THURSDAY, AUGUST 1, 1901.

SPECULATIVE BIOLOGY.

Les Problèmes de la Vie. Essai d'une interprétation scientifique de phénomènes vitaux. I^e^ Partie. *La Substance Vivante et la cytodiérèse.* By Dr. Ermanno Giglio-Tos, of the University of Turin. Pp. viii+286. Thirty-three figures. (Turin: Chez l'auteur, Palais Carignano, 1900.) Price, 10 francs.

AT a time when many, if not most, biologists are confessing that they find no helpful analogy between the operations of not-living matter and the adaptive and coordinating activities of the living organism, it is interesting to find one who maintains that vital phenomena are much simpler than they seem. It is maintained in the book before us that we have invested with a veil of mystery what are really "the natural consequences of chemical, physical and mechanical phenomena." This has been a frequently recurrent idea in the history of biology; but the author has worked it out in a theoretical system in which biomolecules and biomores, bioplasm and biomonads play a part supposed to be comparable to that of atoms and molecules and radicals in chemistry.

The fundamental facts of life with which Dr. Giglio-Tos begins his materialistic reconstruction of biology are assimilation and reproduction. In assimilation, the organism adds to its own organisation at the expense of material different from itself; in reproduction, it gives rise to other units which are actually or potentially like itself. These processes of growth and multiplication may seem simple in words, but whenever we pass to the things themselves they impress us as marvellous, even in simple creatures like amœba or diatom, monad or microbe, coccidian or myxomycete. And the impression of marvellous complexity, in spite of apparent simplicity, is heightened whenever the organisms show, as they so often do, some evidence of "behaviour" (whether it be chemotactic attraction and repulsion or adaptive and coordinated movements in search of food). But by dwelling on this "behaviour," which seemed to us of the very essence of life, we have become blind—so this book suggests—to the real simplicity of the assimilative and reproductive processes, which are "truly and exclusively chemical." To prove this last statement directly is not at present possible, for we do not know the chemical composition of living matter; but what the author proposes is the legitimate and practicable test—Are the interpretative formulæ of the chemist sufficient for a simpler re-description of vital phenomena? His answer is an emphatic affirmative. To be convinced, we are invited to make a simple experiment, in regard to which a chemist's opinion would be of much interest. We are told to "feed" two molecules of acetic acid with perchloride of phosphorus; and the resulting chloride of acetyl with zinc-ethyl; we are asked to subject the resulting methyl-ethyl-ketone to oxidation; and the result is that from two molecules of acetic acid we get four.

"May we not say that the two molecules of acetic acid have assimilated and reproduced? . . . Reproduction is the fission of a living molecule ('biomolecule'), which, after a series of assimilatory reactions, divides into other molecules of the original constitution."

We do not ourselves find any cogent evidence to show that a living molecule or biomolecule exists, or that it is needed as a theoretical postulate in biological interpretation; it seems to us highly probable that living matter is a complex mixture (organisation or synthesis) of organic substances whose virtue is in their interrelations; we do not see in the acetic acid story more than an analogy of very doubtful suggestiveness. But we must let the author tell his own tale. He devotes his second chapter to mapping out the possible developmental cycles of the imaginary biomolecule. Through phases of assimilation, followed by rearrangement of atoms, the biomolecule matures and multiplies, and there are three possible schemes: of (I.) autogenetic, (II.) homogenetic and (III.) heterogenetic development:—

(I.) a becomes b, then c . . . . d . . . . m, which divides into $a+a$.

(II.) a' . . . . b' . . . . c' . . . . d' . . . . $m'=e'+e'$ (and e' may thereafter give rise to $a'+a'$).

(III.) a'' . . . . b'' . . . c'' . . . . d'' . . . . $m''=e''+i''$ (of which e'', called genetic, may regenerate a'', while i'', called somatic, cannot).

The third chapter, dealing with the physiology of the biomolecule, discusses at some length the proposition that "respiration is not a process of combustion but of oxidation," and that the formation of CO_2 is an indirect result, comparable to what occurs when acetic acid acts on isocyanate of ethyl. The author is under a misapprehension when he says that "respiration is generally regarded to-day as a simple combustion . . . . an interpretation accepted by almost all biologists." Although we cannot explain *how* the oxygen, as Pflüger said, helps to wind up the vital clock, although we cannot as yet trace the oxygen through its sojourn in the tissues, we have left the false simplicity of the crude combustion theory far behind. In the pages of the book devoted to this subject, and in those dealing with the formation of starch in vegetable cells, the author argues against positions long since abandoned, and makes no new contribution to the problems.

The fourth chapter introduces us to "the biomore," an old acquaintance with a fresh alias, the visible living particle. It is, of course, formed of biomolecules, probably different from one another and juxtaposed like the inorganic molecules in double salts. The life of the biomore is not dependent on its constitution; it lives because it is formed of molecules themselves alive. Nevertheless, the accomplishment of vital functions is facilitated by the juxtaposition of the biomolecules, and by the increase in their instability which thus results. The arrangement of the biomolecules in the biomore depending on their chemical constitution, there is in the biomore, during assimilation, a continual displacement of biomolecules by reason of their chemical changes. Physiologically considered, "the biomore is a veritable mutual symbiosis of biomolecules." Had the author developed the fruitful idea of "symbiosis," he might have been led to the conception of "protoplasm" (=bioplasm) as an organisation of substances not in themselves living, but in virtue of their interrelations giving rise to the phenomena of life.

The next chapter deals with bioplasm and the biomonad—to wit, protoplasm and the cell—another instance of the craze for rechristening. Perhaps a micrococcus or some similar microbe is composed of but one biomore, but such simplicity is rare. Most unicellular organisms consist of diverse biomores living symbiotically in an interbiomoric fluid (water, nutritive substances in solution and products of secretion). The author explains that *bioplasm* includes nucleoplasm as well as cytoplasm, and that it excludes the metaplasm; it is Huxley's protoplasm, in fact. The *biomonad* is a living unity, a symbiotic system of biomores, characterised by the chemical nature of the biomores which form the nucleus; it is a cell, in fact. But while the author emphasises the fact of symbiosis, he does not, as we have said, really appreciate the idea that vitality is an expression of the interrelations of diverse complex substances associated in a particular organisation or synthesis.

"The faculty of living resides in the biomolecules themselves. The biomores are living because they are composed of biomolecules. The bioplasm is living because it is composed of biomores. The cell is living because it consists of bioplasm. . . . The phenomena of life and their possibility are based on the properties of carbon compounds. . . . The essential characteristic of life, reproduction, is fundamentally a phenomenon of molecular fission into two or more equal molecules."

Thus assertion follows assertion, all, to our thinking, "in the air."

The author's interpretation of cell-division, which is the subject of the three final chapters of this volume, may be inferred from what has been already noticed in regard to the process by which four molecules of acetic acid may be produced from two. Assimilation is the indispensable, though not always sufficient, cause of the division; it leads to an orientation of atoms which makes a division of the biomolecule imperative; the division of the biomolecules provokes the division of the biomore, and the division of the biomores provokes the division of the biomonad. How this speculation in any way interprets the actual processes of cell-division we entirely fail to see; but we are not surprised to find the author insisting that the phenomenon of division is independent of the nature of the division-figures. The figures cannot be chemically interpreted, so they do not count for much. They are dependent on the initial disposition of the biomores in the biomonad.

Assimilation leads to doubling of biomolecules, and this to doubling of biomores; the doubling expresses itself as cell-division, because of the particular orientation of the component biomores, which in turn is due to their reciprocal attractions. If this be granted, it is possible to deduce a number of "rational laws of cell-division," which may be verified by observation. The author deduces no fewer than twenty-eight laws, but many of them read more like assertions, while others are certainly not deductions, but statements of observed fact. We must content ourselves with referring to the first three. The first law is that the living parts of the cell have all the same importance in cell-division; the biomores enjoy perfect equality; this is "a natural consequence of the previous interpretation," and, like it, is all in the air.

The second law is "that the divisions of the diverse parts of the cell are independent of one another," and the third "that the direction of the division of the nucleus is determined by the direction of the division of the cytoplasm." This may seem to the matter-of-fact a contradiction, but the author maintains "that between the cellular body and the nucleus there is at once a complete independence and a close dependence." This is too subtle for our understanding.

Recognising that the phenomena of cell-division, which he has interpreted as "purely and exclusively mechanical," were somewhat "ideal" ("sont naturellement quelque peu idéaux"), the author proceeds to discuss the modifications which the ideal scheme suffers in real life. Perhaps this may prove to be the most useful part of the book, for the author proposes a series of thirteen problems dealing with the influence of the position of the central corpuscles, of gravity, of mechanical obstacles, of pressure, of the cell-membrane, of adjacent cells, and so on (pp. 184-285). We do not propose to discuss these problems, for an appreciation of the author's mode of treatment is quite impossible to those who find themselves compelled to reject his premises. But let us state his general conclusions.

The property of dividing, which characterises living matter, is not due to a special force. It is a consequence of the constitution of living matter and of assimilation, which doubles the number of the parts of the system and may thus lead to the formation of two systems. The force which unites the parts of living substance in a system is the same as that which unites the parts of dead matter. This force is sufficient to explain the phenomena of division. The figures which characterise cell-division are the structural results of the constitution of living matter, and have no importance in the phenomenon, which is purely and exclusively mechanical. As to the direction of the division, it is partly determined by the position of the central corpuscles, but almost wholly by environmental influences in the widest sense.

Let us sum up our impression of this ambitious book. The author abstracts from his consideration of the living organism its most characteristic features of adaptive and coordinated behaviour, and thus gives a false simplicity to the whole problem. He invents a theoretical system of biomolecules, biomores, bioplasm and biomonads, which depends on the postulate that there are biomolecules—a gratuitous assumption, since it is quite as likely that matter exhibiting vital phenomena owes its virtue to the interrelations of a peculiar organisation or synthesis of not-living molecules. From the doubling of a chemical molecule (of acetic acid) he passes, with an entirely inadequate discussion of the magnitude of the step, to the structural division of a cell. In spite of his hypothetical diagrams, his mathematical formulæ and his twenty-eight so-called laws of cell-division, he leaves the problem all unsolved. The use of a hypothetical system is to furnish convenient modes of re-statement in simpler terms, but we cannot find that the system of Dr. Giglio-Tos makes the division of the amœba under our microscope any more interpretable than it was before. The author is continually combating the assumption of "special forces"—and here we are at one with him—but the neo-vitalists do not believe in vital force. They content themselves with disbelieving that the behaviour

of a living organism is as yet interpretable in terms of the formulæ used by the chemist and the physicist. And we find nothing in this volume to shake this disbelief.

J. A. T.

A PHILOSOPHER ON EVOLUTION.

The Limits of Evolution. By Prof. Howison. Pp. xxvii + 380. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1901.) Price 7*s.* 6*d.* net.

THE main argument of the book is clearly summarised in the preface. Nothing has any real existence except mind. There are a number of coexistent minds. All else is but the items of their experience, which they arrange in order for themselves. God is the "fulfilled type of every mind," an ideal to which it is trying to assimilate itself. These minds are citizens of an eternal republic. They have had no origin in time. They have not been created in the sense in which the word is ordinarily understood. They are free: "nothing but their own light and conviction determines their action towards each other and towards God." This freedom is made possible by the substitution of a final for an efficient cause. "Real creation means such an eternal dependence of other souls upon God that the non-existence of God would involve the non-existence of all souls." Evolution is the "movement of things changeable towards the goal of a common ideal," and spirits can "neither be the product of evolution nor in any way subject to evolution," which can only reign in "the incomplete and tentative world of experience."

The first and last essays elaborate the theory, insisting always on the freedom of the will. It is in order to prove that the will is free that our author has established his republic of independent minds. If the mind of an individual man is merely part of the force that permeates the whole universe, it can have no freedom. Pantheism, therefore, must be rejected. Creation, too, in the old sense must be given up; if created, the mind can have no independence. Hence the assumption that it has had no beginning and will have no end. Thus war is declared against the monistic philosophy, according to which body and mind are but different aspects of what is divisible only in thought, and the mind, therefore, as perishable as the body.

Prof. Howison fears that philosophy is tending towards determinism, and this tendency he considers fraught with the gravest danger. No doubt if a man puts his determinism into practice, and, when called upon to act, feels that he is a mere automaton set in motion by influences from without, he is not one who can fill any post where energy and determination are required. We must imagine that our wills are free or we are helpless. Whether we are really free is unimportant. The belief is strong in almost every man, at any rate in almost every European. Most men are content to leave the matter undiscussed, holding that they have a real freedom, however inexplicable and even unthinkable it may be. But Prof. Howison tries to find a philosophic explanation for the belief, and, interesting as his book is, we cannot think that he has been successful.

Let us first consider his "republic of minds." They exist in a world the existence of which is "incomplete and tentative." Nothing but mind is really existent. We start, then, each of us with our own mind. And how do we become cognisant of the existence of other minds? This can only be through our bodily senses. Yet our bodies are not things really existent. Moreover, we cannot touch, see or hear other men's minds; we only infer their existence from their looking out upon us through their bodily eyes or speaking to us with their bodily vocal organs. Thus the existence of a real world of minds is accepted on the evidence that is obtained for us by mere phenomena. Next as to the free will that Prof. Howison has to offer us. If he reduced the whole universe to unreality except each man's own *ego*, then the mind would move *in vacuo*, not tyrannised over by any external influences. As he himself puts it, the condition of freedom for man is that "the world shall be a world of *phenomena*—states of his own conscious being, organised by his spontaneous conscious life—and not a world of 'things-in-themselves.'" But he does not make other minds mere phenomena.

Any individual mind must, therefore, be influenced from without by the other citizens of the republic of minds. No doubt even under these conditions there may be autonomy: the mind may decide *in accordance with its own character* which influence from without it will allow to prevail with it. The existence of other minds need not destroy autonomy in this sense. But free will, such as this, is quite consistent with the monism which Prof. Howison condemns. It is not the freedom in which the ordinary healthy man has at least a practical belief. He has the feeling that he can transcend his own nature, conquer his weaknesses and bad tendencies and develop other and better tendencies. It may be impossible to explain how he can have such a power. Certainly this book leaves us dependent on our instinctive feeling of freedom.

Next as to our author's view of evolution. Evolution, he insists, cannot explain the origin of life or the origin of mind. But no clear-headed evolutionist holds that evolution can originate. We must assume an underlying force which, through evolution, is variously manipulated and concentrated. As to the ultimate origin of the underlying force, evolution has nothing to say. This much we may concede. But Prof. Howison assumes that, not only mind, but *the individual mind* has existed from eternity, and in this he is unreasonable. The development of certain bodily organs proceeds *pari passu* with the development of mental power. We can trace the gradual evolution of nerve till it culminates in the human brain. We are bound to assume, then, that a particular mind is the product of evolution; like the body, it has been elaborated out of something that preceded evolution. This question is not fairly faced by Prof. Howison. In a footnote (p. 10) he allows that we can trace the upward steps of intellectual development, and there he leaves the matter, assuming as the basis of his dualistic philosophy that the mind of each individual has existed from eternity and has, apparently, been inserted extranaturally in the body.

Some of the contradictions involved in his system our author sees and attempts to remove. If each individual

mind has an independent existence from eternity, monotheism seems to disappear. On the other hand, if monotheism is insisted on, what becomes of the free-willing, independent minds, the citizens of the republic of minds? We are expected somehow to accept what look like contradictory propositions simultaneously. Again, all minds are different from one another and yet all are straining towards the same ideal. Here is a sentence that aims at explaining this:—

"In fine, its self-definition (*i.e.* the self-definition of each spirit) is at the same stroke in terms of its own peculiarity, its own inerasable and unrepeatable *particularity*, and of the supplemental individualities of a whole world of others—like it in this possession of indestructible difference, but also like it in self-supplementation by all the rest: and thus it intrinsically has *universality*" (p. 353).

We have left little space for the discussion of the essays that deal less directly with the main argument. One of them gives an interesting account of later German philosophy, another deals with the "art-principle in poetry." The essay on the "Right relation of reason to religion" is certainly the best. Everywhere in the book, but most of all in the last-mentioned essay, we feel that the author is a man who hates any notion that is in itself or in its implications degrading to human nature. In religion he boldly rejects authority and bases it on reason, defined as the mind's own insight, as its true source.

There is much in the book that it is good to read. The author hates pessimism; most of all he hates determinism as a belief that unnerves the character and robs human life of what is best in it. But he has found no philosophic basis for his views. In fact, we have in this book an instance of what is not uncommon: a man's opinion is often of far greater value than all the reasons he is able to give for it.

COAL MINING.

A Text-Book of Coal-Mining. By Herbert W. Hughes. 4th edition. Pp. 513: 670 figures. (London: Griffin and Co., Ltd., 1901.) Price 24*s.* net.

MR. HUGHES and his publishers may fairly be congratulated on the success of a text-book which requires a new edition about once in every three years, and this, too, in spite of its high price, which is beyond the means of the average student. The new edition contains ninety more pages and 184 more illustrations than the first.

It can hardly be expected that a large treatise of this description should be free from some minor errors; but when these are decidedly numerous, one cannot help feeling that there is want of care on the part of the author. Mr. Hughes seems to think (p. 3) that reversed faults are rare; surely he can never have carefully looked at the sections of some of the Continental coal-fields. On p. 4, while speaking of the Carboniferous system in Scotland, he appears to be ignorant of the coal in the Calciferous Sandstone below the Carboniferous Limestone.

The chapter on boring is weak; it may be said with a good show of truth that the colliery engineer nowadays frequently entrusts the work of boring to a contractor; but this is an argument for omitting the chapter altogether, rather than for treating the subject in a slovenly fashion. There is no figure of a derrick of any kind. On p. 22 it is stated that the American boring tool is rotated by hand; this was done formerly, nowadays turning by hand has been given up. The rotatory and percussive systems of boring are mixed up in a manner puzzling to the student, for the description of the diamond drill says: "This method differs from the others in the fact that the tool receives a rotary instead of a percussive motion"; and yet just above, on the very same page, Mr. Hughes has been describing Davis's calyx drill, which works by rotation.

Timbering is not treated so fully as one would like, and we scarcely think that Haselmann would be content to hear his process of preserving timber spoken of as similar to the Aitken process.

