowledge of Differentiation must just precede the inverse operation of Integration; but that does not justify our present system of carrying the student through the Differential Calculus before starting on the Integral; the two subjects should be carried out, as far as possible, *pari passu*.

Classified Reference Tables of Integrals form a feature of this work; and the author has also touched upon the useful portions of Differential Equations.

Any analytical difficulty is explained preferably by means of a careful diagram (as might be expected from an author of Graphical Calculus), and by intuitive reasoning, rather than by processions of unconvincing equations and inequalties, employed by schoolmen of the pure orthodox mathematical faith; whose indulgence the author begs in his Preface, asking them to remember that there is arising a rapidly increasing army of men eagerly engaged in the development of physical research, . . . whose mental facilities have been wholly trained by continuous contact with the hard facts of sentient experience, and who find great difficulty in giving faith to any doctrine which lays its basis outside the limits of their experiential knowledge. G.

Zur Zoogeographie der landbewohnenden Wirbellosen. Von Dr. Otto Stoll. Pp. 113. (Berlin: Friedländer, 1897.)

THE majority of treatises upon geographical distribution have used as facts and framed their conclusions upon the range of vertebrated animals only. A few manuals, such as M. Trouessart's excellent book, and Mr. Beddard's "Text-book of Zoogeography" in the Cambridge series of scientific handbooks, have attempted a rather wider survey of the facts of the science, the necessity for which is emphasised by the short essay now before us. The main object of the science of geographical distribution is clearly, we take it, to state the facts; but it is illogical to avail oneself merely of a selected series of facts. This is particularly evident in view of another aspect of the science; for some of its more important inferences deal with the former changes in the relative position of oceans and continents. Birds and mammals being comparatively modern creations, can throw no light upon more distant changes of this kind; and facts drawn from those groups are by no means sufficient to serve as a basis for the view, now so generally becoming accepted, that there was in earlier times a vaster antarctic continent than the shrunken remnant now existing. Dr. Stoll strongly supports this notion, and it is from invertebrate groups that arguments are to be drawn. He is, moreover, against the theory of polar dispersal, which by its ingenuity, if for no other reason, has commanded much attention. Dr. Stoll clearly shows the importance of a consideration of invertebrates in discussing the inferences of geographical distribution, and we could have wished that his little brochure of only 113 pages had been more expanded.

Transactions of the American Microscopical Society. Edited by the Secretary. Vol. xviii. Pp. 413. (Buffalo, N.Y.: A. T. Brown, 1896.)

THIS report of the proceedings of the American Microscopical Society at the nineteenth annual meeting, held at Pittsburg in August of last year, is a very creditable publication. Many of the papers are distinctly valuable contributions to science, and the plates which illustrate them are of a high standard of excellence. Among the subjects and authors are the following:—Notes on comparative histology of blood and muscle, by Miss Edith J. Claypole; the character of the epithelium of the peritoneum of the tailed amphibia of the Cayuga lake basin, by Miss I. M. Green; several interesting papers on photomicrography, and on water supply; the red blood corpuscle in legal medicine, by Dr. M. C. White (accompanying this paper are some fine photo-engravings of blood corpuscles of man and various animals, magnified × 10,850, 2560, 840, and 640 diameters); yeasts and their relation to malignant tumours, by Dr. A. R. Defendorf; the bacteriology of diphtheria, by Dr. C. F. Craig; and an instructive address by the President, Dr. A. Clifford Mercer, on the effect of aperture as a factor in microscopic vision.

Experimental-Untersuchungen über Elektricität von Michael Faraday. No. 86, Series iii. to v., pp. 103; No. 87, Series vi. to viii., pp. 179. Edited by A. J. v. Oettingen. (Leipzig: Wilhelm Engelmann, 1897.)

THESE two volumes are the latest additions to Prof. Ostwald's renowned "Klassiker der exakten Wissenschaften"—a series of edited translations and reprints which has no rival. They contain translations of papers read by Faraday before the Royal Society in 1833–4, upon his electrical researches, the translations being from the *Philosophical Transactions* of those years. A few explanatory notes are added by the editor, Dr. A. J. v Oettingen.

Complaints are often made of the neglect of foreign scientific literature by German investigators, but it should be remembered at the same time that we have no series of translations of scientific classics to compare with the one in which the two present volumes appear.

LETTERS TO THE EDITOR.

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

The Fullerian Professorship of Physiology at the Royal Institution.

I AM writing in the assurance that my letter will or will not appear in your columns, according as you shall have judged whether or no it deals with public matter. And this again depends upon the degree in which the Royal Institution of Great Britain is regarded as fulfilling a public function.

Briefly, the facts are these :—

I hold the "Fullerian Professorship of Physiology and Comparative Anatomy" at the Royal Institution. I am surprised and disappointed to find that the duties of that post are regarded in a very flimsy light, and that no provision can be made, either in the Institution itself or in the adjoining Davy-Faraday Laboratory towards their more adequate performance. The obvious fact that the lecture-room rests upon the laboratory, acted upon with such admirable effect in the case of physics and chemistry, is altogether ignored in the case of physiology, with the result that the instruction that can be offered to the public in this latter subject is deficient or inferior, and—in the bad sense of these words—popular and literary. The very excellence of the lecture-theatre, together with the absence of any work-room, diverts the activity of the chair into other than its proper channels.

The Royal Institution of Great Britain, although it arose by private enterprise, has now for many years occupied the place of a public organ of natural knowledge, and its title expresses its *de facto* relation to the educated public, who look to the Royal Institution for the best information that can be given in the various subjects there dealt with.

It is a matter for regret—indeed in the present state of ignorance of physiology, which by many otherwise well-informed persons is supposed to be synonymous with vivisection—it is an actual misfortune, that the Fullerian Professors of Physiology are not enabled to give to the Institution the best work of which they may be capable. To profess "physiology" of an inferior character, under the auspices of the Royal Institution of Great Britain, is misleading and injurious to the interests of science.

I have felt some hesitation before requesting you to publish this letter, but can see no other means of testing the correctness of my opinion as to what is due to the public at the Royal Institution of Great Britain by the channel of its Fullerian Professorship of Physiology. AUGUSTUS D. WALLER.

July 5.

Streaming Movements of the Protoplasm in Pollen of Flowers.

IT may, perhaps, not be generally known that pollen of flowers affords a convenient example of the circulation of protoplasm. If pollen from a fox-glove be placed in a solution of sugar at ordinary temperature in a drop-slide, the grains sprout within twenty minutes, and grow during several hours at an average rate of 1/10 millimetre per hour. The granules of protoplasm move in opposite streams side by side, turning at the lower end of the tube and inside the grain ; the rate of motion may be calculated at 1 millimetre in one and a half to two minutes. The rapidity and duration of the streaming movement vary in different species ; in the pollen of the fox-glove it seldom continues longer than five or six hours, but in that of the bee orchis it may be still observed on the third day, after the tubes have ceased to grow. Protoplasm which has been set free by the bursting of tubes or grains, continues to show signs of life for a longer period. The granular character of the protoplasm is less distinct in some species than in others, but with a sufficiently high power—1/8—a visible motion of the contents of pollen tubes appears to be common. H. B. POTTER.

July 13.

Sensitiveness of the Retina to X-Rays.

WHILE trying a few days ago to detect the position of a coin which a child had swallowed, I found that the retina is affected by the X-rays. I have since learnt that this observation is not new, but my method of work may be of interest. For the purpose of the coin experiment the tube of the usual Jackson type was placed immediately under a table of 1-inch deal in a dark room ; on bringing my eye close to that part of the table where a phosphorescent screen showed the most intense radiation, after I had been in the dark for at least ten minutes, I could perceive a faint illumination of the retina, and on moving small metal objects to and fro immediately in front of the eye, I could see their shadows on the retina appearing to move always in the opposite direction. On moving the eye further away from the object the shadow enlarged. It is possible to make out the shape of small letters about ¼-inch long cut out in the middle of a sheet of lead, if they are placed close to the eye. It makes very little difference whether the eyelid is open or shut. The front of the eyeball in my experiment was about 4 inches from the platinum radiating plate.

The condition for success is that the observer should be in the dark for some time—not less than ten minutes, and in some cases twenty minutes. A person who has recently been in full daylight appears to require a longer time in the dark before the sensitive condition is developed.

Mason College, July 1. GUY OLIVER HARRISON.

Distant Stars.

IN the interesting extract of Prof. Newcomb's address at the Flower Observatory, University of Pennsylvania, given in NATURE, p. 139, on the distance of the stars, he says :—

"Evidence is gradually accumulating which points to the probability that the successive orders of smaller and smaller stars, which our continually increasing telescopic power brings into view, are not situated at greater and greater distances, but that we actually see the boundary of the universe," &c.

It would be extremely interesting if some of the reasons for this theory were given ; it seems so startling to imagine that after all we are practically the "hub of the universe," or very nearly so ; and so opposed to the idea that what our most powerful telescopes can show, may possibly only be in proportion to the whole universe as one drop of water to the Atlantic Ocean.

ALBERT COLLISON.

Sound of Distant Firing.

I SEE a correspondent reports hearing the saluting at the Portsmouth Naval Review at Chelsea. It was distinctly audible here, loud enough to be heard at some distance further, though the wind was E.S.E., a fresh breeze, and therefore unfavourable for helping sound. Also there were no clouds—in sight, anyhow—which might aid in reflecting the sound-waves. The reports began a few minutes after 2 p.m., and continued at intervals up to nearly three o'clock, at which time I ceased listening for them. I make the air-line distance just sixty statute miles.

I may add that, when walking on Wimbledon Common, I frequently hear loud detonation, which I put down to Shoeburyness, as I do not know of any other place in that direction at which heavy firing takes place. The distance would be about fifty miles, but across London, which one would think might interfere with sound-transmission. C. MOSTYN.

Wimbledon, July 12.

Blackbird's Nest appropriated by a Wagtail.

THE double bird's nest I send you was found some time ago in a stack of hop-poles when they were taken down for use. The lower nest is clearly a blackbird's, and in it, below the lining, were two blackbird's eggs when found. The upper nest (or lining ?) is, I am informed, that of a pied-wagtail, with four eggs, and also the egg of a cuckoo. It is suggested the blackbird was disturbed (by a cuckoo ?), and a wagtail, assuming the nest, completed it in its own fashion, the cuckoo therein laying its egg. (The same cuckoo which had disturbed the blackbird ?)

The double nest was found by Mr. Pattenden, a farmer here, and seen by his wife and son *in situ*. I have sent you a letter written by the son, and stating how the nest was found. I do not doubt the story is true. F. C. CONSTABLE.

Burwash, Sussex, July 7.

THE ETIOLOGY OF YELLOW FEVER.

YELLOW fever is an acute infectious disease, endemic in the West Indies, the shores of the Mexican Gulf, and in some parts on the West Coast of Africa, whence the disease has been repeatedly transported into other localities, causing here epidemic outbreaks. Like other infectious diseases, yellow fever is supposed to be caused by a specific living entity which, invading a predisposed person, multiplies there and causes the peculiar pathological changes in the gastro-intestinal tract and the liver, characterising yellow fever. Within recent years the supposed specific microbe has been discovered several times. Dr. Domingos Freire, of Brazil, and Dr. Carmona y Valle, of Mexico, have announced such discovery, but Dr. Sternberg, of Washington, who has himself studied the disease on behalf of the United States Government, has shown that none of these discoveries are a reality, and after a prolonged investigation, including the examination of a great many cases affected with, or dead from the disease, has arrived at the following conclusions, embodied in a lengthy report to his Government: that none of the different species of bacilli and cocci, present in the intestinal canal, in the blood, the liver and other tissues of persons affected with yellow fever, can have a claim to be considered as the specific microbe; that in a number of cases the examination, microscopic and cultural, of the blood and tissues yielded no bacteria recognisable either by the known methods of staining or culture; and he finally implied that the specific microbe of yellow fever is most probably not of the nature of a bacterium at all. After these very definite conclusions by Dr. Sternberg, it came rather as a surprise when, some months ago, the announcement was made that Dr. Sanarelli, Professor of Experimental Hygiene in Montevideo, formerly in the Pasteur Institute in Paris, had discovered the true cause of yellow fever in the form of a bacillus, *Bacillus icteroides*. This surprise is still further heightened by the statement in Dr. Sanarelli's lecture, that the *Bacillus icteroides* is demonstrable by the ordinary methods of staining and by culture in the ordinary well-known media. The morphological and cultural characters of the bacillus show it to belong to the group of coli-like bacilli; it is rarely demonstrable in a pure state in the blood or tissues, being generally associated with a more or less copious admixture of other microbes—*Bacillus coli communis*, *streptococci* and *staphylococci*; as a rule it is present only in small numbers in the capillary blood-vessels of the liver, spleen and kidney. It reflects great credit on the perseverance and sagacity of Dr. Sanarelli to have been able, notwithstanding all these difficulties, to select out the *Bacillus icteroides*, and to have by animal experiment been able to demonstrate, at least, as highly probable that the *Bacillus icteroides* is the true microbe of yellow fever. As mentioned just now, the distribution of the microbe in the affected person, its morphological and cultural characters do not in themselves offer strong *prima facie* evidence, and Dr. Sanarelli himself fully recognises this; but when we come to the experimental evidence which he furnishes, the evidence as to the *Bacillus icteroides* being the specific cause of yellow fever assumes considerable power.

In the first place, Sanarelli shows that dogs, goats, and horses are susceptible to infection both with the living bacilli as also and particularly with the highly poisonous toxin produced by the bacilli in broth culture; the symptoms and anatomical lesions hereby produced in these animals in the intestinal tract, the liver and the kidney, bear a striking resemblance to those of yellow fever in man. In the second place, Sanarelli furnishes proof that the toxin produced in broth culture—and separated from the bacillary growth by filtration through a Chamberland filter—when injected into healthy persons causes a prompt reaction in the form of severe disturbance, primarily of the intestinal tract, but also, further, of the general system closely resembling that in yellow fever. It is to be hoped, nay, it may be assumed as certain, that in continuing his investigations Dr. Sanarelli will ascertain the action of the blood of human beings, who have passed through, and recovered from the disease, on the *Bacillus icteroides*. This disease, as is well known, very rarely occurs twice in the same person, and it is therefore highly probable that, as is the case in other similar infectious diseases, the blood after a single attack possesses agglutinating action (*in vitro*), or germicidal action (*in corpore*), or both on the culture of the specific microbe. If on further investigation the blood serum, after an attack of yellow fever, should be found to show such positive actions on the *Bacillus icteroides*, a strong support will thereby be furnished as to this bacillus being the specific microbe. It will be the crowning of prolonged and laborious studies, if Sanarelli by experiments on immunisation of animals—the horse being evidently well fitted for such immunisation—did, as is highly probable that he will, obtain antitoxic serum by which yellow fever can be successfully combated both prophylactically and therapeutically. E. KLEIN.

