THURSDAY, JULY 5, 1900.

PROTOPLASM.

Allgemeine Biologie. By Prof. Dr. Max Kassowitz. Vols. i. and ii. Pp. xv + 411, and x + 391. (Vienna: Moritz Perles, 1899).

A BAD hypothesis is better than none at all, is a saying of which many have taken advantage; but able minds have agreed with the substance of the remark, and few can dissent from it in connection with that everlasting puzzle—Protoplasm. It is in vain to inveigh against the uselessness of speculations as to the structure or constitution, nature—what you will—regarding the physical basis of life, or regarding attempts to picture, however roughly, the movements, rearrangements and evolutions in that veritable witches' dance, the quadrilles of the molecules in which life consists. The inquiring mind is so constituted that it cannot resist the temptation to fashion some rough hypothesis as a tool wherewith to make one more attempt to pick the lock which hides the secret, and the criticism of the serious as to the futility of his efforts is no more powerful than the epigram of the debater to prevent him returning to the ruins of previous speculations, with renewed efforts to rebuild his frail image of something approaching, as nearly as may be, the inconceivably complex, and exposing it once more to the blows of the critic.

To those who are hopeless, let the more hopeful point out the difference in our present ideas of the nature of protoplasm from those of twenty years ago, and say whether no advances have been made.

In this extraordinarily well-written work, it is satisfactory to see that the word Biology is used in the sense of "the science of life," and not in the restricted and often unintelligible way so common in Continental works. Still more satisfactory is it to find here a carefully thought out plan of re-examination of the fundamental phenomena of life, and of "the physical basis of life," on which is erected a hypothesis with bold outlines and stately proportions, yet carefully and minutely fitted details, in conformity with the rapidly advancing knowledge of the last two decades.

The subject of "Allgemeine Biologie," as treated by the Viennese professor, resolves itself under the following headings:—

I. "Aufbau und Zerfall des Protoplasmas," forming the theme of the first volume, which is further subdivided into: (1) "Das Problem des Lebens und die Versuche zur Lösung desselben"; (2) "Aufbau des Protoplasmas"; and (3) "Zerfall des Protoplasmas."

II. The second volume is entitled "Vererbung und Entwicklung."

The third and fourth volumes are not yet to hand, but we are informed that they will deal with "Stoff- und Kraftwechsel der Thiere" and with "Nerven und Seele" respectively. That they will be eagerly looked for by all who have read the two at present under review is a safe prophecy.

Kassowitz takes his stand on the conviction—the reasons for which are given at great length in the first half of the first volume—that previous hypotheses as to the nature of protoplasm, based on assumptions that any structure visible after treatment can be translated in terms of its structure during life, break down on examination equally with those which would regard protoplasm as a mere emulsion; and that all attempts to explain what is going on in living protoplasm, which have for their basis the assumption that oxidations, reductions, and metabolic changes generally are carried out in the fluids bathing any such machinery of the protoplasm also fail to withstand criticism. The thermodynamic theory of life fails because the engine itself burns, and the value of a substance as food has no relation to its combustible value. It might have been added that Pfeffer had already shown this in his treatise "Zur Energetik der Pflanze." The osmotic theory of the botanists breaks down, because it attributes to the cell-sap an importance which a mere solution under such conditions does not possess; the fermentation theory fails to explain more than a few bye-phenomena of life, and has no help for us in questions concerning synthesis; the electro-dynamic theory breaks down because electric phenomena are least obvious just where we should most expect them. The molecular-physical theory assumes vibrations and the shaking asunder of molecules which are so stable that it is impossible to believe that they could be shattered and others escape under the conditions imposed; while the vitalistic theory is a mere confession that what is to be explained needs explanation.

Underneath or behind all the assumptions of micellæ, gemmules, biophores, determinants or other formed structural units, as well as all material networks, rods, spherules, fibrils, pellicles and foams, Kassowitz detects the question—Of what are these physiological units and structures composed? And he regards the fundamental fallacies underlying all previous hypotheses regarding the constitution and working of living protoplasm as chiefly two:—viz. the assumption that protoplasm is composed of proteids built up into some sort of more or less stable machinery, and that the chemical and other changes usually comprised in the term metabolism are carried on outside or merely in contact with this machinery—*e.g.* in a meshwork, or on the surface of the physiological units.