An author should be consistent. In speaking of the transmission of power (p. 46), it is said that the choice is limited to compressed air and electricity, and yet a little further on we have a description of Brandt's drill, which is driven by water.

Mr. Hughes is wrong in supposing that the "straw" cannot be employed for igniting charges of explosives other than gunpowder. He is a little behind the times with regard to water injection while boring, as he makes no mention of Bornet's system, which is an unquestionable improvement upon the method tried at Blanzy in 1889, and not 1899.

Granted that some knowledge of electricity on the part of the mining engineer is nowadays desirable, if not imperative, is it not better that he should obtain the rudiments of that knowledge first-hand from an electrician rather than second-hand from a miner? Why should the writer of a mining text-book think it his business to explain the electrical units? Mr. Hughes evidently expects the student to learn elsewhere what is meant by such terms as "limestone," "sandstone," "horse-power," "symbol," "molecular weight"; why then does he go out of his way in the case of electricity, upon which subject there is ample published information? As a consequence, we find the mistake of defining the ampere as "the quantity per minute."

In the same way, it would be better to leave the question of generation of power to an expert. Steam-boilers are mentioned in a somewhat cursory fashion, and all other modes of generating power ignored. One of the statutory fittings to the boiler, viz. the safety valve, is described, but the other two, the water gauge and the steam pressure gauge, are not noticed.

On page 432, Mr. Hughes revives the old question whether the introduction of safety lamps will not produce an increase in the number of deaths from falls of roof and side. Statistics have shown that this fear is ungrounded, and it is a pity to throw doubts upon the subject.

While calling attention to the existence of very numerous minor defects, one cannot be blind to the useful work which Mr. Hughes has done in compiling what is unquestionably the best text-book on coal-mining in the English language, and for keeping it up to date. For this he well deserves the thanks of students and mining engineers. Plate II., reproduced from Mr. Hughes' own photographs, is excellent.

OUR BOOK SHELF.

The Human Nature Club. By E. L. Thorndike. Pp. viii+235. (London: Longmans, 1901.)

Psychology of Reasoning. By Alfred Binet. Pp. 188. No. 47 of the "Religion of Science Library." (London: Kegan Paul, 1901.)

MR. THORNDIKE, already favourably known by his ingenious experimental studies of animal intelligence, has achieved a very fair measure of success in the bold attempt to compose an easy introduction to psychology in dialogue form. His little work is bright and interesting, and should be found an excellent introduction to the genetic study of mental processes. In particular, it is well adapted to be taken up as a first course preliminary to the study of Prof. James' great "Principles of Psychology." In some respects Mr. Thorndike, perhaps, defers too much to the authority of his eminent countryman. When his book reaches a second edition he might do well to add to the chapter in which Prof. James' well-known theory of the emotions is expounded some indication of the grave difficulties which beset the theory, and the flaws of the reasoning by which it is supported. Perhaps, too, he will see reason to modify the passage in which he repeats certain weak metaphysical arguments of the professor in favour of the immortality of the soul. Mr. Thorndike's one really weak point is his style. Dialogue, to be successful, should never be a direct imitation of actual speech, still less of a type of speech like that of Mr. Thorndike's characters, which is at once undignified, ungraceful, and occasionally gravely inaccurate, as, *e.g.*, when the brain is spoken of as "just a 'lot' of nerve-cells," an expression as unfortunate as it is inelegant.

The translation of M. Binet's interesting little work, which appears identical with one issued by the same publishers in 1899, is still valuable as a repertory of interesting experimental facts as to the pathology of the perceptive and reasoning processes. It should, however, be clearly understood that the general psychological basis adopted by the author consists of doctrines which are now largely antiquated. The doctrine that "ideas" are "revived sensations," and that perception and reasoning are founded upon "association," may now be regarded as practically dead, while the part played in mental life by "fusion" needs to be stated with more accuracy than is shown by M. Binet. And the whole attempt to state the relation between the subject and predicate of a judgment, or the premisses and conclusion of an inference in terms of association, seems to rest upon the common but disastrous confusion of psychology—the study of mental processes—with logic, the study of the laws of evidence. A. E. T.

Outlines of Physiography. An Introduction to the Study of the Earth. By A. J. Herbertson, Ph.D. Pp. viii+312. (London: Edwin Arnold, 1901.) Price 4*s.* 6*d.*

WERE it not for the statement at the head of Chapter xxvi., we should not have imagined that this book was intended for the use of students preparing for the South Kensington examination, the ground covered being what is generally regarded as elementary physical geography. The experimental portions of the syllabus, dealing with the physical and chemical properties of matter, are entirely omitted, while other subjects are introduced. Nevertheless, the table of contents indicates a carefully considered classification of the various points to be dealt with, which might have formed the basis of a very profitable course of reading. The subsequent treatment, however, is generally so sketchy that the result will probably be the communication of a number of facts to the reader rather than the enlargement of his powers of observation. A certain amount of carelessness is noticeable in the part which discusses the relation of the earth to the other heavenly bodies. Thus, in Fig. 12, the sun's meridian altitude on March 21 is marked 45°, although there is no reference to the latitude of the place of observation; on p. 31 it is stated that eclipses only occur when the planes of the orbits of the earth and moon coincide; and on p. 34 the obliquity of the ecliptic is not included in the causes affecting the equation of time. The author is much happier in his descriptions of the physical features of the earth and of the causes which mould them, and some of the chapters in this part provide an interesting introduction to various branches of earth-knowledge.

The illustrations are both numerous and good, but the frequent absence of direct references in the text considerably reduces the value of many of them.

Bird Watching. By Edmund Selous. Pp. 337. The Haddon Hall Library. (London: J. M. Dent and Co., 1901.) Price 7*s.* 6*d.*

MR. SELOUS may fairly be called a pioneer. The habits of some few wild animals, such as bees and ants, which can be observed without much difficulty, have been carefully studied; but, except in rare and isolated instances, wild birds have never been made the object of prolonged and patient watching. Since the days of White, Naumann and Montagu, the energies of ornithologists have been devoted rather to problems of classification and distribution than to the "life and conversation" of the birds, and though books by field-naturalists (real and so-called) have been legion, few of them have thrown much light upon problems of animal life and intelligence. Curiosities of bird-life are constantly reported, but the every-day habits of common birds have not been patiently and persistently studied. This work has now been begun by Mr. Selous with admirable accuracy and self-restraint, and his book should have a most wholesome effect on our rising generation of ornithologists, who need to realise that there is a vast field of work still left for them in this country, and that it is not necessary for them to travel long distances in order to make themselves useful or famous.

It is, of course, no easy matter to watch carefully such nervous and restless creatures as birds; a real observer must have both leisure and patience, and must be duly qualified, or train himself to become so, in many other ways. Readers of the *Zoologist* are well aware that Mr. Selous has the necessary qualifications in a high degree, and can have no doubt as to his absolute trustworthiness; and this is everything in a book which is sure to be used by biologists as material for speculation. He has made his notes, for the most part, on the spot, as he watched; where he writes from recollection he is careful to tell us so, and even there we feel that the image left on his mind is clear and strong, just because he sees everything while watching with such an intensity of interest. The notes taken on the spot are often printed *in extenso*, as they were also in the *Zoologist*, and constitute the most valuable part of the book, and it may be hoped that *all* the notes of this kind that he has made may be carefully preserved, whether published or not. But Mr. Selous not unfrequently makes suggestions by way of explaining the phenomena he has observed, and these are always useful and interesting; they are put out tentatively, and the book affords abundant evidence that he does not allow himself to jump at conclusions.

Without anticipating the pleasure or profit which ornithologists and others are sure to gain from the book, it may be said here that Mr. Selous has watched birds courting, dancing, nest-building, feeding, flocking, climbing, singing; and that the range of his studies extends from large birds such as the great skua, the great plover and the cormorants, to the sparrows, chaffinches and blackbirds of our gardens and rickyards. There is a good index, which greatly increases the working value of the volume.

LETTER 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.*]

History as a Science.

THERE have lately appeared in NATURE suggestive summaries of addresses by Sir H. Roscoe, Dr. D. J. Hill and Prof. Ramsay on, respectively, "The Work of the London University," "The Extension of Knowledge" and "The Functions of a University," together with various other papers of an educational character. And to these I would beg permission to add some remarks on the importance of the recognition and endowment, in this country also, of history as a science. Three things are required to make of a body of knowledge a science: (1) verifiability of statements; (2) sufficient length and breadth of survey to make possible the discovery of laws, or verifiable generalisations; and (3) the actual discovery, or an approximation to the discovery, of one or more laws of the facts constituting the body of knowledge considered. But history, as it is commonly studied and taught in British Universities, embraces such brief periods that it can, at best, be characterised only by the most elementary of these three requirements. In geology we have had a science of earth's history since the discovery of the law of the succession of strata. In anthropology we have not, as yet, a science of man's history, seeing that the law of the succession of civilisations has not yet been discovered, or has not, at least, yet been adequately verified. The first object, however, of this letter is briefly to point out that, though the science of man's history would be the most complex of the sciences of evolution, yet the immensely varied results of the researches of the last half, and particularly of the last quarter, of the nineteenth century do bring within the scope of reasonable aims the discovery and verification of general laws of history, with all the incalculable consequences which would therefrom follow in the power given to interpret the past, to guide the present and to forecast the future. And the further object of this letter is to urge that, endowed as the study of history as a science is in all the greater Universities, both of Europe and of America, it should at length be adequately endowed also in British Universities, and more especially in those of Scotland, now so munificently endowed, and whose sons, since Adam Smith, in his "Wealth of Nations," David Hume, in his "Natural History of Religion," and John Millar, in his "Origin of Ranks," have been among the foremost workers and discoverers in this *Scientia Scientiarum*.

But theories of history have also their history. And we may better appreciate the argument for the endowment, at length, of chairs of general history—of history studied with such generality as to make possible the discovery of laws, or, in a word, of history as a science—if we cast a glance on the history of general studies of history during the last century and a half. We shall find it clearly divisible into three periods, on the third of which we are now entering. In all these periods, indeed, two great directions, or rather two great methods of historical research, may be noted—the one synthetic and speculative, the other analytic and inductive. But of the former character was more distinctively the method of the first period, of the latter character the method of the second period, and again, but with incomparably more justification, considering the enormous wealth of facts accumulated in the second period, the third period promises to be, while distinctively synthetic, verifiable in its syntheses.

The first period may be dated from Turgot's second discourse at the Sorbonne, "Sur les Progrès successifs de l'Esprit Humain" (1750), and especially from Hume's "Dialogues on Natural Religion," written about the same time, and his later-written "Natural History of Religion" (1757). This synthetic and speculative era culminated in the philosophies of Hegel and of Comte—for Comte's philosophy is entitled to be called "positive" rather because of its speculative dogmatism than of its inductive verifiability. And around these giants of the forest there grew up such a luxuriance of minor "philosophies of history" as produced a reaction against all general views of history—a reaction from which we, in Great Britain, have unfortunately been the latest to recover.

But among Hume's contemporaries and friends were two masters of the other mode of historical research—the analytic and inductive—Adam Smith and John Millar. From their time to ours the drudging brother has conducted his researches side by side with the high-flying brother, each too apt to sneer at the other, though the function of each was indispensable for the success of the great quest consciously or unconsciously common to both. To the aid of inductive rather than of speculative historical research came, after 1859, the "Origin of Species" year—the immense development of the general theory of evolution which added to the theory of kosmological evolution suggested by Kant and Laplace the theory of biological evolution elaborated by Darwin and Wallace. Simultaneously with the development of this more complex theory of evolution, the researches into man's psychical as well as physical history have had the most fruitful results. And these are now being more and more clearly seen to be contributions to a theory of anthropological evolution which will transform unverifiable, or but partially verifiable, "philosophies of history" into a science of history, conceived at length as the most complex of the verifiable evolutional sciences.

The chief, perhaps, of the contributions to such a science of history may be thus briefly summarised. (1) The ethnological discoveries, which have resulted in a theory of the origins of civilisation in a conflict of higher and lower races. (2) The folklorist discoveries, generalised in a theory of primitive conceptions of nature as conceptions of its solidarity through the interaction and limitless transformation of its parts. (3) The logical and psychological discoveries, which have verified the "Secret of Hegel," or the theory of the process of thought, both individual and historical, as an advance through differentiation to a higher integration. (4) The physical discoveries generalised in the principle of the conservation of energy, and hence in a theory of scientific conceptions of nature as still, even as primitively, conceptions of its solidarity through the interaction of its parts, but now with the profoundly important substitution of the notion of *proved* equivalent, for *supposed* limitless transformation. And (5) the historical discoveries resulting in a theory of civilisation as a process with dateable (as yet no doubt only approximately dateable) beginnings under definable conditions; as a process the astonishing unity of which becomes more and more apparent with the progress of the researches which have demonstrated the derivation, certainly, of Semitic, and, almost certainly, of Chinese, from Chaldean civilisation; the later derivation of Aryan, through Pelasgian, from the connected Chaldean and Egyptian civilisations; and the derivation possibly (as I personally venture to think probably) of the civilisations also of the New from certain of those of the Old World; and, finally, as a process the unity of which further appears in such correlations and synchronisms of development as that illustrated, for instance, in what I have called the moral revolution of the sixth (or fifth-sixth) century B.C., in all the countries of civilisation from the Hoangho to the Tiber, and which has been more and more fully verified since I pointed it out in 1873 ("The New Philosophy of History"). The other theories I have referred to may, or may not, be found fully verifiable. But surely it may reasonably be anticipated that, from consideration of the ever-accumulating facts of these five great classes, we shall sooner or later discover general laws of history—laws of racial evolution, of intellectual development and of social progress—and draw from them results of the highest possible importance for the interpretation of the past, the guidance of the present, and the forecasting of the future?

But, if so, and if I have thus succeeded in showing that the discovery and verification of general laws of history is now brought within the scope of reasonable aims, it should be unnecessary for me to waste many words on the more practical object of this letter, viz. to urge that, endowed as the study of history as a science is in all the greater Universities of our European and American rivals, it should at length be adequately endowed also in the Universities of England, and more especially, perhaps, of Scotland. For, as Lord Rosebery has over and over again said—for instance, the other day (May 15) at a meeting of the University of London—"The struggle of this coming century will not be one so much of brute force as of trained intelligence. . . . No nations are satisfied with the standard of education that prevailed twenty-five years ago. Every nation demands a more keen and more trained and, if I may use the adjective, a more versatile intelligence than that which was adequate for the business methods of the Empire in

former days. In other words, we have to meet much keener competition in every department of life. And I hope, though perhaps not with much confidence, that all our educational institutions are recognising that fact and preparing to furbish up their somewhat antiquated methods to meet the demands of modern civilisation and modern competition." And at the same meeting the Vice-Chancellor, Sir Henry Roscoe, said, "If we are to meet successfully the constant changes of thought and manner of life to which a highly-organised society is increasingly liable, our Universities must not be content with giving instruction or testing attainment, however high, but must make real contribution to the knowledge which alone, in some form or other, will be a guarantee of the stability of that society."

I shall only add that the endowment and teaching of history as a science, the most complex of the sciences of evolution, should renew and vivify the teaching of all other sciences. For as the sciences of evolution, the metamorphic sciences as I would call them, are founded on the physical sciences, the ethical sciences are founded on the metamorphic sciences, and especially on that highest and most complex of all these sciences, the science of history, or science of anthropological evolution. More particularly within the scope of the more general or anthropological professorships of history it would come to set forth in their due connection, and in the inferences to be drawn from them, the great, yet hitherto, in this country, hardly known and wholly unappreciated, results of modern research with respect to the origin and history of civilisation. From such chairs also the keynote would be struck which would give a cooperating harmony to the work of every minor chair in the great faculty of history. For a general theory of civilisation, a theory aiming at setting forth the laws of man's history, would touch the whole circle of historical studies. Every special chair, therefore, of the faculty of history would be a centre of fruitful scientific criticism of whatever theory might be put forth from the chair of general history or sociology (if such should be its title). Imagine the result in new knowledge of such an interworking of generalising theory and verifying research! Were the faculties of our Universities, or even of one of them, reorganised as the contemporary development of the idea of evolution demands, what a school of cooperating workers would thus be created! From standing lowest among the great Powers in organisation and encouragement of intellectual work, Great Britain would take her place as highest! "Lords and Gentlemen of England! consider what nation it is whereof ye are, and whereof ye are the governors, a nation not slow and dull, but of a quick, ingenious and piercing spirit; acute to invent, subtle and sinewy to discourse, not beneath the reach of any point the highest that human capacity can soar to." And what lacks there in order to our showing ourselves worthy of this noble adjuration of Milton's but such institutions as our Universities might be if organised, not as I suggest, but as the idea of evolution demands? J. S. STUART-GLENNIE.

THE CONGRESS ON TUBERCULOSIS.

THE most sanguine expectations of those who have been responsible for the organisation of the British Congress on Tuberculosis could scarcely have led them to anticipate that such a remarkable success would attend their efforts as that which has been achieved. The work of some of these congresses appeals almost entirely to experts, whilst that of others has its interest only for the popular mind. Where, however, such a question as tuberculosis is concerned, the interests involved are so great and far-reaching that the medical man, the dabbler in science and the man in the street are all alike interested and fascinated. From Prof. Koch's splendid address, delivered on the first working day of the Congress, to the practical closing resolutions submitted to the Congress on Friday, those who attended would be ill to please did they not consider themselves provided with subjects for most interesting discussion.

One of the most important items in the success of the Congress was Prof. Koch's address, in which, in masterly fashion, he enumerated the various steps to be taken for the gradual elimination of tubercular process. The very fact that he resiled from one of his original positions—that bovine and human tubercle bacilli are practically identical—aroused such interest that, had no other single subject been discussed, the success of the congress would have been assured, and Prof. Koch is to be congratulated on raising a subject of such vital importance. It cannot but be felt, however, that the experimental evidence on which his opinion is founded is scarcely sufficient to warrant such a sweeping generalisation as that put forward; whilst the clinical evidence brought forward is even less convincing.