THE VARIABLE STAR η AQUILÆ.[1]

THIS essay contains a full discussion of all the available observations of a remarkable variable star, the fluctuation of whose light presents many features the explanation of which is still beset with much difficulty. Of the 12,000 recorded comparisons of the relative brightness of η Aquilæ and neighbouring stars, no less than 7147 are due to the indefatigable perseverance of Julius Schmidt, who for the last twenty years of his life (1859-1879) was director of the observatory at Athens. Taking advantage of the preponderance of Schmidt's records over those of all other observers, the author first investigated the variations of the star's light as shown by these alone, and then examined in how far the results thus obtained were confirmed by the labours of other observers. The discussion of Schmidt's observations was complicated by the circumstance that in the majority of cases he only used two comparison stars, β and ι Aquilæ, one of which there was great reason to believe was itself variable. From the 1700 occasions on which both stars were used, Dr. Lockyer found ι to vary 1·7 grades of Schmidt's scale with a period of about thirty-five years. Associated with this long-period change, the relative brightness of ι was shown to be subject to an annual variability of about one grade, which is clearly traced to the influence of the hour angle at which the stars were compared. This apparent annual variation is, therefore, identical with the "position error" noted by many observers of variable stars, and which has lately been investigated so thoroughly by Mr. Roberts, of Lovedale, South Africa. Schmidt's observations, freed from both the above variations as well as from the slight aberration error due to the changing position of the earth in its orbit, were all reduced to the meridian of Bonn. Owing to the general sparseness of the data, it was necessary to combine the observations of 100 periods, or about two years, into a group represented by a single curve. This was effected with the help of a provisional mean period and date of minimum for which Argelander's values of 7d. 4·23444h. and 1848, mag. 18d. 6·4333h. M.T. at Bonn were adopted, the date being that of epoch 400. To further facilitate the construction of the curve the mean

[1] "Resultate aus den Beobachtungen des Veränderlichen Sternes η Aquilæ." Inaugural Dissertation zur Erlangung der Doctorwürde, von William J. S. Lockyer. 5 plates, quarto, pp. 95. (Göttingen: 1897. London: Dulau and Co.)

brightness in each 6-hour interval of the period was set down for each group, together with the corresponding time and the number of observations. In this way the whole of the materials collected by Schmidt from 1844 to 1879, and thus covering eighteen groups of 100 periods each, are expressed in tabular form on p. 21 of Dr. Lockyer's dissertation. The numbers for each period were then plotted on millimetre paper; tentative and afterwards definitive curves representing the fluctuations of the star's light were drawn through the points thus obtained. The resulting eighteen curves representing Schmidt's observations are reproduced one above the other on a small but distinct scale on Plate I., each curve being prolonged by about one-third of the period to bring out the form of the minimum. A study of these curves shows that Argelander's period cannot, at present, be improved on as a mean value. The *time* of Argelander's epoch 400 is, however, shown to be too early by an interval which the author fixes at 3·2655 hours. The curves also show conclusively that the epoch of maximum oscillates to and fro to the extent of five hours on either side with a period comprising 400 maxima. In the same way the minima are subject to an oscillation of about three hours in approximately 2400 periods. The combined effect of these variations causes the light-period to vary between 7d. 4h. 14m. 40s. and 7d. 4h. 13m. 28s. also in 2400 periods. Superposed on the main light curve are four subordinate undulations, of which more hereafter.

Much the same method was followed with regard to the observations of Argelander, Schönfeld, Heis, Plassmann, Oudemans, Auwers, Knopf, Sawyer, Schwab, and Schur; but with the further step of reducing the estimated grades to Argelander's scale. This reduction, carried out with scrupulous care by the method of least squares, brings out several interesting facts regarding the values which the grade, or unit of brightness, assumes in the case of the different observers, or for the same observer at different times. Here there is only space to mention the observations made by Knopf in Jena. Contrary to the general usage of comparing a variable with stars differing from it in brightness by at most five or six grades, Dr. Knopf often allowed himself a range of no less than nineteen grades. This new departure has most unexpectedly had no injurious effect on the accuracy of the observations, as is abundantly proved by the smallness of the residuals in the evaluation of the brightness of the comparison stars. From the materials collected by the observers just named, the author constructed nineteen further curves, which confirm in a high degree the results from Schmidt's observations alone. Dr. Lockyer also tests the accuracy of his conclusions by means of the long series of observations made by Wurm in the course of twenty-seven years, beginning with 1785. The detail, indeed, of these observations seems never to have been published, but the actual length of the period in accordance with Schmidt, for the epoch of Wurm's observations, differs but seven seconds from Wurm's value; and since the early observations also show decided indications of the oscillation of the time of maximum, it seems certain that the general character of the variability of η Aquilæ has not materially changed in the course of the last hundred years.

As regards the four secondary fluctuations, they are found to recur at intervals of forty-three hours, or one quarter of the main period, the first of these secondary maxima occurring fifteen hours after the chief minimum. The author is the first to have clearly brought out this feature, and he explains it by assuming, in accordance with his father's hypothesis, that the system of η Aquilæ consists of three meteoric swarms, of which the two lesser revolve about the greater in periods of 1d. 19h.+ and 7d. 4h.+ respectively (see "Meteoritic Hypothesis," *passim*, but particularly pp. 475-6). The irregularities in these fluctuations are set down to the perturbations necessarily occurring in such a system, but their investigation did not come within the scope of the essay before us. Figs. 1 and 2 of the dissertation show the proportions of the assumed orbits, together with the form of the light curve resulting from the combination of the two elementary curves. In conclusion, I must express my admiration of the skill and untiring perseverance which Dr. Lockyer has shown in dealing with a large mass of somewhat intractable material. Wherever possible the deductions were made from the original manuscripts, concerning which interesting particulars are given on pp. 19 and 20, where we learn that Schmidt's original notes are preserved at Potsdam, while those of Heis have wandered across the Atlantic to the observatory of Georgetown College.

R. COPELAND.

BRITISH ASSOCIATION TORONTO MEETING.

III. LOCAL ARRANGEMENTS.

THE two leading Hydraulic Companies of Niagara Falls are making special arrangements for the reception of the members of the British Association.

The Carborundum Company of Niagara Falls has extended an invitation to the members of the Association to visit and inspect the Company's works on Saturday, August 21. The manufacture of carborundum by this Company has been fully described in NATURE for May 13 (p. 42).

The Atlantic Cable Companies have generously arranged that members from Great Britain may send two free cable messages from Toronto, and they will then be entitled to two free replies. Each message and reply are not to contain more than ten words each, and they are to be forwarded by agents recognised by the Cable Companies. The agents in Great Britain will, in all probability, be Messrs. Cook and Son, and in Toronto the Honorary Local Secretaries; but the arrangements in regard to this are not complete, and a fuller announcement will be made later. It is to be noted that the transmission of the messages within Great Britain to and from the head office of Cook and Son will be charged for as ordinary telegraphic messages. The arrangements in this respect are the same as those made in 1884.

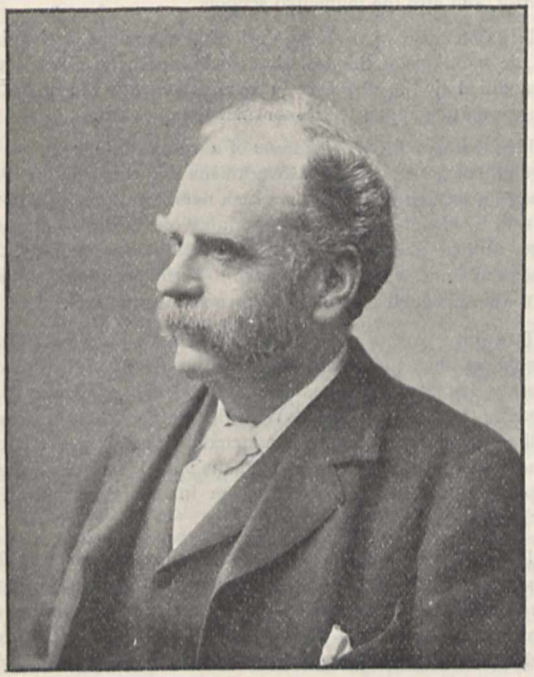
In order to avoid delay in the Customs examination of the members' luggage, the Hon. Mr. Paterson, the Minister of Customs, has given special instructions to the Customs officers at Quebec, Montreal and Niagara to facilitate in every way the examination. A larger number of examining officers will be on duty at Quebec, and one will accompany each steamer from Quebec to Montreal to make the examination of the luggage during the passage. As a result of this arrangement, all delay at Quebec and Montreal will be avoided. The Minister of Customs has also arranged that all scientific apparatus or material for use during the meeting of the Association shall be admitted free of duty if forwarded to me at Toronto, and marked, "For British Association."

It is expected that there will be in attendance at Toronto more than twenty continental men of science of a representative character. Amongst those who have intimated their intention to be present are Prof. Charles Richet, Prof. Yves Delage, both of Paris; Prof. Meslans, University of Nancy; Prof. Gilson, of Louvain; Dr. van Rijckevorsel, of Amsterdam; Dr. Pauli, of Frankfort; Prof. Ladenburg, of Breslau; Prof. Runge, of Hanover; Prof. Brauner, of Prag; Prof. Penck, of Vienna; M. Letourneau, of Paris; M. Gobert, of Brussels; and Prof. P. Magnus, of Berlin.

A. B. MACALLUM.

THE "CHALLENGER" ALBUM.

AT the Ipswich meeting of the British Association, a couple of years ago, a movement was started amongst the zoologists present to congratulate Dr. John Murray, and offer him some memorial of their appreciation of his services to science, on the completion of his editorial work in connection with the fifty volumes of the *Challenger* Reports. A Committee was formed, with Mr. W. E. Hoyle as Secretary, and the offering eventually took the appropriate form of a handsome album containing the portraits and signatures of the contributors to the *Challenger* Series, with an artistic cover and illustrated dedication designed by Mr. Walter Crane. The presentation was made to Dr. Murray at a meeting held in London on November 30, and the happy thought then occurred to Mr. Hoyle to have the volume, cover, dedication and photographs reproduced, so that all contributors, and some others, might have, if they desired, a



John Murray.

copy of this interesting memorial of the completion of the *Challenger* work. The result is now before us in the form of a thin quarto volume, bound in dark green cloth like the *Challenger* Series, and containing some twenty sheets of portraits, along with reproductions of all Mr. Crane's quaint drawings, and an explanatory introduction drawn up by Mr. Hoyle. Messrs. Dulau and Co. have issued an edition of two hundred copies at 12*s.* 6*d.* each. Most of these are being secured by the contributors, but some copies can be obtained by libraries and individuals who desire to add this supplemental volume to their *Challenger* Series. Some of the original photographs were very good, others were poor, and naturally some of the reproductions are better than others (as a specimen we are enabled to show here the portrait of Dr. Murray himself); but all the portraits must be of considerable interest to those who possess, and to those who consult the *Challenger* monographs. The volume is similar in size and style to the well-known Reports, and containing as it does portraits of all the eighty-eight contributors to the *Challenger* work, the pity is that there are not enough copies to go round all the libraries that contain the *Challenger* Series. W. A. H.

NOTES.

THE Sydney expedition to Funafuti, to make borings in the coral, projected and led by Prof. David, started on June 2, going by steamer to Fiji, and thence by sailing vessel to Funafuti. This expedition has been made possible by the liberality of the Mining Department of the Government of New South Wales, which has supplied all the boring plant free of cost, and by the munificent gift from Miss Walker, of Sydney, of 500*l.*, and from the Hon. Ralph Abercrombie of 100*l.* towards the expenses of the expedition.

PROF. SOUILLARD, of Lille, has been elected a corresponding member of the Paris Academy of Sciences.

THE following are the names of the presidents of the several sections of the Australasian Association, the next session of which will be opened on January 6, 1898, under the presidency of Prof. Liversidge, the president-elect:—Section A—Astronomy, Mathematics and Physics, R. L. J. Ellery. Section B—Chemistry, T. C. Cloud. Section C—Geology and Mineralogy, Captain F. W. Hutton. Section D—Biology, Prof. T. J. Parker. Section E—Geography (president to be appointed). Section F—Ethnology and Anthropology, A. W. Howitt. Section G—Economic Science and Agriculture, R. M. Johnson. Section H—Engineering and Architecture, H. C. Stanley. Section I—Sanitary Science and Hygiene, Hon. Allan Campbell. Section J—Mental Science and Education, John Shirley.

THE third annual meeting of the Botanical Society of America will be held in Toronto on August 17 and 18, under the presidency of Dr. J. M. Coulter. The address of the retiring President, Dr. C. E. Bessey, will be given on the evening of the opening day.

THE summer meeting of the Institution of Mechanical Engineers will open at Birmingham on Tuesday, July 27. On the morning of that day there will be a reception by the Lord Mayor in the Examination Hall of the Municipal Technical School. The papers to be read and discussed deal with "Some Points of Cycle Construction," by Mr. F. J. Osmond; "The Birmingham Corporation Waterworks," by Mr. Henry Davey; "High Speed Self-lubricating Steam Engines," by Mr. Alfred Morcom; "Mechanical Features of Electric Traction," by Mr. Philip Dawson; and "Diagram Accounts for Engineering Work," by Mr. John Jameson. A large number of works in Birmingham, Wolverhampton, Oldbury, Tipton, Walsall, and Coventry will be thrown open for the inspection of members. On Wednesday the excursions will be to Wolverhampton district, on Thursday to Stratford-on-Avon and Walsall, and on Friday to Coventry, Warwick, and Rugby.

THE Paris correspondent of the *Times* reports that at the meeting of the Institute of France on July 7, the chief business of the sitting was the consideration of the bequest made to the Institute by the late Duc d'Aumale of his estate of Chantilly, and the discussion as to whether the conservators of the château and grounds should be appointed for life or for three years only. By 58 votes to 53 the Institute decided that the appointment should be for three years, and M. Mézières, of the French Academy, M. Gruyer, of the Academy of Fine Arts, and M. Léopold Delisle, of the Academy of Inscriptions and Belles Lettres, were almost unanimously chosen as conservators for the next three years. The conservators of the new "Condé

Museum" are to receive an annual stipend of 3000f. and to be lodged at Chantilly. The financial administration of the estate will not, however, devolve upon them, but upon three other members of the Institute to be subsequently appointed. Later information has been received saying that M. Limbourg has been appointed Administrator-General of Chantilly.

WE regret to notice the death of Prof. W. Marmé, Director of the Pharmacological Institute of Göttingen; Dr. Giuseppe Fissore, formerly Professor of Pathology in the University of Turin; Dr. E. Legros, Professor of Physiology in the new University of Brussels; and Dr. Maréchal, formerly Professor in the Naval Medical School of Brest. The last-named died of septic poisoning.