He therefore proposes to examine in detail, and step by step, what comes of deductions made from the hypothesis that protoplasm consists of molecules, in the chemical sense, but of extreme complexity, large volume, and very labile, linked one to another in series, and each requiring for its construction, not only proteids, but also fats, carbohydrates and the mineral salts known to be indispensable for life. And that every vital act consists in destructions and reconstructions of these molecules.

To obtain a coarse picture of this invisible structure we may suppose extremely tenuous fibrils of india-rubber joined up into a complex network and bathed in a fluid which contains the necessary ingredients for putting in new pieces wherever, by stretching the net too far, we break the elastic strands; such breakages will occur especially between the nodes, and immediately the gaps are bridged over again by new fibrils, or networks of such, further extension, breakage and restitution are possible.

The linked up chains and networks of protoplasm-molecules—which do not correspond to the networks of coagula of other hypotheses—are termed *stereoplasm*, the bath of liquid containing proteids, carbohydrates, fats, minerals, molecular oxygen, etc.—*i.e.* in which are dissolved all the food-materials as well as all the products of shattered molecules—is termed *hygroplasm*. The osmotic attraction for water of the newly formed molecules (imbibition) would set up pressures resulting in such ruptures of the linked up series.

Kassowitz supposes that every molecule of the *stereoplasm* is liable to disruption when stimulated by any mechanical shock, chemical reaction, thermal or electrical radiation, &c., and that the immediate results of the shattering of a given molecule are somewhat as follows. The products of disruption are partly atom-groups which at the moment of disruption display unsaturated affinities of so energetic a character that they split the molecules of atmospheric oxygen brought into the hygroplasm and combine to form saturated compounds such as CO_2 and OH_2; partly atom-groups containing nitrogen, which rearrange themselves into bodies such as proteids, and can be utilised again in building up new protoplasm-molecules, or temporarily stored, or excreted bodies of various kinds.

The combustions involved in the formation of CO_2 and OH_2, and constituting respiration, of course result in the evolution of heat: they are, in fact, explosions, and each such explosion acts as a new stimulus and shatters more protoplasm-molecules, with results and consequences as before, and it is this repeated play which constitutes the propagation of a stimulus—either irregularly in all directions or, if the stereoplasm is linked up more especially along certain tracts (nerves), in definite directions. The accumulation of metabolic products may result in blocking the meshworks, and so impeding the access of oxygen, and the activities slow down accordingly. In the pauses of rest between such destruction changes, the building up of new protoplasm-molecules is accomplished, and this act of restitutive construction is *assimilation*, while the interposition of the new molecules between those already in existence is *growth*.

In illustration of the kind of forces at work in the construction of a new protoplasm-molecule by assimilation, Kassowitz points to such phenomena as selective crystallisation, whereby a minute crystal of Glauber's salt, for instance, in a mixture of the same substance and saltpetre induces the crystallisation of the former only; and to such cases as mixtures of two optically active salts in which the crystallisation of one only is determined by introducing a minute crystal of like optical activity, and to other cases where substitutions of one atomic group by another can be brought about. These illustrations are not intended to serve as examples of what happens, but to show that the forces concerned in chemical attractions may well be those at the bottom of the phenomena of assimilation of like to like in the stereoplasm, or of the building up into the complex molecule of protoplasm of atom-groupings of similar or not very dissimilar nature; and although we have no hope of following the various stages in detail, it is argued that stereochemistry has at least taught that forms and configurations may result from such molecular phenomena as those indicated.

The arguments to show that the unstable protoplasm-molecule, the lability of which is increased by radiant energy absorbed from without, is itself devoid of oxygen, is capable of reducing highly oxidised food-substances, of absorbing water and setting up osmotic phenomena, of giving rise to metabolites of various kinds, &c., &c., are too long to reproduce here, and I must content myself with one illustration only, of the many given in the remainder of the first volume, to show the application of the hypothesis to special cases.

When the pseudopodium of an *Amoeba* has reached a certain development it suddenly retracts, or rather collapses, for Kassowitz regards the phenomenon as a rapid tumbling to pieces of the molecular structure, owing to stimulation: certain protoplasm-molecules are shattered, atom-groupings of carbon and hydrogen split the molecular oxygen and are at once burnt to CO_2 and OH_2, the heat-vibrations evolved during the combustion shattering more molecules, and so on, throughout that part of the mass. This process exhausted, a period of restitution sets in, and new molecules are built up from the fragments of proteids, carbohydrates, fats and mineral substances at disposal, and become interpolated between those which had escaped destruction, and a new pseudopodium is put out by assimilative growth. Among other arguments for the view that this is really a process of growth, Kassowitz points out that the rate of protrusion of such a pseudopodium, rapid as it appears under a high power, is really not much more rapid than the growth of a stem of asparagus, a mushroom or a bamboo.