The experimental evidence can only be allowed to stand or be controverted on the production of positive evidence that bovine tuberculosis is communicable to man. Such evidence was at once forthcoming, Dr. Ravenel of Philadelphia bringing forward three cases of such infection that had come under his personal observation; one of the patients died, whilst in one more at least the bovine tubercle bacillus was recovered from the local lesion. These cases are, of course, of very great importance, and now that doubt has been thrown on the possibility of such infection, a most careful outlook will, in future, be kept for similar cases. From the clinical side, Prof. Koch's evidence is not convincing, especially as he maintains that no tubercular lesion can be accepted as arising in connection with the intestinal canal in which some effect is not produced on the mucous membrane. It appears to be the experience of pathologists who have examined a large number of cases of abdominal tuberculosis (tabes mesenterica) that a certain proportion, at any rate, whilst showing no local lesions such as ulceration or swelling of the mucous membrane itself, give abundant evidence of invasion of the mesenteric glands, and in a certain proportion of these cases the mesenteric glands only are affected, this proportion ranging from 14 per cent. (Woodhead) to 28 or 29 per cent. (Shennan and Still). Such affection of the lymphatic glands can scarcely be explained on any other assumption than that the infection has taken place from the alimentary canal, whilst there seems to be further collateral evidence that, in some of these cases at any rate, the infective material has been introduced through the agency of cow's milk. So strong is this evidence that most pathologists, on this ground alone, appear to have considerable hesitation in accepting Koch's statements without very careful corroboration, and it is to be hoped that in England, as in Germany and America, the matter will be put to the test as soon as possible. It should be mentioned that Prof. Virchow, one of the greatest authorities on tubercle, is by no means satisfied of the accuracy of Koch's conclusions on this matter. Whatever may be the result of future investigations, however, Prof. Koch may be most heartily congratulated on the courage and lucidity with which he expounded his views and on the interest that he has aroused in the question by the firing off of his bombshell, as it has been called.

The following remarks made by Lord Lister after Prof. Koch's address are of especial interest:—

Lord Lister said the discourse they had listened to was full of profound interest from the beginning to the end. But what had chiefly riveted their attention had been the startling thesis that bovine tubercle could not develop in the human body. This was a matter of enormous practical importance, because, if this conclusion were sound, it would greatly simplify their preventive measures; but it would be a very serious and grievous thing if the rules now in force for securing purity of milk supply should be relaxed and it should turn out after all that the conclusion was erroneous. For his own part he thought the evidence adduced by Dr. Koch to show that human tubercle could not be communicated to bovine animals very conclusive. At the same time he agreed with him that in a matter of such great importance further inquiry was desirable. But even if that were established it would by no means necessarily follow that bovine tubercle could not be communicated to man. He took in illustration the case of variola. Attempts to inoculate human

small-pox into the calf had been so very rarely successful that eminent pathologists had concluded that small-pox and cow-pox were two entirely different diseases. We now knew that this was an entire mistake; that cow-pox was small-pox modified by passing through the cow. He referred to some very instructive experiments by Dr. Monckton Copeman, who entirely failed to inoculate human small-pox into the calf, but invariably succeeded in inoculating it into the monkey, and was as invariably successful when he introduced matter from the pustules in the monkey into the calf, the result being ordinary cow-pox which could be used for vaccinating children. It may be that some species of animal may serve as an intermediary host for tubercle between man and the bovine species. Or it may turn out that, if a sufficient number of experiments are made, human tubercle may prove occasionally transmissible to the bovine animal, as small-pox is in rare instances to the calf, and that the bovine tubercle so produced may be transmissible to man, as is the virus of vaccine. The evidence, necessarily indirect, on which Koch relied as showing that bovine tubercle could not be transmitted to man did not seem at all conclusive. It consisted mainly in the alleged rarity of primary tubercular intestinal lesion in children, in spite of the multitudes of tubercle bacilli swallowed by them in milk. Even if it be admitted that primary tubercular intestinal lesions are as rare in children as Koch's statistics indicate, it is certainly true that tabes mesenterica exists in a considerable percentage of children that die of tubercular disease without tubercle being found in any other part of the body. When the mesenteric glands are thus affected without any discoverable intestinal lesion, the natural, and, indeed, inevitable, interpretation seemed to him to be that the tubercle bacilli had passed through the intestinal mucous membrane without causing obvious lesion in it, and had been arrested in the glands of the mesentery. It was known that even typhoid bacilli, whose essential place of development is the intestinal mucous membrane, occasionally pass through it without producing the characteristic lesion. And if this might occur with the typhoid bacilli, how much more likely was such an occurrence with tubercle bacilli! If this be so, Koch's main argument falls to the ground. As regards the experiments Koch had referred to of inoculating bovine animals with material from the glands of children affected with tabes mesenterica, the result being negative, these experiments had been but few; and even were they more numerous, they would not, to his mind, be quite conclusive. It might be that tubercle from milk in the intestines might be so modified by passing through the human subject that the bacilli in the mesenteric glands, though derived from a bovine animal, might be no longer those of true bovine tubercle, but bacilli having the characters of human tubercle little disposed to develop in cattle. The Congress would probably require a more searching inquiry into the subject before accepting this doctrine of the immunity of man to bovine tubercle.

In all other points Prof. Koch, Dr. Brouardel and Prof. McFadyean are thoroughly at one, and they carried with them, by the simplicity and earnestness of their statements, the whole of the members of the Congress, and the effects of their work and observations were plainly manifest in the resolutions that were submitted at the final meeting. These may be summed up in the statement that for the prevention of tuberculosis it is necessary to attend to the housing of the people, to the provision of a sufficient supply of fresh air, as good nutrition as possible, and to the prevention of the dissemination of the tubercle bacillus (for which purpose proper precautions should be taken to have it collected and destroyed as soon as it comes from the patient); for the cure of consumption fresh air, good food and well-regulated exercise; whilst in regard to bovine tuberculosis there seems to be no difference of opinion that, until the question raised by Prof. Koch is finally settled, no relaxation of the methods at our disposal for the examination and confiscation of tuberculous meat and milk should be allowed.

The work of the sections was, of course, somewhat more specialised in character. The report of the combined discussion on tuberculin will direct attention to the advantages and disadvantages claimed for and against the use of this therapeutic agent. Other methods of treatment also received full attention in Section I (Medicine).

In Section II. (Preventive Medicine) preventive measures were fully discussed, and the number of papers brought forward and dealt with give ample evidence of the interest taken in the work of this section.

In Section III. (Pathology and Bacteriology) some of the most useful work that came before the Congress was discussed. We would specially refer to Prof. Benda's paper on the channels of spread of tuberculosis and Dr. Ravenel's paper on the relation of bovine to human tuberculosis. This latter paper was exceedingly well-timed from the fact, already mentioned, that the author had to record three cases of infection of the human subject by bovine tuberculosis.

In Section IV. (Veterinary Section) an exceedingly interesting series of papers was discussed, especially one dealing with the application of tuberculin to cattle supplying milk. In connection with this, Prof. Bang pointed out that tuberculous animals might have non-tuberculous lesions of the udder; but, if there was any suspicion of tuberculosis of the udder and the animal was otherwise tuberculous, the benefit of the doubt should always be given in favour of the consumer, and the lesion should be looked upon, temporarily at any rate, as of a tubercular nature, and the necessary precautions should certainly be taken. Where, however, it could be proved that the lesion was non-tuberculous he thought that the milk might sometimes be used, if proper precautions were taken; though we should imagine that most people would consider the proper precautions in such a case would be absolute sterilisation of the milk.

As proof of the great interest taken by the King in the work of the Congress, His Majesty received a number of the foreign delegates in the Throne Room at Marlborough House. The delegates were accompanied by the Earl of Derby, Sir William Broadbent (chairman of the Organising Committee), Prof. Clifford Allbutt (regius professor at Cambridge and chairman of the General Purposes Committee), Mr. Malcolm Morris (honorary secretary-general of the Congress), and Dr. St. Clair Thompson (honorary financial secretary of the Congress). The following delegates were presented by the Earl of Derby, but Dr. Koch, who had promised to open a discussion at Eastbourne, and a few other foreign delegates were unable to be present:—Prof. Osler and Prof. Janeway, United States; Hofrath Prof. von Schrötter and Prof. Dvorak, Austria; M. le Sénateur Montefiore Lévi and Dr. van Ryn, Belgium; Dr. Mickailovsky, Bulgaria; Prof. Bang and Dr. Charles Gram, Denmark; Dr. Brouardel (Doyen de la Faculté de Médicine de Paris), Prof. Bouchard and Prof. Nocard, France; Geheimrat Prof. Gerhardt, Prof. Flügge, Geheimrat Prof. von Leyden, Prof. Fraükel, Dr. Werner and Dr. Dettweiler, Germany; Prof. Thomassen, Holland; Prof. Koranyi, Hungary; M. Malm, Norway; Prof. da Silva Amado, Portugal; Señor Don Antonio Espina y Capo, Spain; Hof-Marshal Printzjold, Sweden; and Dr. Neuman, Switzerland. His Majesty shook hands with each delegate as he was presented, and then said:—

"GENTLEMEN,—Let me express to you the great pleasure and satisfaction it has given me to ask you to come here to-day; I only regret that you should have arrived during such a severe thunderstorm. It has been a source of great concern to me that, owing to circumstances over which I had no control, I was prevented from presiding at the opening of your important Congress and attending its meetings; but I can assure you that, though not present, I take the deepest interest in its proceedings, and that I follow with much interest, through the medium of the daily Press, the papers which are read and the discussions on the subject. There is no more terrible disease than that known as consumption, and I only hope and trust that you may be the means of minimising its evil effects, and thereby receive the gratitude of the whole world. There is still one other terrible

disease which has up till now baffled the scientific and medical men of the world, and that is cancer. God grant that before long you may be able to find a cure for it, or check its course; and I think that to him who makes the discovery a statue should be erected in all the capitals of the world. In taking leave of you I trust that your stay in London and in England has been an enjoyable one, and that you will one and all carry away pleasant recollections of your visit to my country."

There can be no doubt that the King's desire will be gratified, for, if the foreign delegates have received the some amount of pleasure from the scientific and social work of the Congress as have their British *confrères*, they should go away amply satisfied and with very pleasant recollections indeed. That they were prepared to enjoy everything may be gathered from the fact that they cheerfully, and apparently even willingly, sat through twenty-seven speeches at the final banquet given on Friday night.

The other social features of the Congress were the receptions at the Mansion House by the Lord Mayor, at Apsley House by the Duke and Duchess of Wellington, at the Victoria and Albert Museum by the Earl and Countess of Derby, and at Sion House by the Duke and Duchess of Northumberland; whilst evening parties, private dinners, water parties and the like afforded ample entertainment for all who were able to attend such functions.

Altogether the Congress may be looked upon as one of the most interesting and successful ever held in London, and the results promise to be very far-reaching.

POSITION AND PROSPECTS OF ELECTRO-CHEMICAL INDUSTRIES.

THE presidential address delivered last week by Mr. J. W. Swan, F.R.S., to the Society of Chemical Industry, though it covers the same ground as the one he delivered three years ago as President of the Institution of Electrical Engineers, does so in a much more comprehensive and detailed manner. The paper is very valuable and instructive, though not always pleasant reading for the English electrochemist, who cannot help reflecting that his country is much behindhand in the development of those industries of which Davy and Faraday laid the foundations. It cannot be urged that our backwardness is wholly due to the lack of water power in the British Islands, though doubtless this has contributed in many instances to our failure to keep pace with our competitors. But there are many electrochemical industries in which, though cheap power is by no means essential, other nations have been the pioneers and are likely to reap the reward. Thus, to quote one striking example, there appears to be no English bullion refinery using electrochemical processes, although these are finding extensive employment in America and Germany. The value of the output for 1900 from two out of the three German refineries is given by Mr. Swan as 2,500,000*l.*, the source of power in all three cases being steam.

The fact remains, however, as Mr. Swan points out, that the greater number of electrochemical plants are operated by water power. For fifty European works the figures obtained show that there is 149,000 h.p. available from water, 16,700 h.p. from steam, and 250 h.p. from gas. The great bulk of the horse power generated from water is used in the production of aluminium and calcium carbide, industries in which cheap power is paramount. Is it to be feared, therefore, that the more extended use of electrochemical processes will cause chemical industries to leave this country for others more fortunately supplied with waterfalls? The question is one, as Mr. Swan says, "of national importance, for chemical manufactures occupy, and have always occupied, a leading place among the industries of our country." Something, perhaps much, is to be hoped for from the reduction in the cost of power generated from coal, in which connection we may quote Mr. Swan's words:—

"Great advances have in recent years been made in the direction of reduction of cost, by improvements in the steam engine, the gas producer and the gas engine. In the best modern steam engines a heat efficiency of 15 per cent. is obtained. There is great reason for hope that help in the more economical generation of power for electrochemical work may come from the further development of the gas engine. Already much has been done, both in the improvement of the gas engine and also in providing it with cheap gas. Our honoured past president, Dr. Mond, has made a valuable contribution in this direction.

"One of the drawbacks to the employment of gas engines for large operations has been that they were not adapted for large units of power, but now engines of 500 h.p. and even 1000 h.p. are manufactured, and work with successful results."

It is to be feared, moreover, that we are not only hampered by unfavourable conditions, but that we do not make the most of the opportunities we possess. The position deserves the most careful consideration of all chemists and electricians, or the former will one day awake to find that his purely chemical manufacturing processes have been superseded in other countries by electrochemical methods, and the latter will find, as he has already found largely in electric traction, that, whilst he was sleeping, a new field of development has been fully exploited by American and continental engineers. We cannot help thinking that the fault is, to a considerable extent, due to our educational system and to the bias of the English manufacturer against college-trained men. Mr. Swan's remarks on this point are worthy of very careful attention:—

"In England and Ireland we are suffering acutely from dire educational neglect and destitution, and that worst kind of poverty, *insensibility to our deficiencies*.

"Our English system of scientific and technical education is not equal to the present needs of the country, seeing how severely we are pressed on every side by the most energetic and intelligent competition. We are giving to the classes at the bottom of the industrial ladder a disjointed smattering of miscellaneous science, of no great value, though probably good so far as it goes, while we are neglecting to educate thoroughly those upon whose shoulders will soon rest the weight of the management of our great manufacturing industries. In the present state of things a competent knowledge of the science of the business a man is engaged in, as well as an active interest in it, whether it be chemical industry or any other, are essential conditions of any large degree of success in meeting the emergencies of a highly competitive and progressive time. A scientific training of university standard, for our manufacturers and for our technical chiefs, is an absolute necessity. Surely public money cannot be better spent than in providing adequate facilities for the educational equipment of the men of the future, with this essential means of national defence. Our country possesses great stores of mineral wealth, a precious heritage that we are lavishly spending. That gift of nature will certainly not avert, and cannot go far to compensate for, the consequences of neglect of the scientific training necessary to turn our fast-diminishing mineral wealth to the best advantage.

"One of the most pressing requirements of the moment, demanded, not only in the interest of chemical industry, but in that of our manufacturing industries generally, is *adequate endowment and encouragement of research*. Original scientific research is the fountainhead of new knowledge, the vital stimulus of industrial growth, the originator of new industries and sustainer of old. Yet, nationally, in the organisation of our educational and industrial system, we give to scientific research no hospitality—we barely pay it the respect of recognition."

These arguments have been advanced again and again by educational enthusiasts, but they have as yet borne but little fruit. Perhaps now that they have been so strongly endorsed by one so well qualified to speak from the manufacturer's point of view as Mr. Swan, they may find their way into the minds of those in whose hands lies the future industrial prosperity of England.

MISS ELEANOR A. ORMEROD.

UNIVERSAL regret will be felt at the death of almost our only prominent lady entomologist, and our best authority on farm and garden entomology. Miss Ormerod was born at Sedbury, in Gloucestershire, and breathed her last on July 19, 1901, in her seventy-fourth year, at Torrington House, St. Albans, where she resided for some years with her sister, Miss Georgiana Elizabeth Ormerod, who died in 1896 at the age of seventy-three.

At the time when Miss Eleanor Ormerod turned her attention to injurious insects, no popular English work existed on the subject; for Curtis's "Farm Insects" was too large and costly for wide circulation. We do not know if Mr. E. A. Fitch, who had been projecting a work on the subject himself, suggested it to Miss Ormerod, or whether the initiative came from her; but in 1877 appeared the first part of the well-known "Notes of Observations of Injurious Insects," by E. A. Ormerod, T. A. Preston and E. A. Fitch. About this time Mr. Fitch found that pressure of business prevented him from giving much attention to entomology; but for twenty-three years afterwards appeared annual reports, under the editorship of Miss E. A. Ormerod, embodying the observations of a great number of observers on those species of insects which had been most destructive, or which had attracted special attention during each year. From time to time she published detached observations in different journals on subjects of much importance connected with her favourite subject, supplementary or preliminary to her reports, and she also published several books which had a wide circulation, and some of which went through several editions. Among the most important of her separate works are the following:—"A Manual of Injurious Insects, with Methods of Prevention and Remedy for their Attacks to Food Crops, Forest Trees and Fruit, and with short Introduction to Entomology" (first edition, 1881); "Guide to Methods of Insect Life, and Prevention and Remedy of Insect Ravage" (1884); republished in 1892 under the title of "A Text-book of Agricultural Entomology"; "Notes and Descriptions of a few Injurious Farm and Fruit Insects of South Africa, compiled by E. A. Ormerod, F.R.Met.Soc., &c., with Descriptions and Identifications of the Insects by Oliver E. Janson" (1889); and "A Handbook of Insects injurious to Orchard and Bush Fruits, with Means of Prevention and Remedy" (1898).

Miss E. A. Ormerod was assisted in her work by her sister Georgiana, who was likewise an ardent entomologist, though we are not aware that she ever published anything under her own name. Both the sisters were Fellows of the Entomological Society of London, having joined in 1878 and 1880 respectively, and at one period they were regular attendants at the meetings. For some years Miss E. A. Ormerod held the appointment of consulting entomologist to the Royal Agricultural Society. She was also an examiner in agricultural entomology to the University of Edinburgh; and in 1900 that body conferred upon her the honorary degree of D.C.L.

W. F. K.

NOTES.