MR. R. D. OLDHAM, the Acting Director of the Geological Survey of India, has sent to a correspondent a letter on the recent earthquake in Calcutta, from which we have been permitted to make the following extracts:—"I was at Naini Tal at the time, and as soon as I knew how bad it was, came down here [Calcutta] to make arrangements for a thorough investigation of it. At present it is not possible to say more than that it is the biggest and most severe of which there is any record in India, and that its investigation will be attended by considerable difficulty and inconvenience, not to say hardships, to the men employed, owing to the rainy season having commenced immediately after the earthquake. I have had orders from Government to prepare a full and detailed scientific report in the Geological Survey Department; have issued circulars to all station masters, telegraph officers, and other people likely to be able to give information, and have despatched every available man to investigate the damage done at all accessible places. Some that would have been worth visiting are, unfortunately, inaccessible at this season of the year."

IN addition to the foregoing communication we have received a lengthy letter on the subject, and a photograph, from Mr. T. D. La Touche; and these we hope to publish in a subsequent issue.

A DINNER was held on the 7th inst., under the presidency of the Duke of Cambridge, to commemorate the twenty-first anniversary of the formation of the Sanitary Institute. Speeches were delivered by Lord Kelvin, Sir Douglas Galton, Prof. Corfield, and others.

The American Naturalist notes that Dr. W. H. Evans, of Washington, D.C,, has gone to Alaska for several months to investigate the agricultural resources and possibilities of that portion of the territory lying south of the Aleutian peninsula. He will report to Congress as to the advisability of establishing experiment stations there. Dr. Sheldon Jackson is to collect similar information regarding the Yukon Basin.—Prof. Nelson, the University of Wyoming botanist, will make an excursion into the Red Sea Desert. This tract of land has, so far, never received a botanical investigation, and the Professor has planned to make three other trips into the desert during the summer. He expects to obtain many rare botanical specimens.—Prof. Bruner, of the University of Nebraska, has sailed for Buenos Ayres, where he will spend a year investigating the injurious locusts which have, of late, increased enormously in three of the eastern provinces of the Argentine Republic.

WE learn from the *Journal of Botany* that Mr. George Murray and Mr. V. H. Blackman have sailed for the West Indies, in order to work at the plant-plankton of the Atlantic, especially the forms found remote from coastal waters, such as the coccospheres and rhabdospheres. Their method of capture is by pumping sea-water through very fine silk bags, thus attaining practically the same result as by the tow-net, and without stopping the ship.

ACCORDING to *Science*, Major Powell is at present on the coast of Maine, engaged in research concerning shell mounds, in the interest of the Bureau of American Ethnology.

A MEETING was recently held in Glasgow, on the initiative of the Lord Provost, the Principal of the University, and the President of the Faculty of Physicians and Surgeons, to further the proposal to establish a memorial to William and John Hunter, and an executive committee was appointed to collect subscriptions; it is hoped that from 3000*l.* to 4000*l* may be raised.

THE Berlin Town Council, on the motion of Prof. Virchow, has decided to appoint a municipal "hydrologist," for the constant examination and hygienic supervision of the different Berlin waterworks. In connection with this appointment, the creation of a municipal board of health for the city of Berlin is being much discussed. If such were established, the municipal hospitals, orphanages, and asylums would be placed under its control, and also the municipal schools.

THE Park Board of New York City has adopted the plans for the buildings of the new Botanical Gardens in Bronx Park, as modified by the directors in accordance with the advice of the committee appointed to consider the question.

THE German *Imperial Gazette* of a recent date contains the regulations issued by the Government for the sale of Prof. Koch's new tuberculin, under which name the new specific will be sold by chemists in phials containing one millilitre at marks 8.50, and in phials containing five millilitres at marks 42.50. The tuberculin will only be given to certificated medical men, or to those provided with an authorisation from such.

THE July part of the *Journal of Anatomy and Physiology* announces that in consequence of the death of Sir George Murray Humphry, it has been considered advisable to reorganise the editorial staff. With the October part the *Journal* will, as regards anatomy, be conducted by Profs. Sir W. Turner, MacAlister, Cunningham and Thane; and the physiological department will, as heretofore, be in the hands of Prof. M'Kendrick.

IN our issue for June 24 we briefly described the run of the *Turbinia* from the Tyne to the Solent. We understand that during the three weeks the *Turbinia* was in the Solent she made frequent runs of many miles at a time, at speeds of from 30 to 35 knots, and that her performances were witnessed by many leading authorities in naval matters, as well as the mercantile marine. On Tuesday, June 29, with a distinguished company on board, she was run up to nearly full power, and maintained the unprecedented speed of 35 knots, or over 40 miles per hour, for the length of the line of battle-ships, or about 5 miles. During this run there was an absence of strain, and from this fact it seems that the limit of speed in this little vessel has not yet been reached, and that after further improvements, at present in progress (having returned to the Tyne last week), she will be capable of not only maintaining her position as much the fastest vessel afloat, but will be able to give many knots to any competitor engined with reciprocating engines. We purpose, in a subsequent issue, to give a further account of the compound turbine engines which, by the most direct and economical conversion of the power of the steam into effective horse-power in engines of unprecedently small weight, enable the *Turbinia* to achieve without stress or vibration such remarkable results.

THE Pilot Chart of the North Atlantic Ocean for July, issued by the American Hydrographic Office, contains a supplementary chart showing the tracks of floating bottles which have been returned to that office during a year ending June 1 last. Of

the bottles recovered, eighty-one were thrown overboard in the North Atlantic, and these are the only ones dealt with upon the chart in question. Taken collectively, the courses followed by the bottles elucidate the main principles of oceanic circulation, and show the close agreement that exists between the motion of the surface water and the direction of the prevailing winds. Dividing the list into groups, according to latitude, and dealing only with those bottles whose drifts exceed 300 miles, we have the following average velocities of the daily drift:—North of 50°, 5·3 miles; between 40° and 50°, 5·3 miles; between 20° and 40°, 5 miles; between 0° and 20°, 9·8 miles. A noteworthy drift shown on the chart, is that of a bottle thrown overboard in lat. 2° 9′ S., long. 30° 25′ W., and picked up on the African coast, at the mouth of the Bathurst River. This bottle, set adrift in the strong south equatorial current, must have been transferred to the Guinea current, and carried by it to the exceptionally northern position at which it was recovered.

THE Director of the National Observatory at Athens (M. Eginitis), has made an important contribution to the meteorology of Southern Europe by the publication of a careful discussion of the observations at Athens during the present century, and now continued at the Observatory. Although there are several interruptions in the continuity of the earlier observations, they have been carried on regularly during the last thirty-seven years. The discussion, which extends to 220 large quarto pages, contains an exhaustive account of the climate, each element being separately treated, and, in addition to the instrumental observations, notice is taken of all information obtainable from the most ancient periods. The absolute extremes of temperature vary from 105·3° to 19·6°, giving a range of 85·7°. Rain falls, on an average, during ninety-eight days in the year, the normal annual amount being 16 inches. Athens enjoys a large amount of sunshine, the values recorded by a Campbell instrument in 1894 amounted to 2527 hours; at Eastbourne in the same year the amount registered by a similar instrument was 1669 hours. In some years the sun shines incessantly from morning till evening, for a month at a time.

THAT birds play an important part in relation to agriculture has long been known to ornithologists; but farmers have a tendency to dwell upon the harm they do, rather than the benefits received. A better feeling is, however, being cultivated by means of the publications of the Society for the Protection of Birds, by County Councils, and by a host of books on birds; so that the hope may be cherished that agriculturists will soon be able to discriminate between their feathered friends and foes. In the United States, serviceable knowledge of this character is communicated to all who are concerned with it. For instance, in the *Farmers' Bulletin* (No. 54), which has just been issued by the U.S. Department of Agriculture, Mr. F. E. L. Beal describes "Some Common Birds in their Relation to Agriculture." The *Bulletin* contains short accounts of the results of food studies of about thirty grain and insect eating birds belonging to the different families. It is pointed out that the value of birds in controlling insect pests should be more generally recognised; for while it may be an easy matter to exterminate the birds in an orchard or cornfield, it is an extremely difficult one to control the insect pests. How very valuable birds are, is illustrated by the fact that during the recent plague of Rocky Mountain locusts in the Western States, it was found that locusts were eaten by nearly every bird in the region, and that they formed almost the entire food of a large majority of this species. In winter sparrows are active weed destroyers, weed seed forming an important item of the winter food of many of these birds.

THE uncertainty which attaches to the specific-heat-ratio of gases as a means of distinguishing between monatomic and polyatomic molecules renders it of great interest to investigate other properties dependent on the molecular volume or cross-section. In the *Proceedings* of the American Academy of Arts and Sciences, xxxii. 11, Messrs. A. A. Noyes and H. M. Goodwin describe a new determination of the viscosity of mercury vapour and its comparison with those of hydrogen and carbon dioxide, the method used consisting in measuring the flux through a capillary tube under constant difference of pressure. By the application of O. E. Meyer's formula, the authors deduce that the cross-section of the mercury molecule or of its sphere of action is nearly the same as that of the carbon-dioxide molecule, and about two and a half times as large as that of the hydrogen molecule. Whether the authors are justified in their conclusion, "that atoms and molecules are of the same order of magnitude," depends on how far the value of the ratio of the specific heats in mercury is admitted to be indicative, on the kinetic theory, of the monatomic nature of that gas.

A NOTE has been communicated to the *Atti dei Lincei* by Dr. Emilio Oddone, on an apparatus for determining the thermal conductivity of substances which are bad conductors. The apparatus is based on the model of one constructed and described by Dr. Venske, of Göttingen, in 1891, and the author describes a determination made by it for glass. It is proposed to apply the method to the conductivity of rocks, and we hope that the investigations will throw fresh light on the past history of the earth.

IN a very suggestive, privately published, essay entitled "Demeter und Baubo, Versuch einer Theorie der Entstehung unsres Ackerbaus," E. Hahn puts forward a number of new views, and combats many old ones. He believes that man was primitively an omnivorous "collector," later he severally diverged into a hunter, a fisher or a planter, or in certain districts into a herder; but he denies the evolutionary series of hunter, herder and agriculturist. He argues that the first cultivated plant was millet, and he draws a sharp distinction between hoe-culture and the cultivation of cereals with the use of the plough, He believes barley was the earliest cereal, and wheat the latest. There is no necessary connection between our method of tillage with the plough (with the keeping of domestic animals), and the use of milk. Cattle were first domesticated as draught animals and to draw the plough, and it was only long afterwards that they were trained to yield milk for human food. The author is greatly impressed with the effect of religion on the progress of early culture; for example, he holds that the waggon was originally employed for the transport of effigies of the goddess of fertility, probably the moon, and that later it became a secular vehicle. He does not believe that wheels were evolved from rollers, but that they were derived from spindle-whorls, four of which were attached to a board, and so arose the diminutive and primitive conveyance of the goddess. The author invites criticism, and would be glad of references to researches bearing on his subject; these should be addressed to him, care of Max Schmidt, bookseller, Lübeck.

HERR F. R. FRIIS has just completed and published the correspondence between Tycho Brahe and Oligerus Rosenkrantz during the years 1596 and 1601. This book, which is entitled "Epistolæ quas per annos a 1596 ad 1601 Tycho Brahe et Oligerus Rosenkrantzius inter se dederunt," contains in its 80 pages twenty-four letters, most of which were written by Tycho Brahe *to* Rosenkrantz. In the appendix are given ten other interesting communications, written about the same time. The compiler of this collection is to be congratulated on the important service he is rendering history by this collection, which is a further addition to letters already published. The first publication was entitled "Tychonis Brahei et ad eum doctorum virorum Epistolæ ab anno 1568 ad annum 1587," and

was accompanied "cum effigie Tychonis Brahei et exemplo ipsius manus." We may mention that only a small number has been printed, and those wishing to acquire copies can do so from the following address:—F. R. Friis, Copenhague, Cart Adelersgade 7.

THE report on the operations of the Department of Land Records and Agriculture, Madras Presidency, for the official year 1895-96, has just reached us, and is full of interest. The department, during the period under survey, appears to have been most active in the performance of its duties, and good work was carried on, or attempted under, in many instances, great disadvantages. The unfavourable character of the weather caused a failure in many of the planting experiments. Courses of lectures were delivered on the subjects of agricultural chemistry and veterinary science, and experiments were made with various kinds of ploughs in Kurnool district. Inquiries were made "as to whether any animal or vegetable parasites have been anywhere observed, or can be found feeding upon the prickly-pear in such a manner as to warrant a hope that it might be used as an agency for destroying the said plant," and the opinion arrived at, from the reports received, was that there are no parasites known in the Presidency which can be depended upon to destroy prickly-pear growth.

THE alleged reflexion of kathodic and Röntgen rays have been made the subject of two independent but closely-allied investigations by Prof. A. Battelli (*Nuovo Cimento*, v. 4) and M. P. Villard (*Bull. Société Française de Physique*, 95). Prof. Battelli's conclusions are as follows: (1) It cannot be asserted that kathodic rays are reflected according to the regular law; (2) rays coming from the speculum of a focus-tube have the same properties as direct kathodic rays; (3) the same properties are possessed by rays coming from the anterior face of a very thin lamina, on whose posterior face kathodic rays impinge; (4) a pencil of such rays seems to be constituted of different kinds of rays which, when they fall on a thin body, appear to traverse it in somewhat the same manner that they would traverse a filter which allowed some rays to pass through more freely than others. M. Villard finds that kathodic rays that have fallen on a thin metallic lamina, emerge in the form of a diffused pencil, whose general direction is normal to the lamina, but the phenomenon appears to be a kind of refraction. Reflexion is more easily obtained, and the phenomenon can be photographed; the reflected rays possess all the properties of kathodic rays, and are strongly deflected by the repulsive action of the kathode. Experiments show that this reflexion, though evidently anomalous, is perfectly definite.

DR. ITALO BOSI contributes to the *Nuovo Cimento*, 4, v. a series of observations on the electric resistance of solutions of salts in motion, which have an important bearing on Hittorff's and Arrhenius' theories of electrolysis. Dr. Bosi finds that in solutions where the effect of electrolysis is to produce greater concentration at the positive pole, the resistance increases when the liquid is moving in the opposite direction to the current, and decreases when it is moving in the same direction; but the increase in the first case is greater than the decrease in the second. Where the concentration is greater at the negative pole the effect is reversed; the increase of resistance, however, still exceeds the decrease. Finally, when electrolysis produces no difference of concentration at the two electrodes, the resistance is unaffected by the motion of the liquid. These conclusions do not entirely accord with the hypotheses either of Hittorff or of Arrhenius. An investigation somewhat allied to the present had previously been made by Edlund, but this was rather qualitative than quantitative in character, and, moreover, the fluids used by Edlund (town water, alcohol and water, and others) left some doubt as to the nature of the dissolved salts contained in them.