The most interesting part of the second volume will, for most readers, be those dealing with the questions of variation and evolution.

Having elaborated his theory of the essential structure and mode of working of protoplasm, Kassowitz proceeds to consider the complexities which arise, first, on the differentiation of the nucleus and "germ-plasm," and then on the further divisions of labour involved in multicellular organisation. In these cases the nucleus, internal cells, &c., obtain for their immediate environment, not the outer world, but protoplasm exposed to the action of the latter and modified by it. Whereas undifferentiated protoplasm obtains its supplies of food and energy direct from the environment, the nucleoplasm can never do this, as it never comes in contact with it. Its protoplasm-molecules must select their assimilable materials from the fragments of shattered cytoplasm molecules, and *if any modifications in the modes of disruption and reconstruction of the molecules of the stereoplasm—i.e.* in the "somatoplasm" of authors—*have been brought about by the action of the environment*, the slightly altered atomic groupings and modes of disruption thus put at the disposal of the nucleoplasm—*i.e.* the "germ-plasm" of authors—will affect the building up and modes of disruption of the new molecules of this, and these in their turn react again, and so on.

This short summary of a long argument must serve to indicate the nature of the author's grounds for concluding that Weissmann's contention against the transmission of acquired characters cannot be upheld. It is

also the basis on which Kassowitz founds his theory of variation, which latter he regards as always due to the action of the environment, translated in slight differences in the mode of breaking down and reconstruction of protoplasm.

It is impossible to summarise vol. ii. in a review with any hope of doing justice to the criticisms—some of them undoubtedly clever—of contemporary writers on evolution, Weissmann especially coming in for lengthy and severe treatment, particularly with regard to the theory of determinants, and his peculiar views on the meaning of amphimixis, natural selection, and acquired characters. It must suffice to say that Kassowitz offers—assuming the validity of his fundamental hypothesis—what he regards as convincing arguments to prove the essential truth of Darwin's conclusions as to the inheritance of adaptations, of the effects of use and disuse—in short, of the gradually accumulated effects of the environment on the somatoplasm, until the latter is so altered as to affect the germ-plasm, and so fix and hand on the changes.

The author regards the theories of pangenesis and their like, equally with such as Haeckel's suggestions as to transmissions of modes of vibrations, as far too complex: his chief objections are that it is to him inconceivable how every structural part could be represented by a physical unit or by a mode of motion transferred to the germ-plasm, and that he cannot see how those who conceive this can get over the difficulty that such vibrations would annul each other as their paths cross, or that the pangenes, biophores, determinants, &c., would get lost on the road. Further, these latter units are, by hypothesis, themselves living, and hence the real difficulty is only shelved.

Kassowitz, however, only demands of his germ-plasm that it be made up of a certain, and probably not a very large number of similarly built and very complex, but not infinitely complex, molecules. He does not suppose that every form-unit of the future organism is represented, but that certain characteristic atom-groupings out of the chemical units of the somatoplasm are utilised in the architecture of the molecule of the germ-plasm, and that in ontogeny these atom-groupings make their effect felt, either directly or indirectly, by the way of correlations of various kinds.

This is true epigenesis. In the developing organism every part is formed anew, from a substance in which none is especially represented. The forms and arrangements which ensue are simply the results of the activities of the atom-groupings already there, working on the materials supplied. When these latter have been assimilated—*i.e.* built up into protoplasm molecules—they exert their cumulative effects on more substance, and also *modify those already present by serving as new environment*—and so the process of evolution proceeds. Every now and again a slight variant gets its play, and the results may be far-reaching; but, on the whole, the dominant play of the constellations of molecules at work leads to what we term uniformity—a relative term.