THE French Minister of War has asked the Paris Academy of Sciences to give an opinion as to the possibility of danger arising from the establishment of wireless telegraphy stations in the neighbourhood of magazines containing powder or other explosives. It is suggested that the nature of the cases containing the explosive may be an important matter for consideration in connection with the subject.

THREE prizes have been offered to the Marine Biological Association of the West of Scotland by Sir John Murray, K.C.B., in memory of the late Mr. Fred. P. Pullar, who was associated with him in the bathymetrical survey of the Scottish fresh water lochs, and lost his life on Airthrey Loch, Bridge of Allan, in February last. There will be a prize of 50*l.* for a paper on each of the following subjects:—(1) The seasonal distribution and development of pelagic algæ in the waters of the Clyde sea area. (2) The reproduction, development and distribution in the Clyde sea area of the genera Nyctiphanes and Boreophausia. (3) The formation and distribution of glauconite in the deposits of the Clyde sea area and the adjacent seas of Scotland. These prizes are open to investigators from any part of the world who conduct observations in the several subjects at the Millport Marine Station, and who produce, at any time before January 1, 1905, papers which, in the opinion of a committee of three scientific men, to be nominated by the committee of the Association and by Sir John Murray, shall be deemed of sufficient value to merit publication. The honorary secretary of the Association is Mr. John A. Todd, 190, West George Street, Glasgow.

THE annual meeting of the British Medical Association was opened at Cheltenham on Tuesday, when Dr. G. B. Ferguson, the president, delivered an address on "Scientific Research as the Indispensable Basis of all Medical and Material Progress." In the course of his remarks, Dr. Ferguson said that medical progress owed more to the biologists and to the men of pure science than to the so-called practical men. The cell theory, for instance, originated entirely with the biologists. It led up to bacteriology, the most imposing and the most impressive department of medical biology. Bacteriology itself now rested on cultivation and staining; and if year by year more and more of the germs of disease were recognised, it was because of the improved methods of colouring and making them visible. All this strengthened his contention that the basis of modern medicine was essentially scientific. Then in surgery the discovery of the Röntgen rays had been of priceless benefit, but most certainly Röntgen was thinking of nothing less than of surgery when he made that discovery. Antitoxins, which are among the most valuable resources of remedial art, medical men owed to strictly scientific investigators. Personally, he placed much faith in the anti-typhoid inoculations of Prof. Wright, of Netley, and in the anti-tetanus serum, and he felt sure that many more equally effective means would soon be available. Dr. Ferguson next recalled the splendid work—purely scientific again—of the French and Italian investigators of malaria, together with Major Ronald Ross, Dr. Manson, and other English observers, by whom the mosquito theory had been worked out. Turning to ophthalmology, he asked what would have been its state to-day without the invention of the ophthalmoscope by the physicist Helmholtz. Then there was the marvellously successful treatment of lupus by the chemical rays of the electric arc devised by Finsen, of Copenhagen. And where would medical men be without the chemists, who had provided iodine, bromine, iodoform, chloroform, chloral and cocaine? As the result of several visits to the continental capitals he had been struck with the thoroughness and scientific spirit everywhere there manifested, very different from the anti-scientific spirit characterising most of the wealthier and more cultivated classes in this country. France, Germany and the United States educated at their Universities approximately one student in every 1500 of the population, but we were content with less than one in 2000. Yet the matter was one of life or death for the country, for more and more every year the victory and the predominance would pass to the possessors of the latest knowledge, the deepest science and the most perfect and economical processes.

THE Harben medal of the Royal Institute of Public Health was presented to Prof. Koch at the annual dinner of the Institute on July 24. The medal is awarded in recognition of services rendered to the public health, and is conferred irrespective of nationality. In presenting the medal, the president of the Institute, Prof. W. R. Smith, described Prof. Koch's career of scientific activity. In reply, Prof. Koch remarked that when, as a young doctor, he went to take up his practice at Wallstein he found himself in a country where anthrax was to be seen on every hand, and he was naturally led to make the matter one of research. In that research he was greatly assisted by the perfection to which the microscope had been brought, and this gave the key to the wider discoveries in bacteriology that followed. He was gratified to receive the medal as a testimony of their concurrence with the scientific methods which he had followed, and he was all the more pleased to have such an honour from an English institute, because it was in England that his researches in reference to anthrax and the treatment of wounds met with the first appreciation.

PROF. W. A. HERDMAN has received letters and natural history notes from Mr. Nelson Annandale and Mr. H. Robinson, who left Liverpool University College a short time ago for a year's exploration in the Siamese Malay States. Some of the observations made and material collected will be described at the forthcoming meeting of the British Association at Glasgow. Meanwhile, it is interesting to read the following notes from the naturalists:—"We have obtained what is either a second species of Periophthalmus or a genus closely allied to it, and we have to-day ourselves collected a series of young specimens, which show that in extreme youth the eyes are normally placed on the sides of the head, and only migrate to the top later in life. We also got in water less than a fathom a most interesting case of commensalism, in which a small crab, with a very soft back, has the two last pairs of legs specially modified for holding on a sea-anemone, which it grasps by the foot. . . . A good many cases of mimicry between different orders and families, principally between spiders and ants, homoptera and beetles, were noted—in at least ten cases the mimicked animal being an ant."

THE programme of the seventy-third meeting of German Men of Science and Physicians, to be held at Hamburg on September 22-28, has been issued. As there are eleven sections dealing with different departments of natural philosophy, and twenty-seven sections in the group of medical sciences, it is easy for all who are engaged in scientific work to find a section in which they are particularly interested. The general science sections are:—(1) mathematics, astronomy and geodesy; (2) physics, including instrument making and scientific photography; (3) mixed mathematics and physics (electrotechnics and scientific engineering); (4) chemistry, including electrochemistry; (5) general chemistry, including agricultural chemistry and food investigations; (6) geophysics, including meteorology and terrestrial magnetism; (7) geography, hydrography and cartography; (8) mineralogy and geology; (9) botany; (10) zoology; and (11) anthropology and ethnology. On September 23 and 27 there will be general meetings at which lectures will be given. On the former date the lectures to be delivered will be on Hertz electric waves and their further development, by Dr. E. Lecher; the chemical possessions of the cell, by Dr. F. Hofmeister; and the problem of fertilisation, by Prof. T. Boveri. On September 27 the lectures will be on medicine and maritime intercourse, by Prof. H. Curschmann; the significance of electrical methods and theories in chemistry, by Prof. W. Nernst; and on the natural energy of organisms, by Prof. J. Reinke. There will be a joint meeting on September 25 for the discussion on atoms, from the point of view of recent investigations and conclusions on ions and electrons. The president of the meeting is Prof. R. Hertwig, of Munich. Prof. van 't Hoff is the president of the group of natural philosophy sections, and Prof. Naunyn the president of the sections of medical sciences.

THE presidential address delivered by Mr. G. C. Druce at Dublin on Tuesday, at the opening meeting of the British Pharmaceutical Conference, was a survey of the important scientific discoveries made during last century, and their relation to the art and practice of pharmacy. In pharmaceutical chemistry, the active principles which have been isolated are now appalling in number, and have assisted in making great changes in the character of dispensing. In addition, a stream of artificial compounds, many of which possess marked therapeutic action, has flowed from the laboratory of the chemist. Referring to botany and systems of classification, Mr. Druce said: "One marked change has taken place during the past century so far as the professional teaching of botany is concerned, for in the early years of last century all the important botanical chairs in Britain were held by systematists, now not a single one is so occupied. This is not an unalloyed advantage. That systematic botany alone should be taught to the almost absolute neglect of histology or physiology was doubtless an evil, and it has been said that taxonomic teaching was choked by its own nomenclature; but the whirligig of time brings its revenges, and now we may without injustice retort that laboratory botany is being strangled by the exuberance of its terminology. And the positive evil exists that with the neglect of systematic teaching in Britain our continental and transatlantic *confrères* are occupying the ground in which Britain for long held a foremost position, and which, from the extent of our colonial possessions, should be especially its own."

DR. CARL PETERS has returned to London, after an extended journey from the Zambesi to the Sabi rivers, and has brought home news of interesting archæological discoveries on the frontier of Mashonaland. One of these is a small female figure of Egyptian workmanship, which is believed to date back to 2500 years before the Christian era. There have also been found thirty-three copper and six silver coins and a couple of stones bearing inscriptions. It is hoped that a scientific expedition will be sent out to make further investigations.

WE learn from the U.S. *Monthly Weather Review* that the German South Polar Expedition will systematically make kite ascensions in the trade winds from aboard ship during the southward journey, and continue the work in the Antarctic regions. The expedition is fully equipped with suitable apparatus, all substantially of the Weather Bureau pattern, and the scheme will be that followed at Washington, with modifications required by the conditions and resulting from extensive experiments at the Deutsche Seewarte. The kites are of three sizes, the large Marvin of 6½ square metres surface, Hargrave kites of 4 and 2¾ square metres surface and light Eddy kites of 2¾ square metres, which are very advantageously employed in lifting and sustaining the larger kites with the instruments in light winds. This appears to be the first occasion on which preparations have been made for the systematic exploration of the upper air conditions in the polar regions.

AFTER a protracted spell of dry weather, London was visited by a violent thunderstorm about noon on July 25. The weather chart issued by the Meteorological Office on that day showed that a shallow depression lay over the south-eastern parts of England, and this moved very slowly to the westward during the next few days. Except that the conditions were very unsettled there was nothing to indicate the occurrence of a storm of unusual violence. The rainfall was of great intensity, amounting to nearly an inch and three-quarters in about an hour

and a half, and to three inches within forty-eight hours. In some parts of the metropolis much damage was caused by flooding, and railway traffic was suspended for a considerable time. As late as Sunday last this same shallow storm area was still lingering over the southern portion of the country, the centre being in the morning in the south-west. Heavy thunderstorms were still occurring in those parts which lay near the path of the disturbance. On Saturday there was again exceptionally heavy rain in parts of London, an inch falling in less than an hour in the southern suburbs. The midland districts of England have experienced very heavy rains, the fall at Oxford amounting to 4·33 inches in the four days ending last Sunday morning.

WE have received from Dr. W. Doberck, director of the Hong Kong Observatory, a copy of the observations made there during the year 1900. The work contains, in the same form as in previous years, a very valuable series of hourly meteorological observations and mean results deduced from them, as well as magnetical and astronomical data. In addition to the usual work of a well-equipped observatory, much attention is given to various researches, including the collection of observations at about forty land stations and from ships' logs, with the view of contributing to our knowledge of the climatology of the Far East and of the destructive typhoons of the eastern seas. The total number of days' observations collected from different ships during the year amounted to nearly 20,000; these are regularly entered in degree squares for the construction of trustworthy pilot charts. Weather forecasts are also issued daily about 11h. a.m., and a comparison with subsequent weather shows that the amount of total or partial success reached the high figure of 93 per cent. during the year in question.

THE Meteorological Office Pilot Chart of the North Atlantic and Mediterranean for the month of August shows that there has been a very decided increase in the quantity of ice in the neighbourhood of Newfoundland, the reports, which are as late as July 3, being too numerous to admit of all being given on the chart. The bergs crowd mostly from Cape Race eastward to the Flemish Cap, but there are a good many scattered about down to 42° N., 49° W. and 43° N., 43° W. In the notes on the winds, further information is given relating to West Indian hurricanes, some of which, there is reason to believe, originate in the neighbourhood of the Cape Verde Islands, where the prevailing winds for August exhibit a cyclonic circulation. To the mean path of these hurricanes is added an indication of the southern and the eastern and northern limits within which they have been experienced in this month, the South American coast westward to Honduras being practically free from actual hurricanes, but experiencing very disturbed seas, occasioned by the distant gales. In Trinidad, the hurricane months are marked by violent squalls and heavy rain. The region of ordinary gales has commenced to work southward after having nearly disappeared northward in July. After steadily extending eastward from the American coast until the Bay of Biscay was reached in July, the fog area has suddenly shrunk, the main area being now to the westward of the 30th meridian, only a small patch being shown off the English Channel; but it is stated that while there is this diminution off our south-western coasts there is an increase in progress up the east coast of Britain and about the Clyde and Irish Sea. Other notes deal with the salient features of the ocean currents; with British thunderstorms which form locally; and with the winds of the Sea of Marmara, and currents of this sea and the Dardanelles and the Bosporus.

THE Report of the Council issued in the *Proceedings* of the South London Entomological and Natural History Society for 1900 discloses a satisfactory state of the roll of members and of the finances of that energetic body. The average attendance at the meetings has been about 30, which is remarkably good for a society whose members number only 170. Mr. R. Adkin communicates an interesting article on the life-history of the goat-moth, in which it is shown that the change from caterpillar to chrysalis does not take place in the stems of the living willows tunnelled by the former, but rather in dead trunks or any other situation where soft, friable matter is to be met with.

A VIEW of M. Fagel's statue of Chevreul, unveiled at Paris on July 11, is given here by the courtesy of the *Chemist and Druggist*. The monument stands in the Cour d'Honneur of the Paris Museum of Natural History, and is an excellent representation of the eminent chemist, whose investigations have greatly assisted in promoting the commercial prosperity of France. The base of the statue bears inscriptions recording the principal events of Chevreul's life, the front one being as follows:—"Chevreul, Michel-Eugène, né a Angers le 31 aout 1786; mort a Paris le 7 Avril 1889. Professeur de Chimie

Statue of Chevreul.

Organique, 1830–1889; Directeur du Muséum d'Histoire Naturelle, 1863–1884." Upon the occasion of the unveiling of the statue, M. E. Perrier, the present director of the Paris Museum of Natural History, delivered an address which is given in full in the *Revue Scientifique* of July 20, with discourses by M. A. Gautier, who represented the Academy of Sciences, and M. Arnaud, who succeeded Chevreul in the chair of organic chemistry at the Museum in 1890.

THE latest issue of *Notes* from the Leyden Museum contains an article by Dr. F. A. Jentink on the collection of antelopes in that institution, in the course of which the author pays a tribute to the value of the "Book of Antelopes," by Messrs. Sclater and Thomas. The Leyden collection appears to be very rich in antelope skins from the Cape, many of these belonging to species which are at least locally extinct. The author believes the white-tailed gnu to be quite extinct as a wild species,

and the same is true for the eland in Cape Colony. The head of a female of the latter with an abnormal form of horn is figured. In the same journal Dr. Finsch continues his catalogue of the Leyden bird collection, dealing in this section with the bee-eaters.

ANOTHER ruminant—the Louisianian representative of the white-tailed deer—receives a new name in the June number of the *American Naturalist*. Recently some American writers announced that the proper specific name of the Virginian white-tail was *americanus*, instead of the time-honoured *virginianus*, and the former name has consequently been generally adopted in literature. Others say they were wrong in the change, and propose to revert to *virginianus*. Nothing can be more unsatisfactory than such perpetual changes, and it is far better to adhere to one name, even if it be not what is called the right one. To the same journal Dr. R. W. Shufeldt contributes a paper on the affinities of the American birds commonly known as screamers (Palamedeæ). While admitting their affinity with the duck tribe, he suggests that they may be the survivors of the common ancestral type of both the anserine and the gallinaceous birds. In all their characters these birds are archaic, and the author is of opinion that they serve to connect the duck tribe with the ostrich group.

IN launching a new periodical, the *Museums Journal*, of which the first number is dated July, the Museums Association has full justification, and the venture has our best wishes. It is edited by Mr. E. Howarth, of Sheffield, with the cooperation of other museum officials from England, Germany, the United States, Australia, the Cape and New Zealand; and by this wide basis any danger of cliquism gaining a predominance in the new journal should be obviated, while it will ensure attention to the needs of museums in all parts of the world. Following the introductory notice is an address on the museums of Edinburgh by Sir William Turner, the president of the Museums Association, whose portrait forms the frontispiece to this issue. Next comes a specimen museum label, to be followed by others month by month. This label, which deals with British pottery, is, in our opinion, too long and too verbose. In order to avoid wearying museum visitors, it should clearly be divided into two—the first descriptive and the second dealing exclusively with the various British potteries. The part closes with a series of general notes, of which one section is devoted to home and the other to foreign museums.

SOME interesting conclusions have been arrived at by Dr. Ford, of the McGill University, Montreal, in the course of his investigations on the bacteriology of the healthy organs of animals. The liver and kidneys of a number of rabbits, guinea-pigs, cats and dogs were examined, and at least eighty per cent. were found by Dr. Ford to contain bacteria. This is contrary to the results obtained earlier by Neisser and Opitz, who in similar examinations found no bacteria. This apparent discrepancy in the two series of investigations is explained by Ford as due to Neisser and Opitz only cultivating the organs examined by them for two, at most three, days, whereas it is necessary, Ford states, to leave them for several days, a week, and even two weeks to obtain the development of the bacteria present. Each animal, regardless of its species, showed its distinct bacteriology, and as a rule the Carnivora—dogs and cats—exhibited bacteria similar to each other, but absolutely different from those obtained from the Herbivora—rabbits and guinea-pigs. These results are quite consistent with the difference in the food used by the animals, which would determine to a large extent the intestinal flora. Dr. Ford's paper is published in the *Transactions* of the Association of American Physicians.

The *Revue générale des Sciences* for June 30 and July 15 contains an article by Dr. Cureau on the geography of equatorial Africa. The subject is well treated in its most general aspects, and a number of interesting sections, particularly of the Nile-Congo region, are given. The second article deals with the population.

THE new number of the *Mitteilungen aus den deutschen Schutzgebieten* contains two important series of determinations of heights in Togoland. Dr. A. Lübbert contributes a paper on native treatment and medicines in German South-west Africa, and a report on the system of land surveying employed in Cape Colony and its application in modified form to German South-west Africa. From German East Africa Captain Prüssing writes on the Rufiyi delta, and Dr. Kandt on Ruanada. Dr. Pflüger contributes some notes on the geology of the Bismarck Archipelago.

The *Zeitschrift* of the Berlin Gesellschaft für Erdkunde contains an important report by Dr. von Oppenheim on his journey in Asiatic Turkey during 1899. The region traversed is of special interest in relation to the proposed railway from Constantinople to Bagdad, and the paper discusses the best available route for such a railway, and the prospects of its financial success. Dr. W. Brennecke gives, in the same number of the *Zeitschrift*, the results of Prof. Philippson's determinations of heights in the neighbourhood of Pergama.