THE *American Naturalist* for June contains an account, by Mr. G. C. Whipple, of the biological laboratory instituted by the Boston Water Works for the examination of the purity of the water supplied to that city. The object of the laboratory work is to ascertain and keep a record of the condition of the water in all parts of the supply at the same time. The microscopical work consists chiefly in the quantitative determination of the various microscopic organisms, except bacteria, in each sample of water, by the Sedgwick-Rafter method. In addition to this, the number of bacteria is determined in the water of all the reservoirs, aqueducts, and service-pipes, and a careful watch is kept for those of a pathogenous character. It is stated that the work done in this and in other similar biological laboratories in Massachusetts (there is a separate one for the city of Lynn) has been of great value, both from a purely scientific and from a sanitary point of view, and that by these investigations the supply of inferior water has several times been prevented.

IN "Minnesota Botanical Studies" (*Bulletin* No. 9, Parts x. and xi.), published by the Geological and Natural History Survey of Minnesota, are several papers of more than local interest. Mr. J. M. Holzinger calls attention to some mosses found by him at high altitudes. On Pike's Peak, Colorado, between altitudes of 12,502 feet and the top of the peak (14,147 feet), he collected thirty species of mosses which deserve attention. Mr. R. N. Day contributes a paper on the relative value of various forces operative in the production of the positions of dorsiventral leaves. He concludes that light cannot induce epinasty or hyponasty, and adds: "This is in direct support of the position taken by Vines, and the results upon which it is based demonstrate that the photo-epinasty of Detmer does not exist as such." Mr. A. A. Heller gives a valuable description of the ferns and flowering plants of the Hawaiian Islands; and the phenomena of symbiosis is the subject of a paper by Mr. Albert Schneider. Mr. Conway MacMillan, State Botanist of Minnesota, discusses his observations of the distribution of plants along the shores of the Lake of the Woods, the purpose of his paper being to point out the dependence of plant formations over such an area as the shores of the lake upon topographic and environmental conditions. It is shown how each formation may be explained briefly as connected with a certain *mélange* of outward conditions, and an effort is made to analyse these conditions both by themselves and as connected with the growth of vegetation.

THE first part of an "Essai sur les éléments de la mécanique des particules," by M. H. Majlert, has been received from MM. Gauthier-Villars et Fils, Paris. The object of the work is to bring forward some new geometrical views on problems of hydrodynamics. In the present part, entitled "Statique particulaire," the author deals with general principles referring to matter and energy, atoms and molecules, states of aggregation of simple bodies, chemical combinations, and co-related subjects. He reserves for a second part, to be published under the subtitle "Dynamique particulaire," the results of his special studies on energy and its manifestations; and we reserve our review of the work until that part appears.

THE fourth number of *Archives of Skiagraphy*, edited by Mr. Sydney Rowland, has just been published. Among the subjects and objects illustrated upon the six collotype plates are the dislocation of an elbow, fracture of radius and ulna, the lobster, edible crab, hermit crab, and five of Dr. Macintyre's Röntgen photographs of a frog's leg in movement.

SEVERAL articles on subjects of scientific interest appear in the July magazines. Mrs. Percy Frankland gives in *Longman's Magazine* an outline of the rise and development of bacteriology during the past sixty years; and to *Good Words* she contributes a sketch of the career of the great leader of bacteriological

science, Pasteur. The Zoological Gardens at Amsterdam are described in *Macmillan's Magazine* by Mr. C. J. Cornish; and Mr. H. W. Seton-Karr narrates in the *Century* his hunting experiences in Africa and India, referring incidentally to his discovery of palæolithic flint implements in Somaliland. An interesting account of the discovery of the American continent by the Cabots, illustrated from original documents, autograph letters and ancient maps, is contributed to *Scribner's Magazine* by the Marquis of Dufferin.

THE Department of Agriculture, Brisbane, Queensland, has recently issued the second edition of "A Companion for the Queensland Student of Plant Life, and Botany Abridged," by Mr. F. M. Bailey, the Colonial Botanist. Many of the notes are given with a view to assist school teachers, and particularly those residing in the country districts, to some of the more prominent distinctive characteristics of common plants. We notice that copies of the pamphlet can be obtained free by persons interested, on application to the Under-Secretary for Agriculture, Brisbane.—A translation, by C. S. Fox, of the official "Guide to the Royal Collections of Dresden," comes to us from Albanus, of Dresden. In it will be found very full information as to the collections housed in the Museum (Zwinger), the Royal Palace, the Johanneum Museum, the Albertinum, and the Japanese Palace. It remains to be said that the Guide is very well got up.—The third report of the Commissioners of the Whitechapel Public Library and Museum has reached us, and contains much interesting matter. Science is not overlooked in Whitechapel, as the list of sixteen lectures by well-known men of science shows. The library contains, in its lending branch, 541 books dealing with natural science, and in works relating to voyages and travels 614 books. In the reference department natural science is represented by 444 works, and voyages and travels by 89. We are sorry to see that there was a falling-off in the number of readers of books dealing with the subjects mentioned, as compared with the numbers given in the preceding report.

AMONG official American publications relating to botanical and agricultural science recently received, are the following:—Twentieth Annual Report of the Connecticut Agricultural Experiment Station for 1896, chiefly devoted to the properties and analysis of fertilising manures; Studies on American Grasses, being Bulletin No. 8 of the U.S. Department of Agriculture, Division of Agrostology (New or little-known Grasses, by F. Lawson-Scribner; Leaf-structure of *Jouvea* and of *Eragrostis obtusiflora*, by Miss E. L. Ogden); Bulletins Nos. 141–144 of the Michigan State Agricultural College Experiment Station (Forage crops and Wheat; Small fruit trials at the College; Fruit tests at South Haven; Vegetables, old and new).

THE additions to the Zoological Society's Gardens during the past week include a Syrian Bear (*Ursus syriacus*, ♀) from the hills north of Bagdad, presented by Mr. B. T. Ffinch; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. J. B. Gowing; an Osprey (*Pandion haliætus*) from Aberdeenshire, presented by Major-General Russell, M.P.; a Cayman-Island Amazon (*Chrysotis caymanensis*) from the Cayman Islands, presented by Mr. C. Home Sinclair; a Blue-fronted Amazon (*Chrysotis æstiva*) from South America, presented by Mrs. Reynell; a Shag (*Phalacrocorax graculus*) British, presented by Mr. Edward Step; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Miss Amy Meyer; a European Tree Frog (*Hyla aborea*) from Southern Europe, presented by Mrs. Nicolas Wood; a Bonnet Monkey (albino) (*Macacus sinicus*, ♂) from India, a Rock-hopper Penguin (*Eudyptes chrysocome*) from the Antipodes Islands, a Thick-billed Penguin (*Eudyptes pachyrhynchus*) from the Stewart Islands, a Graceful Ground Dove (*Geopelia cuneata*), two Ganga Cockatoos (*Callocephalon galeatum*) from Australia, deposited; a Dwarf Finch (*Spermestes nana*) from Madagascar, two Barred-shouldered Doves (*Geopelia humeralis*) from Australia, two Chinese Turtle Doves (*Turtur chinensis*) from India, purchased; an English Wild Bull (*Bos taurus*), two Common Blue-Birds (*Sialia wilsoni*), four White-backed Pigeons (*Columba leuconota*), two Triangular-spotted Pigeons (*Columba guinea*), a Spotted Pigeon (*Columba maculosa*), a Crested Pigeon (*Ocyphaps lophotes*), an Auriculated Dove (*Zenaida auriculata*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

JUPITER'S SATELLITES.—In a previous note we referred to the period of rotation of the third satellite of Jupiter as determined by recent observations made by Mr. Douglass at the Lowell Observatory. In the current number of the *Astronomischen Nachrichten* (No. 3432) he communicates a more detailed description of the observations, together with reproductions of the surface markings, which led him to the determination of the length of the period of rotation. Attempts were at first made to discover signs of surface movement within three to five hours of continuous observation. None, however, could be detected, so that the 24-hour period had to be discarded as untenable. A large series of sketches showed that the satellite's period was nearly the same as its period of revolution, namely, 7d. 5·1h. ± 1·2h. The surface markings seem to take the form of lines, their maximum width being estimated at less than 0″·1, or 200 miles. The fourth satellite was also observed minutely, and on its surface were seen markings which are described as similar to those found on the third. Its period of rotation was also noted as being probably nearly equal to its period of revolution round its primary. Prof. W. H. Pickering's discovery of the variability in the elongation of the first satellite seems to be confirmed by Mr. Douglass, who found this satellite at the time of observation "most remarkably elongated."

THE CONSTANT OF ABERRATION.—Mr. C. L. Doolittle has recently concluded a discussion of several observations with the object of determining the value of the constant of aberration (*Astr. Journal*, No. 406). The series of observations used possessed some special advantages for such an investigation, since the stars were distributed very uniformly throughout the twenty-four hours of right ascension, and each group was observed both morning and evening at approximately the same interval before and after midnight. In all, 107 pairs of stars were used, the series extending from 1892 October 10 to 1893 December 27: these included 1744 determinations before, and 1052 determinations after midnight. The final value obtained, namely,

$$20''{\cdot}55 \pm 0{\cdot}01$$

seems rather high when compared with those obtained by other investigators. The following brief table brings together a few of the results previously determined.

1843	Struve	...	20″·445
1844	C. A. F. Peters	...	20·503
1849	,,	...	20·481
1859	Maclear	...	20·53
1861	Main	...	20·335
1882	Downing	...	20·378
1883	Nyrén	...	20·492
1888	Küstner	...	20·313
1895	Newcomb	...	20·511

CATALOGUE OF 480 STARS FOR ZONE OBSERVATIONS BETWEEN −20° AND −80°.—Ten years ago Prof. Auwers published a list in the *Monthly Notices* of 480 stars to serve as standards for zone observations. It was then suggested that these stars should be systematically observed at those observatories situated in southern latitudes. Sufficient material has, however, been obtained to enable Prof. Auwers to publish in the current number of the *Astronomischen Nachrichten* (No. 3431–32) a complete catalogue of the positions of these 480 stars, together with a selection of nineteen other southern fundamental stars. Prof. Auwers mentions, however, that we must not treat the

places of all these stars as if they were as accurately determined as fundamental stars should be, because there was not in some cases sufficient material for the determinations of accurate proper motions. It is suggested that after an interval of fifteen to twenty years these stars should be again systematically observed and computed afresh. The catalogue, which is arranged for the epoch 1900, further contains the values of Bessel's constants computed for that year. There is also added the places of twenty-four stars, lying near the south pole, which have been chosen by Dr. Gill, and observed at the Cape Observatory.

LATITUDE OBSERVATIONS AT THE U.S. NAVAL OBSERVATORY, WASHINGTON.—Prof. W. Harkness describes the results of a determination of the latitude, and its observed variation, of the Washington Observatory in the *Astronomical Journal* (No. 404). The method employed involved the use of two instruments, namely, the transit instrument, of 77 inches focal length and 4·86 inches aperture in the prime vertical, and the meridian instrument of 30 inches focal length and 2·55 inches aperture; the latter could be used either as a transit instrument or as a zenith-telescope. The plan of work adopted was to observe α Lyræ at every possible culmination, both night and day, throughout the year, and also to observe four other stars near the times of their maximum aberration, in order to eliminate the latter constant from the latitude variation. The final result of the investigation is given in a table showing the observed values of the variation of the latitude.

APPEARANCE OF D'ARREST'S COMET.—A communication from America informs us that Prof. Holden telegraphs that D'Arrest's comet was observed by Perrine June 28·9764 Greenwich mean time. Apparent R.A. 30° 21′ 9″. Apparent polar distance 83° 46′ 29″. The ephemeris, which was given in *Ast. Nachr.*, No. 3405, requires the correction, according to Prof. Kreuz, of −3m. 58s. in R.A. and −4″·4 in declination.

SPECIES OR SUBSPECIES?

OF late attention has frequently been called in scientific journals to that rapid multiplication of nominal species of mammals which forms one of the most striking features of the systematic zoology of the last few years. To take an extreme instance: In eastern Europe and northern Asia there exists a pretty little rodent allied to the squirrels, and forming the single Old World representative of the genus *Tamias*. Until quite recently this creature was supposed to be common to North America, and was generally known as the Asiatic Chipmunk (*T. asiaticus*); and it is not many years ago that a well-known American zoologist fully recognised the specific identity of the eastern and western forms. Soon afterwards, that very same writer not only separated the American from the Asiatic race, but considered that the former constituted more than a score of distinct species! To take another example. The coyoté, or prairie wolf, has been very generally recognised as constituting a well-marked species distinguished from the ordinary wolf, not only by its inferior size, but by differences of colour and pelage. During the present year Dr. C. H. Merriam, the well-known Government zoologist of the United States, has, however, thought proper to split up the coyoté into a number of what he regards as distinct species. And it may be added that he has done the same for the brown and grizzly bears of his own continent, and also for those of north-eastern Asia.

It is, perhaps, needless to say that this species multiplication is a direct consequence of the increased attention which has been given of late years to the collection and description of mammals; and that, so far as the actual work itself is concerned, we have nothing but praise to bestow on the workers. Every one will admit that we ought to know as much as possible about all animals, and that if an American bear, wolf, or stoat can be distinguished from its cousin of the Old World, it is right and proper that the differences should be duly recorded. But is it right or advisable to bestow distinct specific names on animals so near to one another that it often requires the aid of a specialist to distinguish the one from the other? No one will deny that the lion and the tiger constitute a couple of well-marked species of the genus *Felis*. If, however, we trace the Indian tiger westwards into Persia and northwards into Central Asia, we find that it gradually assumes a longer coat, and either increases or decreases in size. Consequently, some zoologists regard the Siberian (and, for what I know, the Persian) tiger as a species distinct from the royal tiger of Bengal. Apart from the question whether the two intergrade in the intermediate area, if this view be adopted, we have now three species instead of two to deal with, namely the lion, the Bengal tiger, and the Siberian tiger; but it will be obvious that the two last differ from one another much less markedly than they both do from the first. If we only use English names, no very great harm is done, for we still see that two forms are tigers, while the other is a lion. In scientific nomenclature the case is, however, different, for each form receives a distinct specific name under the generic title of *Felis*; and hence there is no means of knowing by the nomenclature alone that two of the three are intimately related, while the other is widely different. Consequently, when we meet with the names *Felis tigris* and, say, *Felis sibirica*, and are told that the former is confined to India, we lose sight of the very important fcat that essentially the same type of animal ranges from Ceylon and India to the arctic tundras of Siberia; the difference in the length and thickness of its fur being obviously adaptations to its different climatic surroundings.

Precisely analogous instances occur in the case of the wolves and bears. The wolf of Europe is closely allied to the large American wolf, and very distinct from the coyoté, but if we separate the European wolf as one species, make several of the large American wolves, and several more of the coyoté, we have no clue to their mutual resemblances or differences; and we thus miss much important information about geographical distribution which ought to be apparent at first sight. Take, again, the deer allied to the red deer. The latter (*Cervus elaphus*) is a very distinct species confined to the Old World. In America it is represented by the wapiti (*C. canadensis*), which differs in colour, voice, and the form of its antlers. But there exists in Central and North-eastern Asia a deer so closely allied to the wapiti, that from the characters of the antlers alone the two cannot be separated. Now, if we regard this deer as a distinct species, under the name of *C. eustephanus*, we have obviously no means of knowing that it is much more nearly related to the wapiti than it is to the red deer, and we also lose sight of the circumstance that whereas the group to which the latter belongs is confined to the eastern hemisphere, the wapiti group is common to the north and north-eastern portions of both hemispheres.