While fully appreciating and endorsing Darwin's conclusions as to the importance of artificial selection, Kassowitz appears to undervalue the power of natural selection, curiously enough, because he, like so many others, cannot imagine it to be effective in the early stages of adaptive changes. He thinks acquired characters must have reached a certain stage of perfection before natural selection can come into play, and argues that when such a stage is reached selection is unnecessary, because so many individuals have already got the adaptation. Kassowitz appears to me to here betray the position of a laboratory philosopher as opposed to a field-naturalist. His own hypothesis points to the laborious accumulation of the effects of repeated stimuli and repeated readjustments: some have survived, others and far more have perished—is this not natural selection? There seems to be some confusion of thought expressed in implications that natural selection is incompetent to explain the *origin* of variations, which primarily it was never intended to do.

In one or two cases, indeed, the Viennese professor appears to me to have completely misunderstood the position—to an extent so remarkable that the question obtrudes itself, whether the whole argument must not be vitiated into which such misapprehension has crept. To quote one instance only. He admits that the struggle for existence between closely allied varieties, races, or species has resulted in the death of some races, &c., but objects that many plants and animals in the past

"nicht auf diesem Wege ihren Untergang gefunden haben, sondern durch ungünstige äussere Bedingungen und feindliche Einwirkungen, also durch Trockenheit, Ueberschwemmung, Kälte, Nahrungsmangel oder überlegene Feinde vernichtet wurden, dass sie also nicht im Concurrenzkampfe, sondern in einem mit ungenügenden Mitteln geführten Abwehrkampfe unterlegen sind" (vol. ii. p. 131).

But what does all this imply if not selection due to the environment, and the struggle for existence?

To find a paragraph like this followed by the question—Is it conceivable that such struggle for existence can have led to any adaptive arrangement whatever? almost takes away one's breath, because it is so totally beside the issues raised by Darwin. The only explanation appears to be that Kassowitz must be combating some foreign misinterpretation of the views of the great master. In spite of these and other faults—I take it, no botanist will accept the explanation of geotropism (vol. i. p. 280)—this remarkable book appears to me to be a valuable contribution to the literature of evolution, well worth reading if only for the numerous criticisms and suggestions scattered throughout its fascinating pages. These, by the bye, are not few—there are nearly 750 pp. of text, and more than that number of notes. It may be that the glamour of the style and the beauty of the theme have led me to pass too lightly over the failings, and to over-estimate the good; but the good is there.

We have heard much of late about useful knowledge. From the point of view of those who regard all knowledge as "useless" which cannot be directly applied to the material improvement of man, the books before me are indeed of little worth; but to those who draw distinct lines between knowledge and learning—information and education—no apology will be needed for the conviction that a treatise of this kind is especially welcome at the present time. It is not only instructive, but stimulating to a degree, and of the highest educational value to the biologist of to-day.

H. MARSHALL WARD.

PITMANESE PHONETICS.

Introduction to English, French, and German Phonetics, with Reading Lessons and Exercises. By Laura Soames. New Edition revised and edited by Wilhelm Vietor, Ph.D., M.A. Pp. xxvii + 178 + 89. (London: Swan Sonnenschein and Co., Ltd., 1899.)

THIS new edition of Miss Soames's work, which was designed by the authoress to provide a convenient method of teaching the pronunciation of the English, French and German languages, will no doubt prove useful to those teachers who believe in the advisability of teaching pronunciation by means of Pitmanese. The book is in no sense a scientific treatise on phonetics; the portion which deals with the production of the sounds of the three languages treated of is simply a very good and useful exposition of the obvious: the main point of the book is the elaboration for teaching purposes of a phonetic alphabet which in many respects falls far short of our ideal of what a phonetic alphabet should be, if such a thing need be constructed for teaching or any other purpose at all, except for the use of scientific students of linguistic phenomena. *E.g.* the authoress uses "*a*" to express the indeterminate vowel-sound: now nobody ever pronounced *the* as "dha"; when it is not fully pronounced "dhî," it is pronounced as a German would pronounce "dhö": to write it "dha" is most misleading. Also, the final *-er* in English absolutely = the German ö; *crozier* is pronounced "krōzyö," though Miss Soames would tell us to pronounce it "krōzhar." She writes *gardener* as "gâdnar": now if we pronounce a true *r* in *gardener* at all, it is most certainly in the first syllable (where it is usually sounded as a faint guttural, a sort of feeble *ayin*), and *not* at the end of the word: *gârdnö* or *gâ'dnö*. Generally speaking, Miss Soames connives at the tendency of modern English to weaken the *r*, and represents it as being far weaker than it really is: in the same way the tendency to lose the distinction between *witch* and *which* is in no way combated by Miss Soames. She spells, most inconsistently, "when," "which," instead of "hwen," "hwich" (hwič), the proper phonetic spelling. Again, to teach a child to pronounce *Sassenach* as "Sas*i*næk" (Pt. i. p. 109), and *Lochinvar* as "Lo*k*invar" (Pt. ii. p. 64), is an extremely slipshod proceeding, if it be not a mere solecism on the part of the authoress.