In *Petermann's Mitteilungen*, M. Gentil-Tippenhauer continues his papers on the geology of Haiti. The present instalment deals with the mineral deposits of Terre-Neuve and Gonaives. Prof. Supan contributes a paper, read at the recent Geographentag at Breslau, on the climate of the Antarctic, in which he discusses the results of recent observations as establishing the existence of a permanent polar anticyclone, surrounded by a ring of low pressure. Dr. Franz Schaffer gives an account of studies in the geotectonics of south-eastern Anatolia, made during journeys in the spring and autumn of 1900.

THOSE of our readers who are interested in the Farthest East should consult the *Mittheilungen der deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens* (Tokyo, also at Asher and Co., Berlin). In vol. viii. part 2 of that journal will be found an account of the existing and proposed state and private railways in Japan, by Inspector F. Baltzer. The ancient national bon-festival is described by Dr. H. Weipert and illustrated by nine plates drawn by Japanese, which present existing and former aspects of certain ceremonies and dances connected with the festival. The bon-dance has been handed down from the mythical period, and the primitive Ainos have a very similar dance. The Rev. A. Lloyd has a paper, in German, on dogmatic anthropology in Buddhism. Prof. Aoyama writes on the plague. The number concludes with a short communication by Prof. Dr. E. Bälz on the racial elements in Eastern Asia, especially in Japan. He characterises (1) the Mongolo-Malayan type; (2) the Korean-Mandschurian type; (3) the Aino type. The latter are, according to Bälz, the remains of a "Caucasian or Caucasoid race" that was widely scattered throughout the whole of the north of Asia.

THE current volume (vol. iii.) of the *Bulletin* of the Free Museum of Science and Art of the University of Pennsylvania has several interesting articles, mainly on collections that have been presented to the Museum. We have previously directed attention to this Museum, which has greatly prospered under the curatorship of Mr. Stewart Culin, and is rapidly becoming an important centre of research and instruction. A copiously illustrated account is given by Mr. Culin of a summer trip among the Western Indians, being a narrative of the Wanamaker Expedition. In addition to much interesting information gained on this trip, large numbers of specimens were obtained, many of which were of objects the use of which has all but died out. Pendant-shaped stones with a groove encircling one end are

constantly found in America in graves and elsewhere. These are popularly called "plummets." The so-called "plummets" form the subject of an illustrated paper by Charles Peabody, who enumerates the numerous uses to which these stones have been supposed to be put. Of these supposititious uses that as true plummets is the most unlikely; probably most were sinkers used in fishing and some were weights used in weaving, while others were probably used for various purposes. The indefatigable travellers, Dr. H. M. Hiller and Dr. W. H. Furness, 3rd, give an illustrated paper on the Veddahs of Ceylon, but there is nothing particularly new in their observations. The games of the Ogalala Indians are fully described by Mr. Louis L. Meeker; these Amerinds are a branch of the Sioux, and the specimens he collected further enrich the unique collection of toys and games that Mr. Culin has been the means of garnering in the Museum under his care.

AMONG the series of useful French handbooks published under the title of *Scientia*, there are few that will prove of greater interest to mathematicians and physicists than M. J. Hadamard's volume of 102 pages on Taylor's series and its extension. The general problem of Taylor's series consists in the determination of an analytical function by the solution of the following problems: (1) calculation of the function at any point whatever; (2) determination of the singular points. M. Hadamard considers that the solution of the first problem is to be found in Mittag Leffler's theorem, but that of the second is at present in a much less advanced stage. In the bibliography, the author gives a list of more than a hundred books and papers dealing with the properties of analytic functions, the convergence of series and other questions arising out of the general problem.

IN the *Psychological Review* (viii. 2), Prof. G. T. W. Patrick studies the questions, "Why do men swear? When they swear, why do they use the words which they do?" From a classification of the various forms of profane expression used by men at different periods of history, and an examination of their connection with religious words, the writer concludes that profanity is not to be regarded as primarily an expression of emotion, but is only to be understood by the genetic method, the point of departure being the growl of anger in the lower animal, which is a serviceable form of reaction in cases of combat. It belongs, therefore, to a primitive form of vocalisation, and hence is ancient and deep-seated, being one of several forms of speech preceding articulate language by an indefinite period of time. By a process of selection it chooses at all times those forms of phonation or those articulate words which are best adapted to terrify or shock the opponent. Although originally useful in combat, the occasion of profanity at the present time may be any analogous situation in which our well-being is threatened, as in helpless distress or disappointment. If, then, the oath is a form of instinctive reaction and even a purifying agent, why is it considered to have an immoral quality? Prof. Patrick thinks for two reasons: first, because advancing civilisation bids us evermore inhibit and repress; and, secondly, because of the unfortunate but inevitable connection between profanity and the sacred names of religion.

AN account of the new eruptive cone on Vesuvius, which commenced to form in September, 1900, up till April last, is given by Prof. E. Semmola in the *Rendiconto* of the Naples Academy (vii. 4). The cone is—or rather was at that time—about forty metres high, but difficult of ascent owing to its steepness and the thick coating of sand on its walls. The internal cavity was irregularly elliptic and was divided along its major axis into two parts. In that part lying towards the north-east a crater had been formed whose depth did not appear to exceed twenty-five metres; at its bottom was the eruptive aperture emitting a copious column of vapour and gas. In the smaller portion was a crateriform dyke, full of cracks, and with the walls smoking in places, this being separated from the crater previously mentioned by a kind of wall rising half-way up and terminating in the floor of the crater. The internal walls of the crater were carpeted with sublimates, in which various shades of red and yellow predominated. The vapour made its exit in globular clouds, which in calm weather spread out into a fine tree-shape some hundred metres high. The gaseous products reddened litmus paper, and here and there sulphurous anhydride was noticeable; the ground at the top of the cone felt hot, and the temperature at a depth of 50 cm. was about 50° C. Reflected light was not seen at night, and Prof. Semmola hence concludes that the source of activity was at a considerable depth. The general character of the phenomena, and in particular the entire absence of explosions or ashes or projected bodies, points to the activity of Vesuvius being considerable, but the channels of activity being altogether free from any obstructions such as would cause violent action to take place.

MR. RAVENSHAW'S paper on the electrical transmission of power in coal mines, and Mr. Walker's on electrical miners' safety lamps, which appear in the last number of the *Journal* of the Institution of Electrical Engineers, contain, with the joint discussion on the two papers, a great deal of valuable information on this comparatively recent application of electricity. The number of purposes to which electricity can be applied, either to supply an existing want or to replace some less satisfactory method, is continually increasing, and as each new problem is attacked special difficulties present themselves. This is very apparent in this instance, where the dangers peculiar to coal-mining make it essential for the electrician to design special machinery to meet the case. Mr. Walker's paper is very instructive as showing how many difficulties have to be overcome before a lamp can be obtained to compete at all successfully with the existing miner's lamp, although at first sight the electric lamp would seem to be so preeminently the best one to use. Thus, apart from questions of cost and weight, the very safety of the electrical lamp is in itself a drawback, since it does not indicate, as does an oil lamp, the presence of dangerous gases. There can be little doubt, however, that the difficulties have only to be fully realised to be successfully overcome, and in the course of time the use of electricity is likely to become general in coal-mines, for which in essential respects it is so peculiarly suitable.

A FEW more details concerning the adoption of the "Parsons steam turbine" as a source of propulsion in the mercantile marine are now available. The vessel named the *King Edward*, the main dimensions of which have been given in a previous number, has been launched and (says *Engineering* of July 5) has so far quite realised the expectations of her owners. The trials were run on the Firth of Clyde, where, on a mean of runs "over the Skelmorlie mile," the speed of 20·48 knots was obtained. The mean revolutions were registered at 740 per minute, boiler pressure 150 lbs. per sq. inch, a vacuum of 26½ inches, and a stokehole pressure (forced draught) equivalent to one inch of water. Among the advantages of the Parsons steam turbine over the ordinary reciprocating engines the following are mentioned:—(1) The weight of the propelling machinery is 66 tons, being, it is stated, roughly half the weight for an engine (of the same power) employed in a paddle steamer of the same type. (2) On account of the lightness of the turbine machinery, very graceful lines have been introduced into the "model" of the hull, both fore and aft, which otherwise could not have been used. (3) The small amount of room taken up by the turbine machinery. All the machinery is placed below the "main" deck, giving the space above otherwise occupied with engines to additional passenger accommodation. (4) The total absence of noise from the turbines when running. In fact it is stated that it is not possible to tell whether they are running

or not; by placing one's hand on them the only slight vibration discernible is right aft, and is due to the propellers. (5) The low centre of gravity of the turbine machinery has given good stability in the *King Edward* without either a "hard bilge or long floor," rendering this class of machinery conducive to high speeds. During the trials Rothesay was "made" as an experiment, and the vessel behaved splendidly, coming to easily and quickly—an important point in passenger excursion traffic, for which the steamer is intended. The *King Edward* is now on her run in Scotland, and is by far the fastest boat of her class.

WE have received from Messrs. Baker and Co., of Newark, U.S.A., an illustrated catalogue of platinum apparatus for use in large and small college chemical operations. The illustrations show a variety of useful contrivances for laboratory purposes, and the catalogue concludes with some valuable observations on the use and care of platinum, on the cleaning of platinum wire, and with some tables which will much assist in calculating the weight, and therefore the price, of platinum apparatus.

THE popular science lectures for young people, which have been given at the Kensington Town Hall during the autumn and winter, will be continued in October next. The aim is to interest juveniles in various aspects of scientific study and encourage them to view natural objects and phenomena in a sympathetic frame of mind. The subjects of lectures arranged for the autumn are secrets in sands, by Mr. C. Carus-Wilson; waves of sound and waves of light, by the Rev. J. O. Bevan; colour and colour photography, by Dr. A. H. Fison; flowers and their insect visitors, by Prof. J. B. Farmer, F.R.S.; and secrets in flint pebbles, by Mr. C. Carus-Wilson.

MR. EDWARD STANFORD has published a South Polar chart which will be of service in following the progress of the expeditions about to sail for Antarctic regions. The chart indicates, by contours and eight shades of blue, the ocean depths, so far as they are known, down to 5000 fathoms and below. Lines are also engraved on the chart to show the approximate limit of the pack ice during the southern summer months, the line of freezing-point in air in January and February, the northern limit of icebergs, and the tracks of the *Challenger*, *Valdivia* and *Belgica* expeditions. It is a little to be regretted that the proposed tracks of the expeditions about to start are not also included, so that the fields of operations of the German and British expeditions could be easily distinguished.

THE paper by Prof. S. P. Langley and Mr. F. W. Very, "On the Cheapest Form of Light," which appeared in the *American Journal of Science* in August, 1890, has been reprinted and published as No. 1258 of the Smithsonian Miscellaneous Collections, with a note pointing out some of the additions to our knowledge of the light from living and mineral sources during the last ten years. It will be remembered that the paper deals with the light of the fire-fly and shows that the insect produces light without heat, so that its efficiency as a light source is far higher than any artificial means of illumination. In connection with this subject, the luminous bacteria cultivated by Mr. J. E. Barnard and Prof. Allan Macfadyen, and shown at the last Royal Society conversazione (see p. 57) are of interest.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Crandon W. Gill; an Alpine Marmot (*Arctomys marmotta*), European, presented by Mrs. Curtis; a Rough-keeled Snake (*Dasypeltis scabra*), four Rhomb-marked Snakes (*Trimerorhinus rhombeatus*, four Rufescent Snakes (*Leptodira hotamboeia*), three Crossed Snakes (*Psammophis crucifer*), a Coppery Snake (*Prosymna sundevalli*), a Delalande's Lizard (*Nucras delalandii*) from South Africa, presented by Mr. A. W. Guthrie; two Pond Herons (*Ardeola grayi*), a Cattle Egret (*Bubulcus coromandus*), a White-bellied Drongo (*Dicrurus coerulescens*), a Common Hawk Cuckoo (*Hierococcyx varius*), two Baya Weaver-birds (*Ploceus baya*), two Scarlet-backed Flower-peckers (*Dicoeum cruentatum*), two Purple-rumped Sun-birds (*Arachnechthra zeylonica*), a Himalayan Black Bulbul (*Hypsipetes psaroides*) from British India, presented by Mr. E. W. Harper; two European Pond Tortoises (*Emys orbicularis*), European, presented by the Hon. Mrs. Fitzgerald; an Algerian Tortoise (*Testudo ibera*) from North Africa, three South Albemarle Tortoises (*Testudo vicina*), two Central Albemarle Tortoises (*Testudo*, sp. inc.) from the Galapagos, deposited; two Herring Gulls (*Larus argentatus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN AUGUST.

August 2. 2h. Mercury at greatest elongation, 19° 23′ West.
4. 14h. 39m. to 15h. 47m. Moon occults δ Piscium (mag. 4·6).
6. 12h. 16m. Minimum of Algol (β Persei).
9. 9h. 5m. Minimum of Algol (β Persei).
11. Maximum of Perseid meteoric display (radiant 45° + 57°).
13. Saturn. Outer minor axis of outer ring = 17″·94.
15. Venus. Illuminated portion of disc = 0·873, of Mars = 0·915.
15. 7h. 21m. to 10h. 26m. Transit of Jupiter's Sat. III. (Ganymede).
17. 6h. 12m. to 8h. 32m. Transit of Jupiter's Sat. IV. (Callisto).
25. 6h. Saturn in conjunction with the moon. Saturn 3° 42′ S.
28. 12h. 54m. to 13h. 59m. Moon occults ε′ Capricorni (mag. 5·2).
29. 12h. 29m. to 13h. 29m. Moon occults κ Aquarii (mag. 5·5).
29. 10h. 47. Minimum of Algol (β Persei).

THE PARIS OBSERVATORY IN 1900.—A Paris correspondent sends us the following note:—The annual report drawn up by M. Maurice Lœwy, director of the Paris Observatory, and adopted by the Observatory Council, has been sent to the National Printing Office for publication. The international mapping of stars not being in operation in three different parts of the southern hemisphere, M. Lœwy, president of the committee, has sent representations to these countries, through diplomatic agencies, with the result that work will soon begin in them. Mr. Thome, director of the National Observatory, Cordoba, has written to M. Lœwy that the Argentine Republic has authorised him to organise an astrophysical service. Mr. Cooke, director of the Perth Observatory in Southern Australia, has been notified by the Colonial Office that a special grant will be at his disposal for the future budget. M. Enrique Legrand, of the Uruguay Republic, has persuaded H.E. M. Cuertas to present a bill for the establishing of an astrophysical service in Montevideo. The work is progressing favourably in all the countries where it has been inaugurated.

M. Lœwy is investigating Prof. Turner's method of determining, from photographs, the positions of the celestial bodies with almost the same exactness as from direct observations in the sky. The report gives for the first time a complete list of the fifty-eight observatories which have taken part in the Eros international observations. According to the last news included in the report, January 6, no single night had passed, since the inauguration of this work, without at least one observatory having made at least one Eros observation. On favourable nights the number of observations exceeded one hundred. MM. Prosper Henry and Boinot took 104 series of photographs of the planet Eros from October 3 to January 6.

Six hundred and seventy stars at a distance of not more than one degree from the path followed by Eros were observed with the meridian circle. For the first time observations of stars were registered on the meridian with a special chronograph invented by the Abbé Verschaffel. Ten sheets, containing 16,500 stars, of the photographic catalogue of the heavens, have been published. Each of these sheets contains a zone of one degree in declination

and eight minutes in Right Ascension. Photogravures for the Lunar Atlas have been prepared for publication; they refer to the first and last quarter. On the occasion of the total eclipse of May 28, MM. Hamy and Bigourdan were sent to Spain and were favoured with splendid weather for their observations. M. Bigourdan continues his observations of nebulæ, and the work of his great catalogue is progressing favourably. M. Callandreau observed with the great equatorial of the western tower, and used a wire illuminated only by points in the field of his refractor; he appears to be satisfied with this method, which prevents the eye from being disturbed by too great a quantity of light when observing feeble stars.

M. Gaillot has worked at the theory of Saturn, using Le Verrier's formulæ, and has succeeded in showing that the discrepancies between the results of computation and observation should be attributed to the fact that a sufficient number of terms had not been taken into consideration.

A staff of six women observers, directed by Miss Dorothea Klumpke, has determined the position of 29,627 stars for the International Catalogue. This is the only department of the Observatory where ladies have been admitted. To the meteorological department a new registering barometer has been added; it is a mercury one, and the end of the index runs through 3 mm. for a variation of 1 mm. in mercury. The publication of the old observations from 1837 up to 1886 will be completed this year, and from 1886 on the observations will be published regularly each year. The observations of 1898 were published in 1900, and those of 1899 will appear shortly.

PHOTOGRAPHY BY THE LIGHT OF VENUS.—In the autumn of last year several meagre accounts appeared in various journals announcing that Dr. W. R. Brooks had succeeded in obtaining good photographic records solely by means of light from the planet Venus. In the *Century Magazine* for August (1901), Dr. Brooks has an article describing his experiences, illustrated by reproductions of the photographs obtained at the Smith Observatory. These are chiefly positives taken by placing a landscape or other negative in a printing frame with a sensitive plate and exposing to the light from the planet, care being taken to shield the frame from all extraneous light. The results described were obtained when the planet was a morning star, shortly after September 17, 1900. Gelatine dry plates (speed not stated) were used, the exposures given varying from thirty to forty-five minutes. A print on bromide paper was obtained by exposure on five consecutive clear mornings. The positives are all apparently well exposed, and a portrait is also shown as being produced by the planet's light, but by what procedure is not indicated.

NEW NEBULÆ.—In the *Comptes rendus* (cxxxiii. pp. 206-208), M. Bigourdan continues his catalogue of new nebulæ discovered with the west equatorial of the Paris Observatory. Particulars as to position, notes of special interest and comparisons with other catalogues are given for twenty-three objects observed between 1884 and 1898.

THE CRYSTALLISATION OF SALT SOLUTIONS.