But this is not all. By using specific terms in a wide sense the amateur zoologist and sportsman is able to keep in touch with the working zoologist, and thus to participate largely in the more important discoveries and advances of the science; whereas when specific distinctions are made on the minute differences now in vogue, he is utterly at sea, and probably throws up the whole study. Very likely the pure systematist may say that this is a matter of no moment, although this is not our own view.

What may be called the revolt of the amateur and sporting naturalist against the undue splitting of the modern specialist, has been initiated by Mr. Theodore Roosevelt, in an article in our contemporary *Science* for April 30, under the title of "A Layman's Views on Specific Nomenclature." Mr. Roosevelt, who holds the important office of President of the Board of Police Commissioners of New York, modestly styles himself a "layman," although he is really a very accomplished field naturalist, and probably knows more about the big game of North America than any other man. In this article the arguments are temperately, but forcibly put, the author laying stress on some of the points alluded to above, and urging that in the case of closely allied forms varietal or subspecific names should be employed in place of specific ones. Thus, the Asiatic wapiti should be a subspecies of the true wapiti, when its name (*Cervus canadensis eustephanus*) would at once indicate its relationship. With regard to the use of specific names for what are essentially modifications of one and the same type of animal, Mr. Roosevelt writes as follows. "New terminology is a matter of mere convenience, and it is nothing like as important as the facts themselves. Nevertheless terminology has a certain importance of its own. It is especially important that it should not be clumsy or such as to confuse or mislead the student. Although species is a less arbitrary term than genus, still it remains true that it is more or less arbitrary. If one man chooses to consider as species what other men generally agree in treating merely as varieties, it is unfortunate, both because the word is twisted away from its common use, and

further because it confuses matters to use it in a new sense to the exclusion of the word commonly used in that sense. Moreover, it is a pity, where it can be avoided, to use the word so that it has different weights in different cases."

After calling attention to the great confusion and difficulty caused by the multiplication of species in genera which, in any case, contain a large number of specific forms, Mr. Roosevelt proceeds to make some very important remarks concerning genera which contain only one or two forms. He observes that—"The points of resemblance between beasts like the wolverines, the beavers, and the moose of the two northern continents are far more important than the points of difference. In each of these cases it does not much matter whether these animals are given separate specific rank, because in each case the Old World and the New World representatives make up the whole genus; but even here it would seem to be a mistake to separate them specifically unless they are distinguished by characters of more than trivial weight. The wapiti and Scotch red deer, for instance, are markedly different, and the differences are so great that they should be expressed by the use of specific terms. If the American moose and the Scandinavian elk are distinguished by specific terms of the same value, then it ought to mean that there is something like the same difference between them that there is between the red deer and the wapiti; and, as far as our present knowledge goes, this is not so. The wolverines, beavers, and moose of the two continents should only be separated by specific terms if the differences between each couple are of some weight, if they approximate to the differences which divide the red deer and the wapiti, for instance; and I know that even these two may intergrade."

With these sentiments we most cordially agree. Although we may prefer to regard each of the couples referred to as constituting only a single species, the harm done by dividing them is comparatively slight, not only, as Mr. Roosevelt states, because they are the sole representatives of their respective genera, but also from the fact that the members of each pair have the same English title; thus at once indicating their relationship and distribution.

If it be admitted that it is advisable to distinguish closely related forms from those more widely separated by means of nomenclature, the next question is whether it is preferable to do this by means of subgenera or subspecies. To illustrate this the case of the deer may be cited. By many writers of the present day the genus *Cervus* is taken to include all the deer furnished with brow-antlers, of which the wapiti is the only American representative. In this sense the genus may be split up into several subgenera, such as the Red Deer and Wapiti group (*Cervus*), the Japanese Deer group (*Pseudaxis*), the Fallow Deer group (*Dama*), the Sambar group (*Rusa*), and the Swamp Deer group (*Rucervus*). If we admit numerous species, we have in the first group the Red Deer (*Cervus elaphus*), the Barbary Deer (*C. barbarus*), the Maral (*C. maral*), the Wapiti (*C. canadensis*), the Asiatic Wapiti (*C. eustephanus*), &c. In the fourth we have the Sambar (*C. unicolor*), the Equine Deer (*C. equinus*), the Rusa (*C. hippelaphus*), the Hog Deer (*C. porcinus*), &c. Now, in the first group the Red Deer and the Maral are very closely allied, as are the true and the Asiatic Wapiti, and to retain these as species, and at the same time to express their true relationships, it is necessary to restrict the term *Cervus* to the Red Deer group, and to take the subgenus *Strongyloceros* for the Wapitis. This entails the raising of *Pseudaxis*, *Dama*, *Rusa*, &c., to the rank of genera. Similarly the Sambar, Equine, and Rusa Deer must form one subgenus of *Rusa*, and the Hog Deer a second. But this scheme has the disadvantage of splitting up the brow-antlered, or typical deer (*Cervus*) into several genera, which are much more closely related than is *Cervus* in its wider sense to the other usually accepted genera of the family, such as *Alces*, *Rangifer*, *Capreolus*, &c. We are, therefore, very little forwarder by this arrangement, by which we also lose sight of the fact that the brow-antlered deer (*Cervus*) are distributed over the greater part of the two northern continents, as well as India and the Malayan countries. On the other hand, if we adopt subspecies, the Maral becomes a subspecies of the Red Deer, as *C. elaphus maral*, and the Asiatic Wapiti of the true Wapiti as *C. canadensis eustephanus*, while the Equine and Rusa Deer respectively rank as subspecies of Sambar under the names of *C. unicolor equinus* and *C. unicolor hippelaphus*. Similarly, the Siberian ranks as a subspecies of the Indian tiger; while the brown and grizzly bears of Kamschatka and North America are ranked as subspecies of the European brown bear (*Ursus arctus*). Otherwise, the lion must be separated subgenerically from the tiger, and the brown and grizzly bears from the black bears. Which is the simpler, and, to most minds, the most philosophic arrangement, needs no mention!

Of course there are difficulties in such an arrangement, as there are in all sublunary matters; and in many cases there must and will be great difficulties in deciding as to what amount of difference constitutes a species and what a subspecies. But the same difficulty occurs when the term species is used in a more restricted sense. And it may be mentioned that even when so employed, subspecies are recognised by American writers. If it be necessary to indicate such "sub-subspecies," quadrinomials must apparently be employed, but these need only be mentioned for the benefit of the advanced specialist. The unfortunate thing in the matter is the existence of the "personal equation," which is one very difficult to get over. If, however, it be borne in mind when we have a large genus containing a number of well-defined types, around all or many of which cluster a series of closely related forms, that the term species be restricted to the former, while the latter are classed as subspecies, there ought in most cases to be no very great difficulty. In such an arrangement the amateur and the popular naturalist, as well as the student of geographical distribution in its wider and more important sense, can confine himself to the species, while the specialist can busy himself about the subspecies, or even the "sub-subspecies."

Possibly a greater latitude may have to be allowed to the students of the smaller mammals, such as the rodents, in which species may have to be based on slighter differences than are taken cognisance of in the case of the larger forms. Although perfect uniformity would be desirable, it is by no means absolutely essential that the same standard of distinction should be applied to all the groups.

As might have been expected, Dr. Merriam, one of the great champions of "splitting," has not allowed Mr. Roosevelt's challenge to pass in silence. And he has published a reply in *Science* of May 14, under the title of "Suggestions for a New Method of Distinguishing between Species and Subspecies." And here a moment's digression may be made to compliment both writers on the good feeling displayed in their criticisms—a marked contrast to some Transatlantic scientific disputations. Dr. Merriam states that hitherto he has taken the following as the distinction between species and subspecies, viz. that "Forms known to intergrade, no matter how different, must be treated as subspecies and bear trinomial names; forms not known to intergrade, no matter how closely related, must be treated as full species and bear binomial names." This is, of course, one of those hard-and-fast rules which look very nice on paper, but are not consonant with nature's system; for it is merely an accident whether the intermediate link is still existing, or has died out at a more or less remote epoch. In his new communication Dr. Merriam, for the first time, recognises the unimportance of the survival or extinction of the connecting link, and views with approval the proposal that our choice of binomial or trinomial nomenclature is to be governed by the *degree of differentiation rather than intergradation*. He expresses his new view as follows, viz. "In my judgment, forms which differ only slightly should rank as subspecies even if not known to intergrade, while forms which differ in definite, constant and easily recognised characters should rank as species even if known to intergrade."

It was not, of course, to be expected that Dr. Merriam would forthwith strike his flag, and admit that Mr. Roosevelt is right and himself wrong, but the giving up of the bugbear "intergradation" as a factor in the question at issue is undoubtedly a great point gained on the side of the "lumpers." It is, in fact, a clear admission that both species and subspecies are pure abstractions in the case of large genera, and that whether an animal is called one or the other is simply a matter of convenience. This being so, we may hope for the future to hear no more about such a creature being a "good" species.

The question of the distinction between species and subspecies is undoubtedly one bristling with difficulties, and it is therefore one which in many cases is incapable of being definitely settled by an individual opinion. Although personally convinced of the advisability of using specific names in a wide sense, and employing trinomials for the designation of the nearly related forms, it may be suggested that an international committee of zoologists should be formed to discuss the question

in all its bearings. Needless to say, such a committee should include representatives of both the "splitting" and "lumping" interests; and if the points at issue were fairly debated, with a full determination to give and take on both sides, it is difficult to believe that a working compromise between the extreme views could not be arranged. Almost anything is better than the present condition of uncertainty and discrepancy.

R. LYDEKKER.

RECENT INVESTIGATIONS INTO THE NUMERICAL VALUE OF "THE MECHANICAL EQUIVALENT."

THE value of the "mechanical equivalent," when deduced from experiments based on the direct transformation of mechanical work into heat, affords the best standard by means of which to test the validity of our system of electrical units. It is evident, however, that the value of this test depends upon the accuracy of the "equivalent" determinations. The engineer may (very rightly) regard extreme numerical accuracy in this case as comparatively unnecessary, but from the physicist's point of view there are few natural constants whose exact determination is of equal importance.[1]

Until the present time the evidence available has been so conflicting that it has been impossible to draw any certain conclusions from a comparison of the heat developed by mechanical work with that resulting from work electrically performed.

In *Phil. Trans. Roy. Soc.*, 1893, I gave an account of an investigation, by electrical methods, into the capacity for heat of water. The chief object of that work was to apply to the electrical units the test above referred to, for I considered that Rowland's admirable series of experiments (*Proc. American Academy*, 1879) on the direct conversion of mechanical energy supplied sufficient data to render such an investigation desirable. I regret, however, to say that, for the following reason, the results of that work have hitherto been of little value for the particular purpose for which it was undertaken. The change in the capacity for heat of water indicated by Rowland differed materially from that obtained by means of the electrical experiments. This difference in the rate of change must be due to differences in temperature measurements. In *Phil. Trans.*, 1893, p. 496, I wrote as follows: "No change in the value of the various units or constants involved in our investigations could bring our results into absolute agreement with those obtained by Rowland, since, owing to the difference in the expressions for the temperature coefficients for the specific heat of water, it is inevitable that if our conclusions should agree at some one temperature, they must necessarily differ when expressed in terms of a thermal unit at any other temperature, and thus changes in the values of the units would only alter the temperature of agreement."

This quotation will, I think, render evident that but little progress could be made until some explanation of the discrepancies in the temperature measurements was forthcoming.

An indirect comparison of Rowland's standard with that of the Bureau International is given in Prof. Schuster's paper on the "Scale value of Dr. Joule's thermometers" (*Phil. Mag.*, 1895). The results indicate that Rowland's rate of decrease in the heat capacity of water would be diminished if expressed in terms of the International Standard; but, as Prof. Schuster remarked, "it would be necessary to have further information before any definite conclusions could be drawn."

I am glad to say that we are now in possession of the further information sought for by Prof. Schuster, and the above brief statement of our difficulties has been made in the hope of drawing attention to the new light now thrown on the whole subject.

[1] It has been decided (see Report of the Electrical Standards Committee, 1896) that the thermal unit is to be a dynamical one, hence the demand for accuracy becomes insistent.

Two entirely distinct investigations have just been brought to a successful conclusion in the laboratory of the Johns Hopkins University.

(1) "A recalculation of Rowland's value of the mechanical equivalent of heat in terms of the Paris hydrogen thermometer," by W. S. Day.

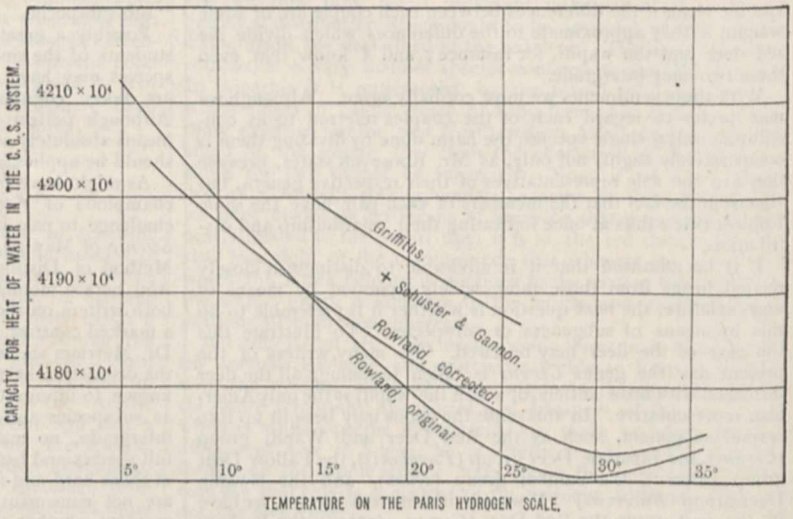
(2) "A comparison of Rowland's mercury thermometer with Griffiths' platinum thermometer," by C. W. Waidner and F. Mallory.

Both the above investigations have been carried out under the directions of Profs. Rowland and Ames. Full particulars of the work will shortly be published in America; but, in the meantime, the authors have very kindly given me permission to publish the results in this country. I will here give no details beyond the statement that the comparison of Rowland's thermometers with those of the Bureau International were made under conditions as nearly as possible similar to those prevalent during Rowland's experiments, and the same remark holds good with regard to the comparison with the platinum standard.

The results of these entirely separate investigations may be briefly summed up as follows:—

(1) The values resulting from Rowland's experiments undergo considerable modification at certain temperatures.

(2) Over the temperature range covered by Griffiths' experiments (14° to 26° C.), the rate of change in the capacity for heat of water becomes practically identical with that given by Griffiths.



(3) Throughout this range, Griffiths' value exceeds Rowland's by about 1 in 420.