In the German phonetic spelling one or two weak points may also be pointed out. The expression of hard *ch* by *x* is a mistake: this appears to give the ordinary symbol for *ks* in the Latin alphabet a value which it does not possess: every learner cannot be expected to know that the Greek X (Russian x), which does possess the value of hard *ch*, has been transported into Miss Soames's phonetic alphabet to express this value. It would have been better to have used the small Greek type and have written *Nacht* "Naχt," not "Naxt." We do not like the adoption of ç to represent final *-g* after front vowels and consonants, as in *Sieg*, *Berg*, &c., either; a wrong primary impression is again given, and the fact is lost sight of that it is an *h*-sound, not a *k*-sound, which is in question. Why not use the symbol well-known in the transliteration of Egyptian and Assyrian, ḫ, for this sound, keeping χ for hard *ch* and final *-g* in *Tag*, &c.? *Sieg* would then be phonetically written "Zîḫ." Miss Soames also made ç stand for the *ch*-sound in *manches*; this is incorrect, *ch* here = "hy" ("mânhyez"), a sound quite distinct from the final -ḫ of *Sieg*.

The authoress appended a list of "Loan words used in English," a large portion of which is made up of words and phrases which are not loan words at all; *e.g.* *ancien régime* (!), *abattoir* (!!), and *Aphrodite* (!!!). On the other hand, such words as *abatis*, *accolade*, *aegis*, or *aiguillette* (which is presumably what the authoress means by "aiguille"), *are* loan words. In this list some mistakes of pronunciation occur, *e.g.* *a fortiori* should be pronounced on Miss Soames's system "ey fôrtiô'rai," not "fôshiô'rai," a vulgarism which no person with the slightest intelligent knowledge of Latin would ever think of using; *anacoluthon* should be pronounced "ænako'lû'tho'n, sounding the *o*, not "ænako'lyû'than"; *Canaan* "Kanâ'an," not "Keynan"; *Koran* "Karân," not "Kôrân"; and *sheikh* "shêç" (German "Scheech"), not "shîk," which is a terrible mispronunciation. On p. 104, *Eisteâdfod*d is given a superfluous final *d*; and on p. 99, the misprint *Bacchas* is noticeable.

On the whole, while this work may be regarded as generally useful for the purpose for which it is intended, it is unluckily marred by a tendency to perpetuate many incorrect and vulgar pronunciations, and even by several mistakes, some of them merely slipshod, others due to ignorance, which the reviser ought to have corrected.

OUR BOOK SHELF.

Psychologie der Naturvölker. By Dr. J. Schultze. Pp. xii + 392. (Leipzig: Veit and Co., 1900.)

IN this study of primitive culture, Dr. Schultze passes under review, from the standpoint of the psychologist, the material which is the common heritage of the anthropologists of to-day. Spite of the suspicions aroused by a sub-title of nineteen words, Dr. Schultze's volume is an unpretentious bit of work by a competent writer, whom no phantasy of construction or love of paradox has led astray from the patient use of authorities and the exercise of a sober judgment. Dr. Schultze's first essays in his subject were printed some thirty years ago. The present contribution is self-contained, though for its author it is but a part of a larger whole, preluded by physiological psychology and a treatise on the psychical life of plant and brute, and to be followed by a study of childhood. It is naturally evolutionist in conception, although the descriptive continuity which the author maintains is accompanied by the refusal to allow that the derivation of apperceptive consciousness from associational, which in the interests of a unitary view of nature he might desiderate, has been adequately made out. A feature of the book is the use made of English authorities. Not only Spencer and Tylor, but McLennan and Lubbock supply the writer with important doctrines, *e.g.* in his account of the evolution of marriage. Mr. Sutherland's "Origin and Growth of the Moral Instinct" is recognised as having anticipated Dr. Schultze in much which he would have been glad to have said, but, far from being dismissed with a *pereat*, is summarised in an appendix. It is on fetichism and animism that Dr. Schultze is most at home. Not that there is not much else of interest on the alleged superiority of vision among savages, on the concreteness of their philology, on the relation of rhythm to melody, on the difference of the sexes in regard to the sense of smell, on the evolution of the sense for landscape, and the like. But to the topics