ALTHOUGH the processes of crystallisation have been known to, and made use of by, chemists for ages, yet it is only within the last few years that the phenomenon of crystallisation from solution has been the subject of systematic investigation. The pioneer work in connection with this systematic study on the basis of modern principles has been done, for the most part, by Dutch chemists. The researches of Roozeboom on the equilibrium of systems in contact with water have shown clearly the importance of the phase rule of Willard Gibbs as a guide in the study of the complex phenomena of heterogeneous equilibrium. The study in van 't Hoff's laboratory of the conditions of existence of crystallohydrates and of the phenomena associated with the formation and decomposition of double salts in contact with water has given us invaluable material for a correct understanding of the processes of crystallisation. Not only is the systematic investigation of this phenomenon of importance to the chemist, but the geologist is also dependent on such knowledge for the final explanation of the conditions of formation of the vast oceanic salt deposits.

A knowledge of the composition of the solution in equilibrium with a system of solid substances is obviously an all important factor for the study of the processes of crystallisation, for the separation of any solid substance from the solution requires that the solution shall be saturated with regard to that substance. In what follows it is presumed that the crystallisation takes place so slowly that supersaturation phenomena can be neglected, and the complications resulting from crystallisation of isomorphous mixtures are also left out of account. Furthermore, we suppose that the temperature of the solution remains constant during the crystallisation.

The simplest conditions are then met with in the case of a solution containing a single substance, say a salt, which is not capable of combining with water of crystallisation. If an unsaturated solution of such a salt is evaporated, the commencement of crystallisation is conditioned solely at a given temperature by the attainment of a definite concentration. As evaporation proceeds the salt then separates out continuously, the composition of the solution undergoing no change until the last trace of water has been removed.

If the dissolved salt forms crystallohydrates, *i.e.* salts with water of crystallisation, then the products of isothermal evaporation are dependent upon the temperature, a less hydrated form separating as the temperature is higher. Thus solutions of manganese chloride yield the tetrahydrate if the temperature does not exceed 58° C., whereas at higher temperatures the dihydrate crystallises out. It is well known that salts containing water of crystallisation undergo at a definite temperature a change in which the whole or part of the water of crystallisation is split off. Glauber's salt loses its ten molecules of water at 32·4° C.; ordinary zinc sulphate containing seven molecules of water yields the hexahydrate at 39° C., and this again, at a higher temperature, yields a lower hydrate. These temperatures are known as the transition temperatures of the salt hydrates, and have a far-reaching analogy with the melting points of solid substances.

The limiting temperatures corresponding to the crystallisation of a definite hydrate from the salt solution are determined by the transition temperatures of the solid hydrates.

If supersaturation phenomena intervene we may observe the separation of hydrates from solution at temperatures below the normal limiting temperature. It is, however, only under this condition that crystallisation of such unstable hydrates takes place, for at a given temperature the unstable hydrates are more soluble than the stable hydrate. If the solution from which an unstable hydrate has begun to crystallise out be impregnated with the hydrate of smaller solubility, the unstable hydrate will redissolve and crystallisation of the normal hydrate ensues.

If a solution contains two dissolved salts having a common ion, the phenomena of crystallisation are about as simple as in the case of a solution containing a single salt. Let us suppose, in the first instance, that these salts do not unite to form a double salt, and that they do not form crystallohydrates. Such a solution is one containing the chlorides of sodium and potassium, and in this case a knowledge of the composition of the three solutions, saturated respectively with regard to each single salt and with regard to both simultaneously, enables us to predict what will take place on isothermal evaporation. A graphic representation of the solubility data facilitates the tracing of the crystallisation process very considerably, and the composition of the various solutions is conveniently expressed by the number of molecules of dissolved salt per 1000 molecules of water. Fig. 1 contains the data for the system consisting of water, potassium chloride and sodium chloride at 25° C., A representing the saturated solution of sodium chloride, B that of potassium chloride, and C the solution saturated with regard to both.

Along the curve A C we have solutions saturated with regard to sodium chloride in which the potassium chloride concentration gradually increases. Similarly, the points along the curve B C represent solutions containing increasing quantities of sodium chloride, all of which are saturated with reference to potassium chloride.

All points within the figure O A C B represent unsaturated solutions, the quantities of the dissolved salts being given by the lengths of the projections on the axes. If a solution corresponding to the point *c* is slowly evaporated at 25° C., the change in the composition of the solution will be represented by the continuation of the line O *c* (O corresponding to pure water). At the point *d*, where this line meets the curve B C, the solution becomes saturated with potassium chloride and the latter crystallises from solution. By the continued separation of potassium chloride the relative proportion of

sodium chloride in the solution increases, and the composition of the solution is represented successively by points on *d* C. At C sodium chloride begins to crystallise and the two chlorides are then deposited in the proportions determined by the position of C on the diagram until the evaporation is complete. The arrows indicate the course of crystallisation for any given solution.

The phenomena of crystallisation may be somewhat more complicated if the two salts in solution are capable of double salt formation. Whether the double salt crystallises out on evaporation depends essentially upon the temperature. For example, the evaporation of a solution containing the chlorides of calcium and magnesium yields a mixture of the simple salts below 22° C., whereas at a higher temperature the double salt, tachhydrite, $CaCl_2.2MgCl_2.12H_2O$, accompanied in general by one of the simple salts, crystallises out.

Let us consider the crystallisation of a solution containing the sulphates of magnesium and potassium at a temperature of 25° C., this lying between the limiting (transition) temperatures at which the double salt, schönite, $K_2SO_4.MgSO_4.6H_2O$, is formed and decomposed.

The solubility data which furnish us with fixed points by means of which the course of crystallisation is determined are in this case four, viz., the saturated solutions of (1) $MgSO_4.7H_2O$, (2) K_2SO_4, (3) schönite and $MgSO_4.7H_2O$, (4) schönite and K_2SO_4.

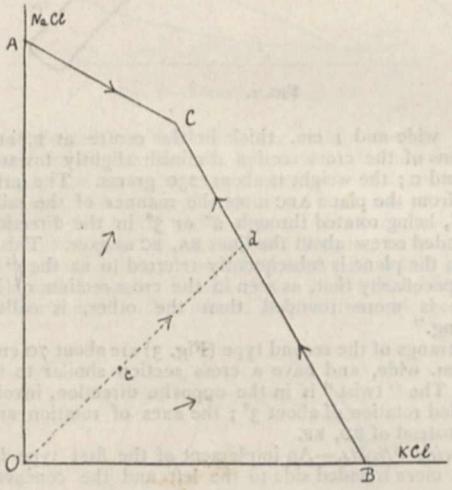


FIG. 1.

In Fig. 2, where potassium sulphate is measured off on the abscissa and magnesium sulphate on the ordinate, these solutions are represented respectively by the points A, B, C and D. The connecting curves have the same significance as in Fig. 1.

Suppose we slowly evaporate at 25° C. a solution the composition of which is given by the point *a*, which lies on the line bisecting the angle between the axes; this solution obviously contains equivalent quantities of potassium and magnesium sulphates. The index point representing successive conditions of the solution advances along the continuation of O *a* until the point *b* is reached, when the solution becomes saturated with potassium sulphate. As evaporation continues and crystallisation of potassium sulphate takes place we advance along *b* D until at the latter point the solution becomes saturated with regard to schönite. On further loss of water schönite crystallises out, and since the molecular concentration of magnesium sulphate in the solution is greater than that of potassium sulphate, the continued separation of the double salt increases the molecular ratio $MgSO_4 : K_2SO_4$ in the solution, corresponding to a movement of the index point along D C, the curve of saturation of the double salt. If the solution were agitated so as to bring the separated K_2SO_4 into intimate contact, some of the latter would again pass into the solution and reappear as schönite. At the point C the solution becomes saturated with regard to $MgSO_4.7H_2O$, and Epsom salts and schönite now crystallise out together until the solution completely disappears. The point C represents the crystallisation end point of all solutions containing magnesium and potassium sulphates, the final separation from all such solutions being a mixture of schönite and Epsom salts. The arrows in the figure show the course of the crystallisation for any solution.

If we now suppose that one of the two salts is capable of dehydrating the other when the solution becomes concentrated, the products of crystallisation which are first separated may undergo a series of successive transformations. If the two salts in solution do not unite to form a double salt, as in the case of magnesium sulphate and magnesium chloride, the

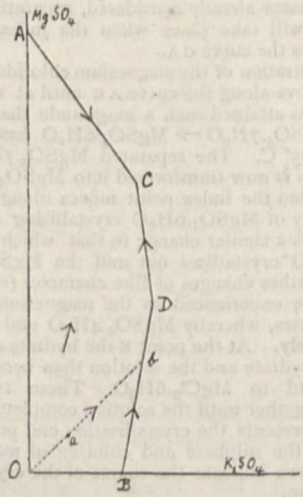


FIG. 2.

phenomenon to be discussed appears in its simplest form. It may be pointed out that the temperature at which any hydrate is transformed into a lower hydrate is lowered if foreign substances are added to the aqueous solution with which the two hydrates are in equilibrium at the transition temperature, just in the same manner as the melting point of a pure substance is lowered by foreign admixtures. Consequently we may expect, at one and the same temperature, higher or lower hydrates to crystallise out from a solution according as the mother liquor contains small or large quantities of other soluble substances.

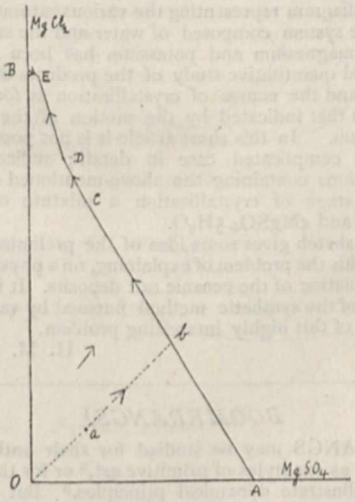


FIG. 3.

The application of these known facts to the crystallisation of a solution containing the sulphate and chloride of magnesium at 25° C. enables us to explain completely the successive changes observed.

Representing, as before, the composition of the saturated solutions of these salts on a system of coordinates, Fig. 3 is obtained. A and B represent the saturated solutions of

$MgSO_4.7H_2O$ and $MgCl_2.6H_2O$ respectively; the point E, which corresponds to the point C in Fig. 1, represents a solution saturated simultaneously with regard to $MgCl_2.6H_2O$ and the hydrate $4MgSO_4.5H_2O$. The broken curve joining A and E has reference to solutions which are saturated with one or other of the hydrates of magnesium sulphate, but not with magnesium chloride.

If a solution containing equivalent quantities of these two salts and represented by the point *a* is evaporated at 25° C., then, as in the cases already considered, separation of salt, viz. $MgSO_4.7H_2O$, will take place when the index point moving along O *a* reaches the curve C A.

As the concentration of the magnesium chloride in the solution increases, we move along the curve A C until at the point C this concentration has attained such a magnitude that the transition temperature $MgSO_4.7H_2O \rightarrow MgSO_4.6H_2O$ has been lowered from 47° C. to 25° C. The separated $MgSO_4.7H_2O$ in contact with the solution is now transformed into $MgSO_4.6H_2O$, and by further evaporation the index point moves along the curve C D, a further quantity of $MgSO_4.6H_2O$ crystallising out. At D the system undergoes a similar change to that which took place at C; $MgSO_4.5H_2O$ crystallises out and the $MgSO_4.6H_2O$ now disappears. Further changes of like character (not indicated in the diagram) are experienced as the magnesium chloride concentration increases, whereby $MgSO_4.4H_2O$ and $MgSO_4.2H_2O$ appear successively. At the point E the hydrate $4MgSO_4.5H_2O$ displaces the dihydrate and the solution then becomes saturated also with regard to $MgCl_2.6H_2O$. These two salts now crystallise out together until the solution completely disappears; the point E represents the crystallisation end point of all solutions containing the sulphate and chloride of magnesium. As before, the arrows indicate the course of the crystallisation for any given solution.

The above crystallisation phenomena may be regarded as typical for solutions containing two salts with a common ion.

The phenomena are much more complex if the solution contains four different ions, as in a solution of the chlorides and sulphates of magnesium and potassium. The four simple salts and their various hydrates, as well as several double salts, may in general crystallise out from such a solution. The course of crystallisation of the solution referred to has been carefully worked out by van 't Hoff, Meyerhoffer and their pupils. The phase rule serves as a safe and sure guiding principle; solubility determinations and measurements of the vapour pressures of solutions supply the data which, when graphically represented in a suitable manner, enable us to follow the various phases of the crystallisation process with almost the same ease as in the simpler cases. The diagram representing the various saturated solutions formed by the system composed of water and the sulphates and chlorides of magnesium and potassium has been tested by a qualitative and quantitative study of the products of isothermal evaporation, and the course of crystallisation is found to agree perfectly with that indicated by the motion of the index point on the diagram. In this short article it is not possible to treat of this more complicated case in detail; suffice it to say that all solutions containing the above-mentioned salts deposit in the last stage of crystallisation a mixture of carnallite, $MgCl_2.6H_2O$ and $4MgSO_4.5H_2O$.

The above sketch gives some idea of the preliminary work in connection with the problem of explaining, on a physico-chemical basis, the formation of the oceanic salt deposits. It indicates the initial stages of the synthetic method pursued by van 't Hoff in his treatment of this highly interesting problem.

H. M. DAWSON.

BOOMERANGS.[1]

BOOMERANGS may be studied for their anthropological interest as examples of primitive art,[2] or for the manner in which they illustrate dynamical principles.[3] But there is extraordinary fascination in making and throwing them, and in watching the remarkable and always graceful curves described in their flight; accordingly, my chief object in the following paper has been to diminish the practical difficulties of the subject by giving some of the results of ten years' experimental acquaintance with it.

The Australian weapons vary enormously in shape and size, while the skill of the natives in throwing them is great in some districts and very small in others. The marvellous flights that were described by former travellers are but rarely seen to-day, and although it is undeniable that many a native can make a boomerang go 80 metres away before returning to his feet, I know of only one trustworthy account of a much more sensational throw.[1] In this the boomerang described five circles in the air, travelling to a distance of about 90 metres from the thrower and rising to a height of 45 metres.

For present purposes it will be convenient to consider two types of implements. The first (Fig. 1) is about 80 cm. in length, measured along the curve, is bent (at B) almost to a right angle, and has the cross section shown in Fig. 2. It is about

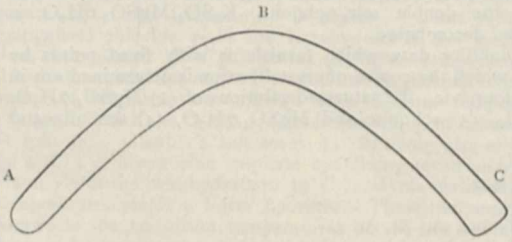


FIG. 1.

FIG. 2.

6·5 cm. wide and 1 cm. thick in the centre at B, and the dimensions of the cross section diminish slightly towards the ends A and C; the weight is about 230 grams. The arms are twisted from the plane ABC after the manner of the sails of a windmill, being rotated through 2° or 3° in the direction of a right-handed screw about the lines BA, BC as axes. This deviation from the plane is subsequently referred to as the "twist," and the peculiarity that, as seen in the cross section of Fig. 2, one face is more rounded than the other, is called the "rounding."

Boomerangs of the second type (Fig. 3) are about 70 cm. long and 7 cm. wide, and have a cross section similar to that of Fig. 2. The "twist" is in the opposite direction, involving a left-handed rotation of about 3°; the axes of rotation are now DE, FE instead of ED, EF.

Returning Flights.—An implement of the first type is held with the more rounded side to the left and the concave edge

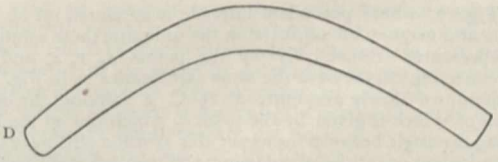


FIG. 3.

forwards. It is thrown, with plane vertical, in a horizontal direction and as much rotation as possible is given to it. The plane of rotation does not remain parallel to its original direction, but has an angular velocity (1) about the direction of translation, and (2) about a line in its plane perpendicular to this.

The effect of (2) is that the path curls to the left; while owing to (1) the plane of rotation inclines over to the right (*i.e.* rotates in the direction of the hands of a clock facing the thrower) and its inclination to the vertical becomes comparable with 30° in two seconds. The angular velocity (2) will now imply that the path bends upwards as well as horizontally round to the left.

When the boomerang has described a nearly complete circle its pace has diminished, and it falls to the ground near the thrower. (See Figs. 4, 5, in which projections on a horizontal and on a vertical plane are given; the direction of the axis of rotation is indicated by giving the projections of a line of

[1] This paper is here published by permission of the editors of the *Physikalische Zeitschrift*, for which it was originally written. A German translation has appeared in that journal, and from its publishers the accompanying illustrations have been obtained.

[2] "The Native Tribes of Central Australia," by B. Spencer and F. J. Gillen (1899), Ch. xix.

[3] E. O. Erdmann, *Ann. d. Phys. u. Chemie.*, vol. cxxxvii. p. 1 (1869); E. Gerlach, *Zeitschr. d. D. Vereins z. Förd. d. Luftschifffahrt*, Heft 3 (1886); G. T. Walker, London *Phil. Trans.*, vol. cxc. p. 23 (1897).

[1] Mr. A. W. Howitt, NATURE, July 20, 1876.

constant length measured along it. The scale of these diagrams is about 1:1000).

The angular velocity (1) is increased by an increase of twist and by an increase of rounding; it also increases when cos θ increases, where θ is the inclination of the plane of rotation to the horizontal. The curling to the left (2) is increased by an increase of twist, or of cos θ, and, in general, by an increase of rounding.

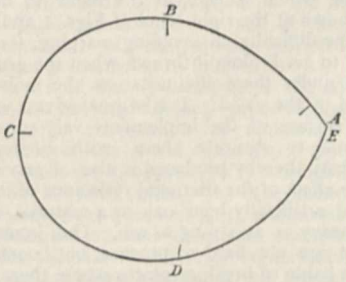


FIG. 4.—Plan.

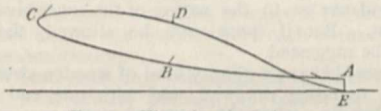


FIG. 5.—Elevation through C A.