(4) Separate standardisations of the same platinum thermometer were performed both in England and in America. The units adopted in the two cases differed slightly, but this is unimportant, as the temperature measurements are independent of the magnitude of the unit. The essential point is the respective values of the ratio of the resistance at 100° C. to that at 0°. These were as follows:

English	= 1·38596
American	= 1·38597

Thus affording satisfactory proof that not only the electrical measurements, but also the barometric standards, &c., are in perfect agreement.

(5) The results of the comparison with the platinum standard are (in the words of the authors) "in almost absolute agreement" with those deduced by Mr. Day from the direct comparison with the international standards, and thus the validity of Callendar and Griffiths' method of standardising the platinum thermometer is confirmed.

In the reduction of Rowland's results, "each individual experiment, the thermometers used in it, and the number of observations made with each thermometer, were taken into account.'

The results of all this labour are shown by the diagram (p. 238), and also by the following table.

Temp.	Old.	Corrected.	Griffiths.
10° ...	4200×10^4 ...	4197×10^4	
15 ...	4189 ...	4189 ...	$4199{\cdot}7 \times 10^4$
20 ...	4179 ...	4183 ...	4193·2
25 ...	4173 ...	4177 ...	4187·4
30 ...	4171 ...	4173	
35 ...	4173 ...	4174	

Prof. Schuster and Mr. Gannon did not extend their determinations over any appreciable temperature range, and it is impossible, therefore, to apply the "rate of change" comparison to their results. Their thermometry, however, was directly based on the International Standard, hence it is probable that we now have *three separate determinations of the "mechanical equivalent" in which the temperature scale is identical.*

It appears to me that the data now at our disposal justify the following conclusions :—

(*a*) That the rate of change in the capacity for heat of water from 10° to 25° C. may be considered as known with sufficient accuracy for present purposes.

(*b*) That the persistent difference in the capacity for heat of water, when determined by mechanical and electrical methods, indicates a possibility that there is some error in one of the electrical units.[1]

One further matter deserves attention, concerning which there has hitherto existed considerable uncertainty, viz. the value of the ratio $\frac{\text{"mean thermal unit"}}{\text{thermal unit at } t^\circ}$.

The value of this ratio is of great importance, as in the absence of exact information on this point we are unable to utilise the results of many notable experiments, such as those performed with Bunsen's calorimeter.

Until recently Regnault's value (1·005 in terms of the thermal unit 0° to 1°) has been universally adopted.

Some experiments performed by me in 1894, on the latent heat of evaporation of water, led to the conclusion that "the value of the 'mean thermal unit' is practically identical with that at 15° C." (*Trans. Roy. Soc.*, 1895, p. 320).

On the publication of this statement, Dr. Joly performed some experiments, from which we obtain the value ·9962 in terms of the thermal unit at 15° C. (*Phil. Mag.*, November 1895, p. 440), assuming Rowland's uncorrected values from 0° to 15°.[2]

In the Report of the Electrical Standards Committee, 1896, Mr. Shaw gives the results of a recalculation of Regnault's numbers, in which, assuming Rowland's uncorrected values, he obtains 1·0016 in terms of the thermal unit at 10°.

The enumeration of these facts indicates the extent of our uncertainty, and here again recent investigations lead us on to firmer ground.

In the Bakerian lecture delivered by Prof. Osborne Reynolds, on May 20, 1897, he communicated the results of an investigation by Mr. Moorby and himself into the value of the "mean thermal unit." Their results are of peculiar importance because they are practically independent of temperature measurements, and also on account of the large scale on which they were conducted. Their conclusion is "776·94 mechanical units at Manchester." I take this as equal to 777·07 at Greenwich = 4184×10^4 ergs. This is about equal to Rowland's corrected value at 19°, or, expressing it in terms of Rowland's corrected value at 15°, we get ·9988, which is sufficiently near to unity to justify my prediction as to the practical equality of the two units.

I trust that the above short summary will suffice to show that great advances have recently been made, and I venture to express a hope that the importance of extreme accuracy with regard to thermal measurements may, in the future, be more generally recognised than, I believe, has been the case in the past.

E. H. GRIFFITHS.

[1] For example, an error of 1 in 1000 in the electro-chemical-equivalent of silver would account for nearly the whole of our present discrepancies.

[2] I find that if we take Rowland's corrected values, this number approximates to ·9975.

THE ACTION OF LIGHT ON DIASTASE.

THE influence of the different rays of the solar spectrum upon the various phenomena of vegetable life has been shown by many observers to be not at all uniform. Speaking broadly, the rays lying to the left of the green, often collectively termed those of the red end, have been found to be most actively concerned with the metabolic processes. They are the ones on which generally the working of the chlorophyll apparatus depends, and in their absence no construction of carbohydrates from the carbonic anhydride of the air takes place. The rays beyond the green to the right, including also the ultra-violet ones, have, on the other hand, been shown to play but a small part in such constructive processes, but to be those on which the phenomena of heliotropism and other interferences with growth depend. They are broadly associated, therefore, with the physical rather than the chemical processes.

In recent years the influence of the blue, violet and ultra-violet rays has been found to be deleterious to vegetable protoplasm, exposure to them destroying many micro-organisms. They have further been shown to share, though to a small extent only, the power of assisting the chlorophyll apparatus. Some time ago a research of considerable importance was conducted by Messrs. Brown and Morris, from which it appeared that the amount of diastase obtainable from foliage leaves varies considerably at different periods of the day, being greater after darkness, and diminishing after exposure to light. An investigation of the action of the different rays of the spectrum on diastase has recently been carried out by Prof. Reynolds Green, which shows that its separate regions possess radically different powers, and that while some rays are beneficial and aid in the secretion of the enzyme, others are as distinctly deleterious and, indeed, affect the diastase in the same way as those of the blue end do the micro-organisms already spoken of.

By the use of appropriate screens the spectrum was divided into seven bands, the infra-red, the red, including the rays of wave-length 720$\mu\mu$ to 640$\mu\mu$; the orange, ranging from 640$\mu\mu$ to 585$\mu\mu$; the green, from 585$\mu\mu$ to 500$\mu\mu$; the blue, from 500$\mu\mu$ to 430$\mu\mu$; the violet, including the visible rays beyond wave-length 430$\mu\mu$; and the ultra-violet.

Solutions of diastase, prepared from malt extract, and from the leaves of *Phaseolus vulgaris*, as well as from human saliva, were exposed to strong illumination, either that of the sun, or of a strong naked electric arc-lamp, for several hours, and after such exposure their hydrolytic power was tested side by side with that of control solutions that had not been illuminated. By the use of the screens already mentioned, the effects of these several regions of the spectrum were ascertained.

Of the infra-red, red, orange and blue regions the rays were found to have a distinctly beneficial effect upon the manufacture of the enzyme. The effect was, however, much the greatest in the red region, these rays, when allowed to act for ten to twelve hours, increasing the amount of diastase by one-half. A second maximum was obtained in the blue, while the rays of the other regions were intermediate in power.

The violet and ultra-violet rays were ascertained to exert a destructive action on the enzyme, an exposure of ten to twelve hours to the latter especially, often resulting in the destruction of 60 per cent. of the diastase. The change set up in the solution was found to be a continuous and progressive one, the extract becoming weaker after removal from the action of the light until the diastasic power entirely disappeared.

This effect was found to follow also a strong illumination of the living leaf. Leaves of *Phaseolus* were exposed to sunlight and the electric arc respectively, half of each being carefully shaded by a cover of blackened paper. After the illumination, weighed quantities of the shaded and unshaded sides were made to act under the same conditions upon a solution of starch, when the hydrolytic power of the unscreened portions was found to have been very materially injured.

The difference in the action of the various rays suggests a modification of the view that the chemical action of light in vegetable metabolism is particularly a property of the red end of the spectrum. This is borne out further by some experiments recently published by Laurent, who has found that the blue and violet rays are especially active in the construction of nitrogen-containing compounds in the plant. All the rays appear to be able to bring about chemical effects, the differences depending upon the materials taking part in the reactions, rather than upon any radical differences in the nature of the light.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Great Hall of the Northern Polytechnic Institute is being opened to-day (Thursday) by the Lord Mayor.

THE Rev. Dr. Thorburn, formerly Science Master in the Royal Grammar School, Sheffield, has been appointed Head Master of the Grammar School, Odiham, Hants.

THE sum of 2000*l.* has been offered to the Smith College for the erection of a building for the scientific laboratories, on condition that the sum of 1800*l.* is subscribed by the alumnæ.

DR. KARL TOLDT, Professor of Anatomy in the Medical Faculty of Vienna, has been elected Rector of the University for the Academic year 1897-98.

MR. C. A. MORTON and Dr. J. Swain have been appointed joint Professors of Surgery in the Faculty of Medicine of University College, Bristol.

A DONATION of 2500*l.* has been promised by Mr. A. F. Calvert to the funds of the proposed North-Western Polytechnic (St. Pancras and Hampstead).

ACTING on the recommendation of the Faculty of Physicians and Surgeons, Columbia University, the chair of Chemistry and Medical Jurisprudence (at present vacant) has been changed to that of Physiological Chemistry.

THE tenth session of the Marine Biological Laboratory, Wood's Holl, Mass., began on July 6, and is to last for six weeks. It is being conducted by Dr. B. M. Davis, of the University of Chicago, and two courses are offered, (1) on Elementary Botany, and (2) on the Morphology of the Algæ.

THE late Mr. J. S. Taylor, of Edderton, near Ross, left 4000*l.* in trust to found bursaries or scholarships to be known as the "John Taylor bursaries," to be competed for by natives of Thurso desiring to complete their education at Edinburgh University. He also bequeathed 1000*l.* to the Tain Academy, Ross-shire.

Science states that an anonymous donor has presented to the library of Columbia University 387 books, valued at about 1200*l.* They include a number of valuable works in natural history, such as Audubon's "Quadrupeds," Sepp's "Nederland'sche Insekten," Gould's "Humming-Birds," and Levaillant's "Oiseaux d'Afrique."

UNDER the will of Mrs. Gee, widow of the late Mr. Robert Gee, lecturer on the diseases of children in the medical school associated with University College, Liverpool, that college receives over 7000*l.* for the purpose of advancing the medical department, and promoting study and research in medical science. It has been decided by the medical faculty to institute a Robert Gee fellowship in anatomy of the value of 100*l.* for one year, and four entrance scholarships of 25*l.* each for one year.

THE following appointments are announced:—Dr. Thomas S. Fiske, of Columbia College, has been made a full Professor of Mathematics; Dr. Wm. Slocum, at present President of Colorado College, has been elected President of Oberlin College; Dr. G. Boccardi has been appointed Associate Professor of Microscopical Anatomy at the University of Naples; Dr. J. Szadowski, Associate Professor of Geology at the University of Klausenberg; and Dr. J. J. Zumstein to be Professor of Anatomy at the University of Marburg.

A MEETING of the subscribers to the Hall Memorial Fund, which was started a few months ago to commemorate the jubilee of science teaching at the City of London School, was held at the school on Monday last. It was announced that the amount subscribed (including 100 guineas from the Corporation) was about 354*l.*, and it was resolved that 350*l.* should be devoted to founding a scholarship to promote the study of chemistry and physics in memory of the late Mr. T. Hall, science master at the school, 1847-1870. The scholarship is to be awarded every fifth year, and to be tenable for two years.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xix. 3.—Development of the A-process in quaternions, with a geometrical application, by Dr. J. B. Shaw, gives several interesting results.—On the analytic theory of circular functions, by A. S. Chessin. The writer points out that the similarity between simply and doubly periodic functions ceases to exist when the behaviour of the function at infinity comes to be investigated. He refers to M. Méray's "Leçons nouvelles sur l'Analyse infinitésimale et ses applications Géométriques," wherein is given a classification of simply periodic functions into *polarised* and *non-polarised* functions. He then states that the character and *rôle* of the *polar values* of a circular function have not been clearly set forth, and that the object of his paper (pp. 216-258) is to supply the deficiency.—Sur un problème concernant deux Courbes Gauches, by Prof G. Kœnigs. The problem, of which a *direct* solution is given, is "une Courbe C étant donnée, en trouver une autre C, qui lui corresponde point par point de sorte que le plan osculateur à chaque courbe aille passer par le point qui correspond sur l'autre au point de contact."—The object of a second paper, by Dr. Shaw, entitled "The Linear Vector Operator of Quaternions," is the development of the linear vector operator, entirely from a quaternion point of view, which amounts, the author writes, to an extension or development of nonions; reference is made to a paper by Dr. H. Taber in vol. xii. of the journal.—On certain applications of the theory of probability to physical phenomena, by Dr. G. H. Bryan. This is a subject to which much has been contributed in our columns. Dr. Bryan arrives at the conclusion that even the theory of probability does not furnish us with a *conclusive* proof of the Boltzmann-Maxwell law. That the law in question represents accurately the state of the molecules in a perfect gas, and approximately their state in an ordinary gas, cannot be doubted; but directly we attempt to generalise the law by applying it to assemblages of densely crowded molecules, we are confronted with the necessity of making some assumption or other, and the above treatment (*i.e.* employed in Dr. Bryan's note) shows that even probability considerations do not afford a sure way out of the difficulty.

MESSRS. W. AND G. S. WEST'S paper on Welwitsch's African Freshwater Algæ is still occupying the pages of the *Journal of Botany*, with the description of a large number of new and interesting forms. In the numbers for June and July descriptions are given of the following new genera: *Athroocystis*, belonging to the Palmellaceæ; *Camptothrix*, the type of a new order, *Camptotricheæ*, of Cyanophyceæ; *Polychlamydum*, near to *Schizothrix*.—Mr. E. G. Baker describes and figures the variety *ceratophyllon* of *Plantago coronopus*, new to Britain.—Mr. Arthur Lister has some notes on rare species of Mycetozoa, in which several new species are described.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 17.—"On the Distribution of Frequency (Variation and Correlation) of the Barometric Height at diverse Stations." By Prof. Karl Pearson, F.R.S., University College, London, and Miss Alice Lee, B.Sc., Bedford College.

This paper is especially intended as an *illustration of method*. The authors believe that hitherto no exact theory of variation or of correlation has been applied to meteorological observations, and they have endeavoured to indicate that fruitful results may be obtained from such a theory when applied to one branch at least of meteorology, namely, barometric frequency.

Their first object was to determine the nature of the barometric frequency distribution. By means of tables and plates it is shown that it can be described with a very high degree of accuracy by the use of a generalised frequency curve of the type—

$$y = y_0 \left(1 + \frac{x}{a}\right) pe^{-\gamma x},$$

a type which has been fully discussed in a previous memoir on skew variation.

A standard frequency curve for the British Isles having been selected, it is shown that the frequency distribution varies continuously from this type as we pass from station to station, and appears to be fairly uniform along lines which are termed generalised isobars.

The authors' next object was to discover what constants of the barometric frequency suffice to describe it with the least probable error. A somewhat elaborate investigation was accordingly made into the probable errors of the constants, and four *physical* quantities, the mean, the variation (or standard

deviation), the skewness, and the modal frequency were found to be the constants, which described a local barometric frequency with the smallest probable errors.

They have next discussed the chief physical features of a barometric frequency distribution.

(*a*) The modal height and the modal frequency are found to possess certain advantages over the mean height and the mean frequency. Various methods are considered for approximately determining the position of the mode.

(*b*) The variability of the barometric height and the skewness of the distribution are discussed at some length.

(*c*) A test of the accuracy of the observations for the twenty coast stations is made by attempting an interpolation of the frequency constants of London and Cambridge between those of Southampton, Hillington, and St. Leonards.

In the second part of the memoir the subject of correlation is dealt with. It is shown that within the limits of the British Isles there is a very high degree of correlation (as high as 0·9824 between Babbacombe and Churchstoke), and only sinking to 0·7572 if we take practically the utmost reach of the British Isles. It is pointed out that the gradual change of correlation with direction and distance, combined with change owing to the interval of time between observations, enables the meteorologist to find systems of stations with almost every variety of correlation coefficient.

The probable height and probable deviation from that height at any given station, based on a knowledge of the heights, contemporaneous or not, at one, two, three, or more other stations, are considered. It is indicated that with proper arrangement of times and distribution of stations it must be possible to make the probable deviation zero or nearly zero, and hence to predict with very great accuracy the height at one station from a knowledge of heights at other selected stations. The suggestion is made that this principle might very possibly be applied to closely predict future barometric heights at a given station from antedated observations at other selected stations.

Various theorems are deduced from the general principles of correlation: thus, it is shown that—

(*a*) There is a balance height for every pair of stations, such that when the barometer stands above this height at one station it will usually stand below it at the other, and *vice versâ*.

(*b*) That for a very considerable number of triplets of stations which are positively correlated together, so that a high barometer at one means usually a high barometer at a second, it can still be predicted that if the barometer be steady at one, a rise or fall at the second denotes a fall or rise respectively at the third member of the triplet.

The writers hope that their paper may draw attention to the importance of rendering the large amount of barometric observations now made, available for the easy calculation of the variation and correlation coefficients. They consider that if a chain of stations round a large continental area could have their correlation for a series of intervals of time worked out, much might be done in the way of very close prediction of barometric changes.

"On the Theory of the Magneto-Optic Phenomena of Iron, Nickel, and Cobalt." By J. G. Leathem, Fellow of St. John's College, Cambridge. Communicated by Sir Robert S. Ball, F.R.S.

In this paper the fundamental equations of a particular type of magneto-optic theory are taken in a general form on the lines of Mr. Larmor's recent papers on electro-dynamics, and developed so as to obtain the solutions of the problems of magnetic reflection and of transmission through films. The formulæ so obtained are compared with the available experimental results.

The notation differs slightly from that of Maxwell: c denotes the velocity of radiation, and (f'', g'', h'') corresponds to Maxwell's total electric displacement; this has components (f, g, h) and (f', g', h'), of which the former is the displacement involved in the ether strain, and the latter that involved in the polarisation of the matter. It being assumed that for light oscillations the magnetic permeability is unity, the fundamental equations of the theory are as follows: (i.) The circuital relations $dc/dy - db/dz = 4\pi u$ and $d\mathrm{R}/dy - d\mathrm{Q}/dz = -da/dt$. (ii.) The equations of the current $u = \sigma\mathrm{P} + g_3\mathrm{Q} - g_2\mathrm{R} + df''/dt$, where the vector (g_1, g_2, g_3) represents the Hall effect. (iii.) The displacement relations, and the elastic relations between electromotive force and polarisation, viz. $f'' = f + f'$, $f = \mathrm{P}/4\pi\mathrm{C}^2$, and $f' = (\mathrm{K} - 1)/4\pi\mathrm{C}^2 \cdot \mathrm{P} + b_3 d\mathrm{Q}/dt - b_2 d\mathrm{R}/dt$, the vector (b_1, b_2, b_3) representing, in transparent matter, the whole magneto-optic effect.

The vector $\{(b_1 d^2/dt^2 + g_1), (b_2 d^2/dt^2 + g_2), (b_3 d^2/dt^2 + g_3)\}$ is assumed equal to $\mathrm{C}_0 e^{ix}(\alpha_0, \beta_0, \gamma_0)$, where $(\alpha_0, \beta_0, \gamma_0)$ is the intensity of magnetisation; and $\mathrm{C}_0 e^{ix}$ is the single magneto-optic constant of the theory.

The principal experiments made use of are those of Drs. Sissingh and Zeeman on magnetic reflection, their observations being measurements of the phase m and amplitude μ of the "magneto-optic component" of the reflected light for various angles of incidence.

The following table will serve to indicate what sort of agreement is found to exist between the theory and the experiments.

Equatorial Reflection from Iron.

Angle of incidence.	Observed value of m.	Calculated value of m.
86° 0′ ...	209° 26′ ...	272° 35′ $- x$
82 30 ...	204 22 ...	265 19 $- x$
76 30 ...	194 49 ...	256 31 $- x$
71 25 ...	190 3 ...	251 13 $- x$
61 30 ...	181 49 ...	244 18 $- x$
51 22 ...	179 0 ...	239 48 $- x$
36 10 ...	174 9 ...	235 27 $- x$

If the value of x is about 62°, the agreement shown is remarkably good. Experiments on polar reflection from iron point to almost exactly the same value for x.

If we suppose the value of C_0 to be given by

$$-\mathrm{C}_0 = 7{\cdot}283 \times 10^{-11},$$

the ratios of the calculated to the observed values of μ for the above angles of incidence are found to be respectively 1·13, 0·96, 0·99, 0·97, 1·01, 1·03, and 0·97; so that in the case of the amplitudes also there is good agreement.

The theory gives a satisfactory account of a phenomenon which has only recently been discovered, namely, an effect of the component of magnetisation perpendicular to the plane of incidence. Good agreement is also found to exist in the case of the experiments on transmission through films.

It is to be noticed that, as b_1, b_2, b_3 are necessarily real, the imaginary part of $\mathrm{C}_0 e^{ix}$ must be entirely accounted for by the Hall effect. Hence the present theory involves the supposition that the Hall effect is very much greater for rapidly alternating currents than for steady ones.

"On the Change of Absorption produced by Fluorescence." By J. Burke, M.A. (Dub.).

A careful series of experiments which have led to the result that certain fluorescent substances—notably uranium glass—absorb the rays which they give out whilst fluorescing differently, according as they are in a state of fluorescence or not; so that if a body, A, of some fluorescent substance, such as uranium glass, be transmitting light from a similar body, B, which is fluorescing the amount of light transmitted by A from B, is quite different, according as A is fluorescing or not.

If α and β are the coefficients of transmission in the two cases for uranium glass 1 cm. thickness, the mean values obtained by eye observation are $\alpha = 0{\cdot}47$; $\beta = 0{\cdot}79$.

The ratio $\frac{\beta}{1+\alpha}$ was also independently determined, the mean value of which $= 0{\cdot}507$. The values of α and β determined photographically were

$$\alpha \begin{cases} < 0{\cdot}48 \\ > 0{\cdot}43 \end{cases} \qquad \beta \begin{cases} > 0{\cdot}75 \\ < 0{\cdot}89 \end{cases}$$

In the determinations of α and β, a null method has been employed, by which any appreciable want of uniformity in the illumination could be detected.

The source of illumination was almost invariably the spark discharge of a Leyden jar between cadmium electrodes, being one of the richest sources of the fluorescence exciting rays, and the photometer one specially constructed for the purpose.

The phenomenon has been exhibited directly by obtaining two photographs side by side upon the one plate: one the effect of the fluorescence due to two layers of the fluorescent substance; the other the result of superposing the effects due to the fluorescent light from a single layer according as it came directly or through a non-fluorescing layer of equal thickness. The exposures being equal in each of the three cases, the superposed photographic effect was greater than the other one,

notwithstanding the fact that the result of superposing two nearly equal effects due to light of the same intensity—or nearly so—had been found not to be equal to, but less than that due to light of double the intensity acting for half the time. If the resultant effect were equal to the sum of the separate ones, the effect caused by the change of absorption would have been still more marked.

The effect can also be shown by the photometer, for if $\alpha = \beta$, taking the maximum value of $\alpha = 0{\cdot}48$, the ratio $\frac{\alpha}{1+\alpha} = 0{\cdot}32$, and instead of obtaining equality when the photometer is adjusted for this value the difference is most marked.

"On the Relative Behaviour of the H and K lines of the Spectrum of Calcium." By William Huggins, D.C.L., LL.D., F.R.S., and Mrs. Huggins.

The problem before us was to find out by experiments in the laboratory, under what conditions the lines of calcium other than the lines H and K, and in particular the strong blue line at 4226·9, were so greatly enfeebled relatively to H and K, that they became quite insignificant, or even disappeared altogether from the spectrum, leaving the very simple spectrum of the two lines H and K, or nearly so.

It was suggested to us by the known rarer state of the gases in the regions above the photosphere, as well as by my long experience with the behaviour of calcium in comparison spectra, that the modifications of the calcium spectrum which we were seeking, would be likely to show themselves under conditions of greatly reduced density of the calcium vapour.

For obvious reasons we elected to use throughout the experiments a spark of very small intensity.

Our expectations were completely confirmed. Under the conditions (*a*) of greatest density of the calcium vapour, when metallic calcium was employed, the blue line was as strong and possessed the same diffuse character as H and K.

As the density of calcium was reduced, the lines were not found to be equally enfeebled, but, on the contrary, the blue line and the greater number of the lines were increasingly reduced in intensity relatively to H and K, until at last with the twice washed electrodes (*d*) the spectrum was simplified to the condition usually existing in the prominences, in which H and K only are present.

A more precise statement of the changes of relative intensity as they are presented in the photographs on the plates are given in the paper.

The only condition which was varied during this set of experiments was the amount or density of the calcium vapour. The changes of relative intensity, and the modifications of the calcium spectrum produced thereby, correspond closely to the behaviour of calcium at different levels near the sun's limb, and in the atmospheres of stars of different orders. There can remain little doubt that the true interpretation of the changes in appearance of the calcium lines in the celestial bodies is to be found in the different states of density of the celestial gases from which the lines are emitted or by which they are absorbed.

In the modifications of the calcium spectrum arising from variations in the relative intensities of the lines which have been discussed in this paper, and which correspond to those observed in the celestial bodies, there does not appear to us any reason for assuming, much less any direct evidence in favour of, a true dissociation of calcium, that is, of its resolution into chemically different kinds of matter.

A letter from Prof. Liveing is added, which contains an account of early experiments on the spectrum of calcium which support, by a different method of working, the conclusions of our paper; and seem to show the possible occurrence of the line H without K. In our experiments both H and K were always present, K being stronger than H, as is the case in the photographs of the prominences by Hale, and by Deslandres.

"Stress and other Effects produced in Resin and in a Viscid Compound of Resin and Oil by Electrification." By J. W. Swan, F.R.S.

In this paper are described the stress and other effects produced by non-luminous electrical discharges on a viscid mixture of resin and oil. Wires from the discharging terminals of an induction coil or Wimshurst machine were led, one above and the other below a glass dish containing the resin mixture. The terminal above the resin surface was usually a point, ball, or disc, and the one below was a disc, forming a support for the dish of resin. The discharging arms of the coil were used as a spark gap. The spark, 25 to 50 mm. long, always passed at the spark gap, the terminals above the resin being so adjusted that the resistance to discharge was slightly greater there than at the spark gap. When the upper terminal is a ball, and connected to the + electrode, then on a spark passing at the spark gap there is produced on the surface of the viscous mixture a star-shaped figure, formed of deeply-furrowed, closely-clustered, outward-branching rays, extending from a circular frill near the centre to the margin of the dish. The figure gradually dies down, and when the surface is smooth it may be produced again and again.

If the terminal above the resin surface be made − instead of +, then on a spark passing at the spark gap, a figure characteristic of the − discharge is produced. This figure is much smaller and weaker than the + one; most frequently it consists of a circular band or ring, more or less indented in outline, enclosing leaf-like rays which tend towards the centre. These are relatively broader and less branching than the + rays, and are in relief, while the + rays are below the plane of the surface. When the electrification is strong, the ring enclosing the rays stands up as a frill in considerable relief. These figures closely resemble the dust figures obtained by Lichtenberg and Armstrong.[1]

The character of the figures depend on

(1) Whether the terminal over the dielectric is + or −.

(2) The form and size of the + and − terminals.

(3) The distance of the upper terminal from the surface of the dielectric.

(4) The character of the spark at the spark gap.

(5) The density of the atmosphere.

Permanent figures may be obtained by substituting ordinary hard resin for the viscous mixture. The figures are then developed by warming and rendering the surface sufficiently plastic to allow of movement. The persistence and fixity of the stresses produced by a discharge on resin is remarkable, figures have been developed two months after the discharge with very slight diminution of effect.

The density of the atmosphere exercises a great effect on the figures obtained. As the density diminishes, the figures become more diffuse and less marked in character, and at an air pressure of 85 mm. a + figure becomes faintly marked by bands without the characteristic rays.

Geological Society, June 23.—Dr. Henry Hicks, F.R.S., President, in the chair.—Notes on a collection of rocks and fossils from Franz Josef Land, made by the Jackson-Harmsworth Expedition during 1894-96, by E. T. Newton, F.R.S., and J. J. H. Teall, F.R.S. A large collection of rocks and fossils, obtained by the members of the Jackson-Harmsworth Expedition, chiefly from the neighbourhood of Cape Flora, on the south-west of Northbrook Island, but also from more distant localities visited during boat- and sledge-journeys, have been sent to the Director-General of the Geological Survey, and examined by the authors. After a summary of what was previously known of the geology of Franz Josef Land, an account of the new specimens was given. The rocks are for the most part basalts, and are described in detail; they are usually formed of labradorite, augite, and interstitial matter which is sometimes represented by palagonite containing a large percentage of iron-oxide. This palagonite is regarded as the hydrated representative of the residual magma left after the separation of labradorite and augite; and the conclusion is reached that in this case progressive crystallisation has resulted in the concentration of iron-oxide in the mother liquor. Most of the fossils have been collected around Cape Flora. The presence of *Ammonites macrocephalus*, *A. modiolaris*, and *Belemnites Panderi* indicate the presence of rocks of Lower Oxfordian or Callovian age; while, apparently above these, a plant-bed was met with in which the genus *Ginkgo* is conspicuous, and this is believed to be of Upper Jurassic age. The oldest fossiliferous bed yet found occurs about twenty miles to the west of Cape Flora, and also contains plant-remains, which, it is thought, may be Lower Jurassic and possibly of the age of the Great Oolite. These plant-beds and numerous indications of layers of lignite seem to show that these Jurassic strata are to a great extent of estuarine or fresh-water origin. The general structure of the country appears to be typified by what occurs at Cape Flora, where cliffs of sedimentary strata some 600 feet high (for the most part hidden

[1] "Electric Movements in Air and Water, with Theoretical Inferences." By Lord Armstrong, C.B., F.R.S. (London: Smith, Elder, and Co., 1897.)

by talus) are overlain by 500 feet of basalt. At some other localities, however, the basalt is found at the sea-level. It is pointed out that the islands, which make up the archipelago of Franz Josef Land, are fragments of a formerly extensive region of plateau-basalts, similar to that of which the Færöe and the Western Isles of Scotland must have formed a part.—Deposits of the Bajocian age in the North Cotteswolds. I. The Cleeve Hill Plateau, by S. S. Buckman.—Pleistocene plants from Casewick, Shacklewell, and Grays, by Clement Reid.—An explanation of the Claxheugh Section (Co. Durham), by D. Woolacott.