If it be desired that the boomerang should describe a second circle in front of the thrower (Figs. 6, 7), it must be thrown much harder, so that when one circle has been described it may still have sufficient forward velocity. When the projectile has described the first circle and is over the thrower's head, the axis of rotation must point in an upward direction in front of him; if it pointed behind him the subsequent path would be behind his back, and a figure of eight (Figs. 8, 9) would become possible. For a path with a second loop in front of the thrower

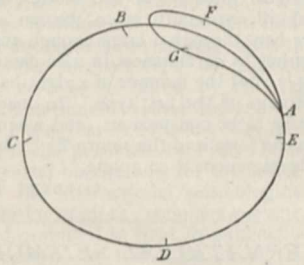


FIG. 6.—Plan.

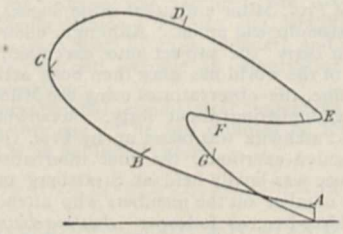


FIG. 7.—Elevation through C E.

he should accordingly choose a boomerang with much twist and much rounding, and throw it with his body leaning over to the left, so that the angle θ between the axis of rotation and the vertical may be slightly in excess of a right angle. The increased twist will mean that the first circle has a smaller circumference and that there will be more pace left after it has been described; and the increased rounding will keep the plane of rotation from becoming horizontal too soon.

For a figure of eight we should require less rounding, or we might give more spin in throwing, and aim a little uphill with θ rather less than a right angle. There are so many elements capable of variation that nothing but experience can teach how to get the best results with any particular boomerang.

The most complex path that the author has succeeded in

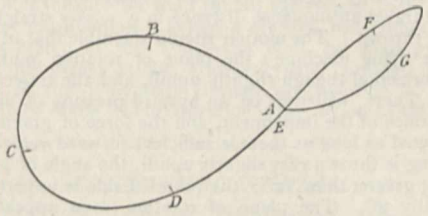


FIG. 8.—Plan.

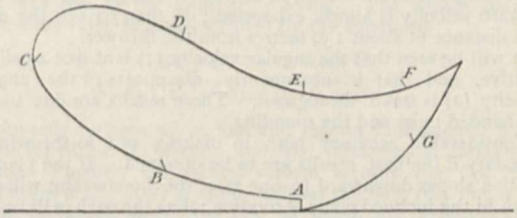


FIG. 9.—Elevation through C A G.

effecting is that of Figs. 10 and 11. But it is certain that these fall far short of what is done by skilful natives of Australia.

If the angle between the arms is increased and the twist and rounding unaltered, the angular velocity (1) is increased, and it becomes easier to make a second loop behind than in front. If the angle exceeds 150°, the angular velocity of the first kind is so large that it is very hard to get a return at all.

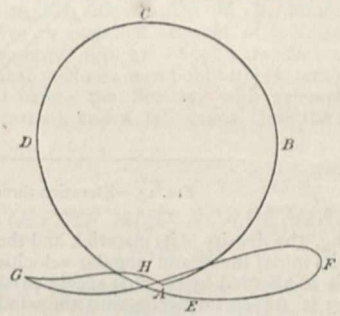


FIG. 10.—Plan.

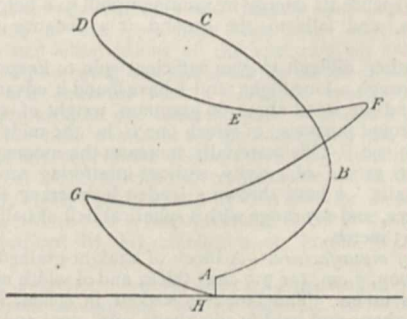


FIG. 11.—Elevation through G F.

When the twist is left-handed and the angle large we have a specimen of the second type (Fig. 3), and it must be thrown with the more rounded side uppermost and the plane of rotation inclined at between 30° and 60° to the horizontal (*i.e.* $30° < \theta < 60°$); the angle of projection (*i.e.* inclination to

the horizon of the initial velocity of translation) must be comparable with 45°.

The uphill path is nearly straight until the forward velocity becomes small; the projectile then returns along a track close to that of the ascent (Figs. 12 and 13).

Non-returning flights.—A good boomerang of the second type will travel an immense distance in a nearly straight line if properly thrown. The motion should resemble that of an aëroplane or flying machine; the plane of rotation must remain nearly horizontal though slightly uphill, and the trajectory must be flat. There will thus be an upward pressure of air on the under surface of the implement, and the force of gravity will be counteracted as long as there is sufficient forward velocity. The boomerang is thrown very slightly uphill, the angle of projection not being greater than 12°; the rounded side is uppermost and θ is initially 30°. The plane of rotation soon appears to the thrower to become approximately horizontal, and it remains so during the flight; the projectile rises to a height of about 12m. from the ground and travels in a nearly straight path until its forward velocity is almost exhausted; it then strikes the earth at a distance of about 130 metres from the thrower.

It will be seen that the angular velocity (1) is at first small and positive, and that it subsequently disappears; the angular velocity (2) is small throughout. These results are due to the left-handed twist and the rounding.

Considerable accuracy both in making and in throwing is necessary if the best results are to be obtained. If the plane of rotation slopes downward to one side, the boomerang will slide down in the inclined plane of rotation; thus the path will be bent and materially shortened. The correct relation has to be found between the twist, the rounding, the angle between the arms of

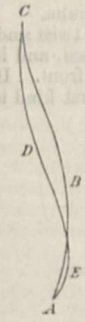


FIG. 12.—Plan.

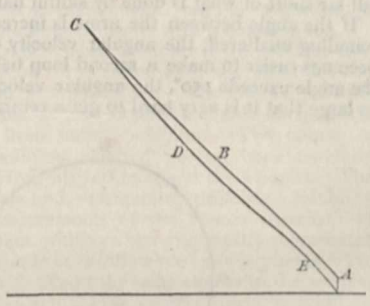


FIG. 13.—Elevation through A C.

the boomerang, the density of its material, and the amounts and directions of its initial linear and angular velocities. An illustration of this is afforded by the first specimen of this type that I have made; it travels further against the wind than with it. In the former case the boomerang keeps quite low, scarcely rising higher than 6 metres, and, being retarded very little by frictional resistance, travels about 125 metres; in the latter case the body spends its energy in running uphill to a height of about 15 metres, and falls to the ground at a distance of about 90 metres.

It is rather difficult to give sufficient spin to keep the motion stable through a long flight, and I have found it advantageous to wind round the wood about 60 grammes weight of copper wire in three equal portions, of which one is in the middle and one near each end. This materially increases the moment of inertia about the centre of gravity without interfering seriously with other details. I have thrown a loaded boomerang of this type 167 metres, and my range with a spherical ball of half the weight is only 63 metres.

Mode of manufacture.—A block of straight-grained ash about 90 cm. long, 7 cm. (or 7·5 cm.) thick, and of width not less than 7 cm. is taken. The block is soaked in steam, bent to the requisite shape and held in this shape until cool and dry. It is then sawn into strips 1·3 cm. thick. After sufficient time has lapsed for the wood to be seasoned, each strip is trimmed into a boomerang, the most useful tool in general being a spokeshave. It is very important that the outer edge, at any rate in the neighbourhood of the bend, should follow the grain of the wood. When the projectile falls hard upon one end the stress near the centre is very severe, and any point at which the direction of the grain meets the convex edge obliquely is likely to develop a split and ultimately a breakage.

It is better to cut the material to its final twisted shape rather than to impart the twist by another steaming and bending. Considerable care is required in the process, for the removal of a layer of wood a millimetre thick in such a way as to increase or diminish the twist will cause a marked difference in the flight. It will be found to facilitate throwing to cut that end of the boomerang which is held in the hand to the somewhat square form shown at the right hand of Figs. 1 and 3.

There is some difficulty in avoiding warping, for boomerangs are less likely to get broken if thrown when the ground is damp and soft, and under these circumstances the moisture is likely to be absorbed by the wood. It is of great advantage, therefore, to make the surface of the implements very smooth with fine glass-paper and to saturate them with linseed oil. The additional density thereby produced is also of service in that it diminishes the effect of the frictional resistance of the air.

I have used artificially bent oak as a material, but have not found it as heavy or as strong as ash. Oak branches that are naturally bent are not hard to procure, but boomerangs made from them are liable to break at places where there are knots or irregularities in the grain of the wood.

Evolution.—Boomerangs of every variety of shape are still to be found in Australia, and it appears impossible to get direct historical evidence as to the nature of the successive stages of development. But if speculation be allowed, the following series may be suggested.

First we should have a clumsy kind of wooden sword, curved, but without rounding or twist, and with one end roughened to form a handle; when the intended victim was out of reach it would be natural to throw the weapon, and at short ranges it would be extremely effective. Bad workmanship would involve the frequent production of implements of which one side was more rounded than the other, and it would soon be found that these missiles, when thrown with the rounded side uppermost, travelled much further and straighter than the former.

Boomerangs of this character vary in length from 50 to 110 cm., and in weight from 200 grammes to 1250. They are, for the most part, twisted in a manner that seems quite fortuitous, and form the enormous majority of the present native implements. Light specimens with a slight left-handed twist may have a fairly straight trajectory of 100 metres, and may return if aimed much uphill, especially when thrown against a wind. Those which are bent through a large enough angle and happen to be twisted (either by carelessness in manufacture or by subsequent warping [1]) after the manner of a right-handed screw are returning boomerangs of the first type. In many of these the twist is so large as to be conspicuous, and when once the connection between the form and the return flight has been noticed, the process of development is complete.

GILBERT T. WALKER.

THE INTERNATIONAL SEISMOLOGICAL CONFERENCE AT STRASSBURG.

IN 1895 the late Dr. Rebeur-Paschwitz proposed, with the approval of Prof. Milne and other seismologists, to form an international seismological union. Although, unfortunately, he did not live to carry the project into execution, the microseismic survey of the world has since then been actively pushed on by Prof. Milne, the observatories using the Milne horizontal pendulums now numbering about forty. Meanwhile, the project of Rebeur-Paschwitz was taken up by Prof. Gerland, and, thanks to his active exertions, the first international seismological conference was finally held at Strassburg on April 11–13. The total number of the members who attended the conference was thirty-five, as follows:—*Austria-Hungary* (Prof. Belar, Prof. Exner, Prof. von Kövesligethy, Hofrath Konkoly, Prof. Láska, Prof. Schafarzik); *Belgium* (Prof. Langrange); *Denmark* (Lieutenant-Colonel Harboe); *Germany* (Dr. Ebell, Dr. Ehrismann, Prof. Futterer, Prof. Gerland, Prof. Günther, Dr. Hecker, Prof. Helmert, Herr Jaehnike, Prof. Kobold, Geheimrath Lewald, Prof. Leutz, Prof. Rudolph, Dr. Polis, Prof. Schmidt, Dr. Schütt, Prof. Straubel, Dr. Tetens, Prof. Wagner, Prof. Weigand, Prof. Wiechert); *Italy* (Dr. Oddone); *Japan*

[1] This may be illustrated by the fact that when the author first made boomerangs he was only aware of the need for rounding; but the first two specimens that he constructed happened to have right-handed twist and returned admirably.

(Dr. Omori); *Russia* (General Pomerantzeff, Prof. Lewitzky, Dr. Wosnesjenskij); *Switzerland* (Prof. Forel, Prof. Riggenbach). Among these thirty-five members there were sixteen official delegates for the different States, as follows:—*Austria-Hungary*, 1; *Belgium*, 1; *Germany*, 9; *Japan*, 1; *Russia*, 2; *Switzerland*, 2.

The principal object of the conference was the establishment of an international seismological union. After some discussion the *projet* of statutes of an "International Seismological Association," formed principally in imitation of the statutes of the International Catalogue Association and of the International Geodetic Association, was unanimously accepted by the conference, the chief points being as follows:—

§ 1. The object of the Association is the advancement of knowledge of all the seismological problems, which can be solved only by the cooperation of numerous seismological observatories all over the world. As the principal means of attaining this object are proposed:—(1) seismological observations according to fixed plans; (2) experiments on certain important seismological questions; (3) establishment and support of seismological stations in certain countries which need assistance from the Association; (4) organisation of a central bureau for collection and discussion of the reports from various countries.

§ 3. The parts of the Association are:—(1) general meeting; (2) permanent commission; (3) central bureau.

§ 5. The permanent commission consists of the director of the central bureau and of one member from each of the States which compose the Association. . . .

§ 8. Each State must duly communicate to the central bureau, through its local central bureau, the results of seismic observations and experiments.

§ 9. Each State must contribute to the central bureau a certain yearly sum of money, to be fixed in proportion to the number of the inhabitants. The sum thus contributed by the different States is to be appropriated to the following purposes:—(1) publications and administration; (2) remuneration to the general secretary; (3) support of those who work in special important seismological investigations; (4) support of those seismological observatories which are established by the Association. The distribution of the sum into these various items is to be decided by the permanent commission.

As to the seismological observations, experiments and publications in the different States, the latter have a perfect freedom. The choice of the instruments is also left free to each State. The statutes of the Association having been thus adopted by the conference, the further steps for the formation of the Association are now to be taken by the Imperial German Government through diplomatic channels.

As there is still one year or so before the Association can be actually formed, it was proposed by Prof. Helmert to establish a provisionary central bureau and let the latter begin at once the function for the international seismological investigation, under the cooperation of all the members present, who approved the proposal and promised to send in publications and reports. Prof. Forel proposed, in the name of all the non-German members to select the Strassburg Seismological Observatory as the provisionary central bureau, under the direction of Prof. Gerland. This proposal was accepted, the Association being thus provisionally formed. Besides the establishment of the statutes, there were given by Prof. Helmert and others a series of valuable reports and lectures on observational as well as theoretical seismology.

The first international seismological conference proved to be a very satisfactory one. The full minutes of the transactions are expected to be published shortly. F. OMORI.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. R. T. HEWLETT, of the Jenner Institute of Preventive Medicine, has been appointed professor of general pathology and bacteriology at King's College, London.

THE following candidates have passed the D.Sc. examination of the University of London:—Mathematics and Physics, J. Buchanan; Experimental Physics, C. V. Drysdale, W. H. Eccles, P. E. Shaw; Chemistry, T. J. Baker, T. A. Henry, W. H. Hurtley, G. D. Lander, H. R. Le Sueur, S. Smiles.

THE following regulation from the new Calendar of the Imperial University at Kyoto show that the Japanese are encouraging scientific research among University students:—"In June and December every year each student shall report to the director of the College, through his professor, the state and progress of research which he has made in his study of special subject; and the director shall submit such report to the Faculty meeting for examination. When a student has completed the work of research at the University Hall, he shall prepare a record of his career at the University and present it to the president of the University, through his professor." Progress is bound to be made where education is carried on in this spirit.

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, July.—Surfaces whose first and second fundamental forms are the second and first respectively of another surface, by Dr. Eisenhart, was read at the February meeting. The results arrived at are—the ruled surfaces, defined by the equations

$$y+\mu x=\sqrt{1+\mu^2}+C_1\mu+C_1$$
$$z-ix\sqrt{1+\mu^2}=\mu+C_1\sqrt{1+\mu^2}+C_2,$$

are the only surfaces whose first and second fundamental forms can be taken for the second and first fundamental forms of a surface. Further, the second surface is only the first to a translation *près*. And of these surfaces the only real one is the sphere of radius unity—the C's, as usual, are arbitrary constants. References are given to work by Bianchi, Casorati, Monge and Forsyth.—On the groups generated by two operators, by Dr. G. A. Miller, was read at the April meeting. This short note, which gives several references, discusses the theorem, "every group that is generated by two operators of order two is a dihedral rotation group, and every dihedral rotation group is generated by two operators of order two."—Mr. G. Peirce gives a curious approximate construction for π, read at the same meeting. This is as neat a construction as we can remember.—Non-Euclidean geometry is a short notice, by J. L. Coolidge, of a work with this title by Dr. H. P. Manning.—J. K. Whittemore gives an extended abstract of "Vorlesungen über Differential geometrie" (pp. xvi+659), a translation of Bianchi's work by M. Lukat.—Notes, new publications, tenth annual list of papers (read before the Society, with references to their places of publication), and a full index close the number and the volume.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 20.—"Further Observations on Nova Persei. No. 3." By Sir Norman Lockyer, K.C.B., F.R.S.

In a former paper an account was given of the observations of the Nova, made at Kensington between March 5 and March 25 inclusive. The observations are now brought up to midnight of May 7. Between March 25 and the latter date, estimates of the magnitude of the Nova have been made on thirty-three evenings, visual observations of the spectrum on twenty-five evenings, and photographs of the spectrum on six evenings.

The 10-inch refractor with a McClean spectroscope has generally been used for eye observations. The 6-inch prismatic camera has not been available for photographing the spectrum owing to the faintness of the Nova, but photographs have been secured by Dr. Lockyer with the 30-inch reflector on the nights of March 27, April 1 and 12, and by Mr. Fowler on March 26 and April 4. With the 9-inch prismatic reflector the spectrum was photographed by Mr. Hodgson on March 30, April 1 and 4.

Change of Brightness.—Since March 25 the magnitude of the Nova has been undergoing further periodic variations, and although observations have not been made on every night since that date, owing to unfavourable weather, yet sufficient data have been gathered to enable a general idea of the light changes to be obtained, and the few gaps can be filled up later by other observers who experienced clearer skies on these occasions.

A table is given containing observations for magnitude made from March 26 to May 5 inclusive.