PARIS.

Academy of Sciences, July 5.—M. A. Chatin in the chair.—The elections of M. Hatt, as Member of the Section of Geography and Navigation, and of M. de Lapparent, in the Section of Mineralogy, were confirmed by the President of the Republic.—Distribution of the velocities of gradually varied flow in tubes of large section, and the equation of the motion to a higher degree of approximation, by M. J. Boussinesq.—On the explosion of a manometer in a projection apparatus, by M. de Lacaze-Duthiers. The manometer in question had been used without accident on many previous occasions, and no explanation can be offered to account for its bursting, which was attended with serious injury to the lantern manipulator. The question was referred to a committee for investigation.—M. Virchow was elected a Foreign Associate of the Academy in the place of the late M. Tchebichef.—On the establishment of a general formula of interpolation for functions of any number of variables, by M. Dupont.—On the algebraic surfaces which admit of a skew cubic as an asymptotic line, by M. Ch. Bioche.—On the partial polarisation of luminous radiations under the influence of the magnetic field, by MM. N. Egoroff and N. Georgiewsky. The experiments show that the luminous intensity of a Bunsen burner always increases under the influence of a magnetic field. By the aid of a Wollaston prism it was found that a magnetic field partially polarises each of the rays of the sodium spectrum in two perpendicular planes. The fine lines of the metalloids, obtained by M. de Gramont's method, remain unchanged in the magnetic field.—The magnetic deviation of the kathode and X-rays, by M. G. de Metz. In a previous paper certain effects were attributed to the kathode rays, which M. Poincaré suggested might really be due to X-rays, the latter being possibly produced by the reflection of the kathode rays at a platinum surface. Preliminary experiments upon the behaviour of the reflected kathode rays towards a magnet tended to show that X-rays were not produced under these conditions, but further researches seem to indicate that the two classes of rays cannot be distinguished by their behaviour towards a magnet.—On the actino-electric effects of the Röntgen rays, by M. S. Puggenheimer. If two similar electrodes are plunged into a liquid and exposed to the Röntgen rays, a current is set up in the wire joining the plates, the intensity and direction of which depends upon the intensity of the radiation.—On a thermal ammeter containing mercury, by M. Charles Camichel. The bulk of a mercury thermometer is placed concentrically in a glass tube containing mercury; the current is passed through the latter for a definite time, and the rise of temperature read. It is shown that for a constant current the rise of temperature is constant, moderate variations of the air temperature being without effect upon the readings.—New mercury pump without taps or mobile joints, by M. H. Henriet. The pump figured appears to be practically identical with the original form of the Töpler pump, except that the side tube for admitting air without bumping to the vacuous vessel is omitted.—Action of tellurium chloride and fluoride upon the corresponding hydracids, by M. R. Metzner. The compounds $TeCl_4.HCl.5H_2O$, $2TeF_4.3TeO_2.6H_2O$, and $TeF_4.TeO_2.2H_2O$ were prepared and analysed.—Reduction of molybdic acid by hydrogen, by M. M. Guichard. Below 470° C. the reduction of MoO_3 to MoO_2 is continuous, no intermediate oxide being formed.—On the manganimolybdates, by M. E. Péchard. The potassium, sodium, and ammonium salts of a new complex acid containing manganese and molybdenum are described.—On veratrylenediamine, by M. Ch. Moureu. The new amine condenses with phenanthraquinone, acetic acid, and benzaldehyde.—On paraxylylacetic acid, by M. Guerbet.—Action of tannin and of gallic acid upon quinoline bases, by M. Oechsner de Coninck.—On a new carbohydrate, caroubinol, by M. Jean Effront. The new carbohydrate, which possesses the general formula of the celluloses ($C_6H_{10}O_5$) is extracted from the grains of *Ceratonia siliqua*.—On fermentation in media consisting of solid particles, by M. Th. Schlœsing, jun.—The potato, by MM. H. Coudon and L. Bussard.—Researches relating to the homology of the shoulder-bone in Batrachians and Saurians, by M. A. Perrin.—On the morphological signification of the hinge teeth in Lamellibranchs, by M. Félix Bernard.—The regeneration of the micronucleus in some ciliated Infusoria, by M. Félix Le Dantec.—Evolution of the parasite found in the cœlom of the house-cricket, by M. L. Cuénot. This parasite belongs to the genus *Diplocystis* (Kunstler). Two new species are described, named *D. minor* and *D. major*.—On the morphology of the compound larva of a Synascidian (*Diplosomoïdes Lacazii*, Giard), by M. Maurice Caullery.—On the hypodermal nuclei of the Anguillulidæ, by M. Joannes Chatin.—The true cause of the disease of the potato known as *Frisolée*, by M. E. Roze.—On a layer of syenite in the ground mass of Mount Genèvre, by M. W. Kilian.—Remarks by M. Michel Lévy on the preceding paper.—Experiments made with an aeroplane moved by steam, by MM. V. Tatin and Charles Richet.—On certain disturbances of the sea-level observed in the bay of Brusc, by M. Barthe de Sandfort.—Account of an apparatus for measuring the speed of boats or of sea-currents, by M. Merlateau.

NEW SOUTH WALES.

Linnean Society, May 26.—Prof. J. T. Wilson, President, in the chair.—Notes on the *Formicidæ* of Mackay, Queensland, by Gilbert Turner. Nearly one hundred and forty species have been collected, and with the kindly afforded help of Prof. Aug. Forel, of Zürich, identified, except in a few cases still under consideration. A general account of their habits and distribution was given.—Descriptions of two new species of *Cypræa* from West Australia, by Agnes Kenyon.—Notes from the Botanic Gardens, No. i., by J. H. Maiden and E. Betche. (*a*) Notes on rare Port Jackson plants, viz. *Siebera Stephensonii*, Benth., at Botany Bay and La Perouse; *Helichrysum adnatum*, Benth., at Oatley and Hurstville; *Acacia Baueri*, Benth., at the Centennial Park, and an almost glabrous form of *Eriachne obtusa*, R. Br., near Rose Bay. The authors also presented a note on the rare *Dodonæa filifolia*, Hook., showing that the doubt cast by Bentham in the "Flora Australiensis" on the correctness of the Sydney locality is now removed. (*b*) Plants new for New South Wales. These are *Acacia alpina*, F. v. M., from near Kiandra; *Pterigeron dentatifolius*, F. v. M., from Olive Downs, Grey Range; *Geodorum pictum*, Lindl., from Byron Bay.—Descriptions of three new Australian plants, by J. H. Maiden and E. Betche. (1) *Dodonæa Camfieldi*, a remarkable species belonging to Bentham's section "Cyclopteræ," but not closely allied to any described form. The leaves have broad sessile bases which appear to be unique in the genus, and the leaves have large groups of resin-secreting glands which give them a dotted appearance. (2) *Helipterum microglossum* (Syn. *H. corymbiflorum*, var. *microglossum*), differing in some important particulars from its so-called variety, between which there appear to be no intermediate forms. (3) *Leucopogon Fletcheri*, a species allied to *L. juniperinus*, from which it is chiefly distinguished by the pendulous flowers, the proportionately longer corolla lobes, and the exserted style.—Descriptions of two new Acacias from New South Wales, by R. T. Baker. Of the two species described, one is allied to *A. elongata*, Sieb., and the narrow-leaved variety of *A. subporosa*, F. v. M.; the other to *A. penninervis*, Sieb., and *A. retinoides*, Schl. Both are from the Rylestone District, the second of them, however, extending also to Cobar and Tocumwal.—On a larval Teleost from New South Wales, by J. Douglas Ogilby. The form described is conjectured to be the larva of one of the ophisuroid eels. Reference was made to Grassi's important researches on the Mediterranean Leptocephali or Glass-Eels; and to the insuperable difficulty which, in the absence of any biological station, effectually precludes the possibility of carrying out similar investigations on Australian forms.

AMSTERDAM.

Royal Academy of Sciences, April 21.—Prof. van der Waals presented, on behalf of Prof. Kamerlingh Onnes, two papers by Mr. E. van Everdingen, jun. (*a*) On the increase of the resistance of bismuth in connection with the dissymmetry of Hall's effect. Experiments with small bismuth bars cut, in different directions, out of the same piece of bismuth, show that the ratio of the amounts of resistance in those directions is modified in the magnetic field. This modification appears to

suffice to account for the sign and amount of the dissymmetry of Hall's effect. (*b*) On the relation between crystal direction and resistance, increase of magnetic resistance and Hall's effect. Hall's coefficient is not the same for a number of small plates, cut, in different directions, out of the same bismuth crystal. (The ratio of the maximum to the minimum value was once found to be nearly 8.) The amount of the increases of magnetic resistance in the plane ⊥ magnetisation is determined by the same angle. (The ratio of maximum to minimum sometimes amounts to more than 2.)

May 29.—Prof. Korteweg, on certain oscillations of higher order and abnormal intensity that can occur in mechanisms of several degrees of freedom. It was shown that, under certain conditions some of the coefficients, and with them, also, the respective oscillations are of abnormal magnitude. The author developed the theory of these abnormal oscillations of higher order. He discussed the part they may perhaps play in the oscillations of a mechanism, in the theory of light, and also in the spectra of gases, if Prof. V. A. Julius's view, that the internal motion of molecules may be conceived as oscillations of moderate intensity about a state of equilibrium, be right.—Mr. Eykman, treating of measures for checking beri-beri, communicated the results of researches made by the Medical Inspector Vorderman, concerning the relation between the nature of the rice-diet and the occurrence of beri-beri in the prisons in Java. From these researches it appears that the disease occurs principally in those prisons where the rice is eaten completely peeled, and, on the contrary, hardly ever in those where the prisoners eat half-peeled rice (*i.e.* rice still covered with the "silvery" pellicle"). This inquiry was suggested by similar results obtained by the author when studying a disease of domestic fowls, resembling beri-beri.—Prof. van der Waals presented, on behalf of Mr. P. Zeeman, further observations by the author concerning the change of spectrum lines by magnetism. Along the lines of force a blue cadmium line was doubled, across the lines of force it was trebled by the action of magnetism, the polarisation of the middle and that of the edges of a broadened line in the latter case being perpendicular to each other. This is in perfect harmony with Lorentz's theory of the effect.—Prof. van der Waals next read a paper by Mr. Zeeman, on a new experiment concerning anomalous wave propagation. Gouy's theory of the subject (*Ann. de Chim. et de Phys.*, vi. 24) was confirmed by means of a combination of a lens and a plate of Iceland spar cut so as to have the optical axis in their planes. Transmitted light was used. The experiment has some advantages over one devised by Joubin for demonstrating Gouy's theory, the principal one being the possibility of having any value for the initial phase difference of the two interfering pencils in the central part of the field.—Prof. van der Waals also presented, on behalf of Prof. Kamerlingh Onnes, (*a*) a paper, by Mr. A. van Eldik, on measurements of the capillary ascent of the liquid phase of a mixture of two substances in equilibrium with the gaseous phase; (*b*) a paper, by Mr. L. H. Siertsema, on the influence of pressure upon the natural rotation of the plane of polarisation in solutions of cane sugar. The measurements mentioned on a previous occasion have been continued with a concentration of 27·84 gr. in 100 cc., and have yielded a variation of 0·270 per cent. for 100 atm. If Tammann's hypothesis concerning the equivalence of internal and external pressure is adopted, these results may be compared with those respecting the variation of the specific rotation capacity by a variation of concentration, or by the addition of an inactive salt. The comparison shows that the phenomenon is probably more complicated than Tammann's hypothesis renders it.—Prof. Lorentz presented, for publication in the *Proceedings*, a paper entitled "On the resistance which a liquid current meets with in a cylindrical tube."—Prof. Bakhuis Roozeboom presented, on behalf of Dr. E. Cohen, a paper on the inversion constant of sugar in an aqueous solution. This constant varies with the concentration of the sugar solution. This difference can be removed if, in calculating the concentration of the inverting acid, the total volume is not used, but if the volume of the sugar in the solution is deducted from it. In this way there arises perfect agreement with the theoretical process of the reaction, as Dr. Cohen demonstrated with experiments made by Ostwald, and observations made by himself, with acids of $\frac{1}{8}$ – $\frac{1}{128}$ norm.—Prof. J. C. Kapteyn contributed a communication on the distribution of stellar velocities, being a sequel to a former paper on the same subject (May 1895). The author shows how the *magnitude* of the proper motions may be made to contribute to the derivation of the law of velocities, as well as their *direction*. The author further shows that the most serious anomalies which remain in the distribution of the directions of the proper motions, even as computed with the best data available for the precession and the position of the apex, will disappear for by far the greater part, by assuming a constant error, or an error proportional to the cosine of the declination, in Auwers' proper motions in declinations.

BOOKS, PAMPHLET, and SERIALS RECEIVED

BOOKS.—Die Mechanik des Weltalbs: Dr. L. Zehnder (Freiburg i.B., Mohr).—Electricity and Magnetism for Beginners: F. W. Sanderson (Macmillan).—Hallucinations and Illusions: E. Parish (Scott).—Wild Flower Lyrics: J. Rigg (A. Gardner).—Electric Smelting and Refining: Dr. W. Borchers, translated, with additions, by W. G. McMillan (Griffin).—Lehrbuch der Erdkunde: Dr. W. Ule, 1 Teil (Leipzig, Freytag).—The Ancient Stone Implements, Weapons and Ornaments of Great Britain: Sir J. Evans, 2nd edition (Longmans).—Reform of Chemical and Physical Calculations: C. J. T. Hanssen (Spon).

PAMPHLET.—On the Synthesis and Molecular Constitution of Dead and Living Proteid: Dr. P. W. Latham (Cambridge, Deighton).

SERIALS.—Traité de Zoologie, Fasc. xi. and xvi. (Paris, Rueff).—Jahrbuch der K. K. Geologischen Reichsanstalt, 1896, 3 u. 4 Heft, and 1897, 1 Heft (Wien).—Mind, July (Williams).—American Journal of Science, July (Newhaven).—Journal of Anatomy and Physiology, July (Griffin).—Geological Magazine, July (Dulau).—Lean's Royal Navy List, July (Witherby).—Plantæ Europæ, Tomus ii. fasc. i. (Leipzig, Engelmann).—Brain, Parts 77 and 78 (Macmillan).

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