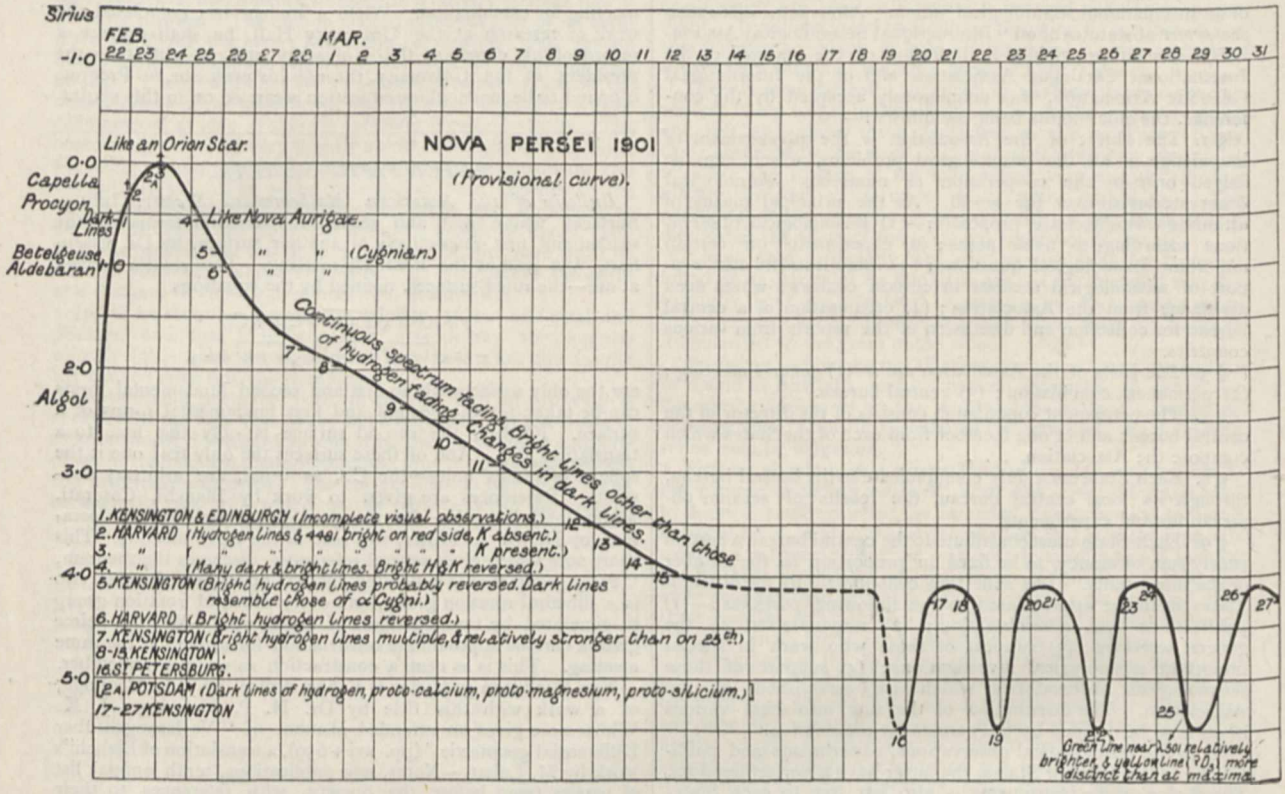
The observations show that the length of the period of variability, reckoning from maximum to maximum, began after March 27 to increase from *three* days to *four* days.

The two following maxima, after that of April 8, occurred on the 13th and 18th, so that the period became still more lengthened, namely to about *five* days. Further observations up to May 5 seem to indicate that the five-day period is shortening.

Another interesting observed fact was that the light of the Nova at the minimum on the 25th was more intense than at the preceding minimum on the 21st, the estimated difference of magnitude at these times being about 4-tenths of a magnitude.

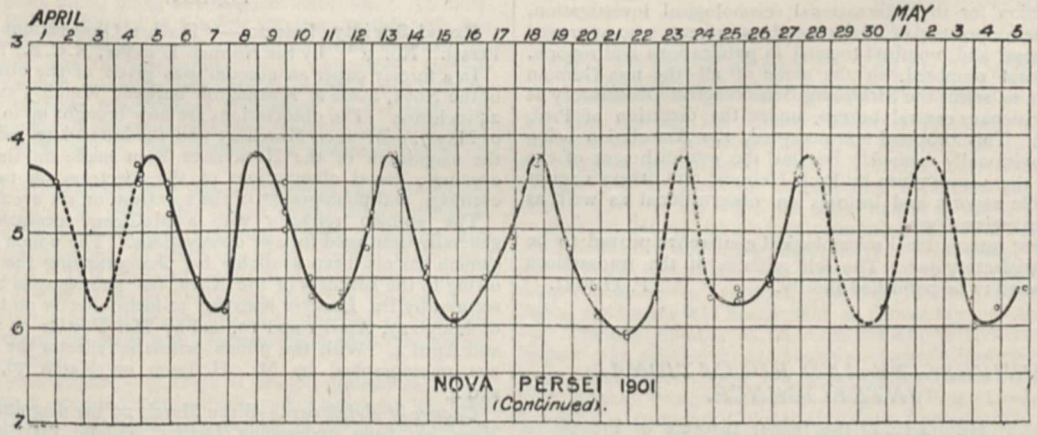
The curve is drawn to satisfy as far as possible all the observations made at Kensington. The dotted portions represent the possible light-curve for those times when no estimates for magnitude could be secured.

In the plates the abscissæ represent the time element and the ordinates that of magnitude.



Colour.—In the first part of the period covered by the later observations, the colour of the Nova has been generally described as yellowish-red, red with a yellow tinge and yellow with a reddish tinge. Since April 25 the colour has been perhaps more red than formerly and sometimes noted as very red.

It is interesting to remark that the colour varies periodically with the change in magnitude. At maximum it is of a distinct yellowish-red hue, but at or near minimum the yellowish tinge disappears and the Nova appears very red.



Unfortunately the increasing twilight and the unfavourable position of the Nova make it very difficult now to determine the magnitudes correctly.

The two plates accompanying this paper illustrate graphically the various fluctuations of the light of the Nova from February 22, when it had not quite attained its maximum brilliancy, to May 5.

The Visual Spectrum.—In the continued observations the C and F lines of hydrogen have always been recorded as "conspicuous," other prominent lines being near λ 447, λ 465 and λ 501 (the last named being sometimes as bright as F or even

brighter), and a line in the yellow which recent measures show to be D_3.

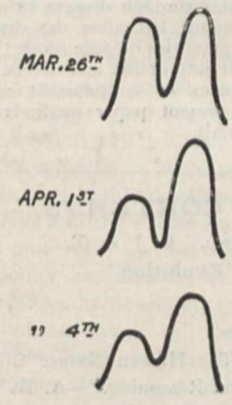
The strong lines in the green at λλ 4924, 5019, 5169 and 5317, which occurred in the earlier photographs and which were ascribed to iron, are either absent from the later photographs or appear only as very weak lines.

It has been noted that the lines 447, 501 and D_3 appear to vary with the magnitude of the star, becoming relatively more prominent towards a minimum.

The continuous spectrum has been described throughout as "weak" or "very weak."

On the evening of April 25 Messrs. Fowler and Butler made comparisons of the Nova spectrum with the spectra of hydrogen, helium, and that furnished by an air spark between poles of iron and zinc. For this purpose a Hilger two-prism star spectroscope was used with the 10-inch refractor. The hydrogen line F and the helium line D_3 were found to be sensibly coincident with Nova lines. The middle of the strong green line, previously mentioned as λ 501, practically coincided with the nitrogen line 5005·7, and therefore there is little doubt that it is identical with the chief nebular line λ 5007·6. This line was also compared with the asterium line at λ 5015·7, but was found to be decidedly non-coincident with it, though of sufficient breadth to nearly reach it.

Photographic Spectrum.—In so far as the number and positions of the lines are concerned, the few photographs available for discussion were obtained in the early part of the period dealt with in the present paper (March 26 to May 7), and show a



LIGHT CURVE OF H_β
(30-inch reflector).

spectrum very similar to that of March 25, which was described in detail in the last paper. The chief lines shown in the photographs are Hβ, Hγ, Hδ, Hε and Hζ, together with 4471 and 4650.

Characteristics of Hβ.—In continuation of the series of light curves of Hβ reproduced in the last paper, I give those plotted by Mr. Baxandall from the later photographs.

It will be seen that the line Hβ still shows two maxima of intensity. As recorded in the previous paper, the less refrangible component gave indications of becoming brighter than the more refrangible member. These further photographs indicate that by April 4 the less refrangible had become twice as intense.

"Total Eclipse of the Sun, May 28, 1900.—Account of the Observations made by the Solar Physics Observatory Eclipse Expedition and the Officers and Men of H.M.S. *Theseus* at Santa Pola, Spain." By Sir Norman Lockyer, K.C.B., F.R.S.

The Report gives details as to the erection of coronagraphs, prismatic cameras and other instruments, and of the results obtained by their use during the eclipse, which was observed under very favourable circumstances. Some of the more obvious results have already been stated in a Preliminary Report (*Roy. Soc. Proc.*, vol. lxvii. p. 341), and the following remarks may now be added.

A comparison of the photographs taken with the coronagraph of 16 feet focus with those taken about two hours earlier in America indicates that while some of the prominences changed greatly in appearance in the interval, no changes were detected in the details of the corona.

The spectrum of the chromosphere, as photographed with the prismatic cameras, so greatly resembles that of 1898 that it has not been considered necessary to make a complete reduction of wave-lengths. The prominences visible during totality had comparatively simple spectra, the greatest number of lines recorded being thirty-six.

The heights above the photosphere to which many of the vapours can be traced in the photographs are tabulated and compared with the results obtained in 1898; the two sets of figures are sufficiently accordant, except in the case of the shorter arcs, the value 475 miles derived for the lowest measurable vapours in 1898 being represented in 1900 by two strata, one reaching to 700 miles and the other to 270 miles above the photosphere.

The bright-line spectrum of the corona was decidedly less bright than in 1898, and a much smaller number of rings is seen in the photographs. The three brightest rings are at wave-lengths 5303·7, 4231·3 and 3987·0, and it may be noted that these were also the brightest in the eclipses of 1893, 1896 and 1898. The conclusion that the different rings do not originate in the same gas, arrived at from a discussion of the photographs of 1898, has been confirmed.

A drawing is given to illustrate the fact that while the details of the green coronal ring are seen in the inner corona, they have no apparent relation to the positions of the great streamers or prominences. For an investigation of this nature the photographs taken with the prismatic camera of 20 feet focal length are specially valuable.

"On the Mathematical Theory of Errors of Judgment, with Special Reference to the Personal Equation." By Karl Pearson, F.R.S.

EDINBURGH.

Royal Society, July 1.—Prof. Chrystal in the chair.—Dr. Thomas Muir communicated a note on a proposition given by Jacobi in his *De Determinantibus functionalibus*, pointing out that the theorem in question was not so general as might at first reading seem to be implied.—Dr. R. H. Traquair read a paper on the distribution of fossil fishes in the Carboniferous rocks of the Edinburgh district. From a complete classification of the known forms, eighty-four in all, it was shown that the same genera and species were found in all the estuarine deposits, even though these were separated by marine limestones which contained a totally distinct set of fossil remains. There was no evidence of life zones. The forms were persistent and no evolutionary change could be detected. After the Millstone Grit there was no further appearance of the characteristic estuarine forms.—Dr. J. Beard, in a paper on the determination of sex in animal development, argued that the sex of the animal into which a given ovum developed was determined from the very beginning before the act of fertilisation. The argument was supported by an array of facts in embryology, such as the two kinds of oocytes which had been observed in certain animals.

July 15.—The Rev. Prof. Flint in the chair.—The chairman made a suitable reference to the sad loss which the Society and the wider world of science had suffered in the recent death of Prof. Tait, who had been their general secretary for more than twenty years.—The following prizes were then presented: the Gunning Victoria Jubilee prize to Dr. T. D. Anderson for his discoveries of new and variable stars; the Keith prize to Dr. James Burgess, C.I.E., for his paper on the definite integral $\sqrt{\frac{2}{\pi}}\int_0^t \epsilon^{-t^2} dt$ with extended tables of values; and the Makdougall-Brisbane prize to Dr. R. H. Traquair for his report on fossil fishes collected by the Geological Survey in the Upper Silurian rocks of Scotland.—Mr. C. Tweedie communicated a paper on the general form of the involutive one-one quadric transformation in a plane.—In a supplementary report on the fossil fishes from the Silurian rocks of the south of Scotland, Dr. Traquair announced some new anatomical features which he had discovered in these fish remains. Thus in some specimens of Cœlolepidæ, two dark spots were found probably representing the position of the eyes; and in one specimen of *Lasanius problematicus*, vertical angulated lines were seen which might very reasonably be regarded as the remains of body muscle. Nearly perfect specimens of *Ateleaspis tesselata* show this remarkable genus to have close affinity to *Cephalaspis*, having two orbits on the top of the head, a small dorsal fin, and a

heterocercal non-bilobate caudal. The cephalic shield is, however, still without cornua.—Mr. Thomas Heath exhibited the photographs of the corona which he had taken during the total eclipse of May 28, 1900. The character of the corona was well marked in all; but from comparison with drawings taken by skilled draughtsmen it appeared that the outlying parts of the corona were not shown in the photographs. This might be due to the brightness of the sky consequent on the eclipse being one of short duration, or to the possible lack of actinic rays in these outlying regions.—Drs. D. Hepburn and D. Waterston read a paper on the true shape, relation and structure of the alimentary viscera of the common porpoise as displayed by the formal method. The animal on which the observations were made was an adult male, captured in fishing nets nearly eight months ago. It was carefully preserved within twenty-four hours of its capture, so that the organs retained their natural shapes and positions, while the various tissues were suitably "fixed" for microscopic examination. The authors have established, among other novel results, the presence of a peritoneal pelvic cavity which was not formerly recorded and which, from its relations to the vertebral column, provides a key to the subdivision of that part formerly called lumbosacral into lumbar and sacral sections. They have also revised the homologies of the multi-chambered stomach and placed them upon a more accurate footing; and similarly as regards the duodenum and intestine. The microscopic structure of the alimentary viscera was likewise examined under favourable conditions. The authors also report the presence of the tape-worm, *Bothriocephalus latus*, not hitherto recorded for marine animals.—Dr. A. T. Masterman communicated a paper on the central plexus of *Cephalodiscus dodecalophus*, M'I.

PARIS.

Academy of Sciences, July 22.—M. Fouqué in the chair.—The president announced to the Academy the death of M. de Lacaze-Duthiers, member of the section of zoology.—Remarks by M. Boussinesq on his work on the analytical theory of heat.—On the acidity of certain animal secretions, by M. Berthelot. In this study of acidity five indicators were employed—methyl orange, dimethylamidoazobenzene, red alizarine-sulphonate, litmus and phenolphthalein. Comparative determinations with these indicators were made of the acidity of the gastric juice, saliva and of urine.—Some observations made with uranium at very low temperatures, by M. Henri Becquerel. It was shown four years ago that between $+100°$ and $-20°$ C. there was no notable variation in the radiation from uranium, and in the present communication the intensity of this radiation is found to be practically constant at temperatures down to that of boiling liquid oxygen.—On the law of pressures in cannon, by M. E. Vallier.—New nebulæ discovered at the Observatory of Paris, by M. G. Bigourdan. Details of the positions and appearance of twenty-three new nebulæ.—On the Hermitian, by M. Léon Autonne. The name "Hermitian" is suggested instead of the "definite form" of Lœwy, and the properties of these functions are summarised.—On an application of potential functions to the theory of elasticity, by MM. Eugène and Francois Cosserat.—On the dielectric cohesion of gases; the influence of the walls, by M. E. Bouty. An experimental study of the disturbances produced by the walls of the vessel containing the gas under examination shows that the critical phenomenon, that is the point at which the discharge commences to take place, is altogether independent of the material of the walls. The action of the latter is indirect, in so far as it modifies in a more or less irregular manner the field in which the gaseous mass stands.—Gratings obtained by the photography of rigorously achromatic fringes, by M. G. Meslin.—On the nature of the X-rays, by M. Jules Semenov. From the experiments described the author concludes that the X-rays represent directions of transmission, by means of the ether, of electrical vibrations. These vibrations communicate themselves to all bodies which they meet in their course. When these bodies are charged with electricity and are protected against discharge by convection, they lose their charge by radiation.—The action of hypophosphorous acid upon acetone, by M. C. Marie. By the interaction of acetone and hypophosphorous acid two new crystallisable acids are obtained, the constitution of which is not yet determined.—The preparation of pure oxide of cerium, by M. Jean Stebba. By the use of electrolysis as a means of oxidation, the method of Wyrouboff and Verneuil is rendered more rapid. The oxide of cerium thus purified from other metals may have a distinct colour, but becomes snow white on completely eliminating the last traces of nitrogen.—The thermal study of the solid hydrates of soda, by M. de Forcrand.—The action of copper hydrate upon solutions of metallic salts, by M. A. Mailhe. With solutions of several metallic chlorides and bromides, copper hydrate gives a mixed basic salt.—The action of silver upon hydrobromic acid and the inverse reaction, by M. Jouniaux. The results obtained were generally parallel with those previously obtained with hydrochloric acid and silver, the value for the heat of reaction calculated from the equilibrium pressures at various temperatures being in practical agreement with the direct determinations of Berthelot.—The oxidation of propylglycol by *Mycoderma aceti*, by M. Andre Kling. The oxidising action of *Mycoderma aceti* upon propylglycol resembles that of the sorbose bacterium, the acetol, $CH_3.CO.CH_2OH$, being produced in both cases.—The action of the pyridine bases upon the tetrahalogen derivatives of benzoquinones, by M. Henri Imbert.—On the chlorides and bromides of the supposed binaphthylene-glycol, by M. R. Fosse.—The action of gaseous ammonia upon the chlorhydrates of fatty amines, by M. Felix Bidet.—On some new vegetable species of Madagascar, by M. E. Drake del Castillo.—Histological researches upon the sporulation of the Schizosaccharomycetes, by M. A. Guilliermond.—On the intracellular diastases of the Amœba, by M. H. Mouton.—Light from the phosphorescent bacilli of the Baltic, by M. J. Tarchanoff.—Electrical stimulation produced by two waves inverse to each other, by M. Georges Weiss.—On the yield of bread from flour, by M. Balland.—The utilisation of wine residues and wines useless through disease as manure, by M. F. Garrigou. The residues left after the distillation of wine, together with large quantities of wine spoilt through disease, are at present discharged into drains and rivers. In this way vast amounts of substances of considerable manurial value are wasted, and in the present paper methods are suggested for utilising these materials.

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