of his earliest studies he returns as to a first love. On the soul-theories of savages and the corresponding eschatology he writes convincingly. The plurality of souls in pulse and blood and breath and shadow, the gradual elimination of some of these and the syncretism of the rest, the place of the dream image in the evolution of the cult of *manes* and in the selection of totems, the literal and unsymbolic character of the latter, the order in which the heavenly bodies enter into primitive worship—these are the points on which Dr. Schultze compresses year-long work into moments of insight and selective description. Believing, as he does, that Germany has a colonial future in direct contact with primitive stocks, Dr. Schultze offers his essay to the understanding of the savage as a help forward to the achievement of the educational mission of his country. A pious gift. H. W. B.

The Study of Bird-Life. By W. P. Pycraft. Pp. 240. Illustrated. (London: George Newnes, Ltd. 1900.)

THIS little volume belongs to "The Library of Useful Stories," now in course of issue by the publishers; and although it must have been difficult to compress a general review of the leading facts of bird-life into such a small compass, the author may be congratulated on the success of his attempt. As Mr. Pycraft is a morphologist rather than a systematist, it would naturally be expected that he would incline rather to the morphological and phylogenetic aspects of his subject, and this we find to be the case. We have, for example, an excellent chapter on the morphology of the bird's wing, while two others treat of avian pedigree, and a third is devoted to the distribution of birds in space and time. Perhaps the most specially interesting chapter in the volume is the one dealing with the flightless birds and their fate, since this is a subject on which the author is peculiarly qualified to speak with authority.

Although, of necessity, written from a purely popular standpoint, the volume contains many passages which are well worth the attention of the scientific ornithologist. If there be a fault, it is the introduction of irrelevant matter, the place of which might have been better occupied by details pertaining to the subject in hand. And if a second edition be called for, the author will perhaps be inclined to modify the statement in the tenth chapter, that "the kind of rock" in which bird-remains are found is sufficient to give a notion "of the bird-life of that particular period of the earth's history." R. L.

An Introduction to the Differential and Integral Calculus and Differential Equations. By F. G. Taylor, M.A., B.Sc. Pp. xxiv + 568. (London: Longmans, Green and Co., 1899.)

THE appearance of still another treatise of this kind shows how earnest and how prevalent is the desire to introduce students of physics to a knowledge of the calculus at as early a stage in their career as possible.

The author has studied simplicity of treatment, but has evidently striven to secure accuracy as well as clearness and distinctness in his exposition of the principles of the subject. A special feature, which will be of great advantage to the ordinary student, is the detailed discussion of numerous examples.

Interspersed throughout the several chapters the student will also find an abundance of not too-difficult exercises carefully graduated and with answers appended.

A fair and not excessive amount of space is devoted to the subject of curves, and the illustrative diagrams are distinctly drawn.

The section on the integral calculus concludes with applications to volumes and surfaces of revolution, centroids, and moments of inertia.

The last section of the book forms a good introduction to the methods of dealing with ordinary differential equations of the first and second orders.

ENGLAND'S NEGLECT OF SCIENCE.

JUST before the first movement organised by Lord Roberts there was probably not one thinking person in England who was not ready to vote for an immediate change in all sorts of English methods of doing things. Consequently everybody was willing to listen to the advice of men who had for years been crying in the wilderness and prophesying disaster. Now, however, that we have worried through our military trouble, we shall probably feel so much ashamed of our intense fright as to put aside most of our desire for reform, and even to have less thought of it than before the war began. It is, therefore, the duty of those who have earned the right to a hearing to prevent the nation from sinking down into its sleepy acquiescence with old methods of working; and I am glad to see that Sir Norman Lockyer, in his speech at the Royal Academy dinner, referred to scientific education as a great, necessary line of defence of our country, secondary only to that of our naval and military forces. Again, two articles have appeared in the *Kölnische Zeitung* (March 10 and 11), which criticise our manufacturing and business and military want of method with an unsparing pen. The German writer and many English writers seem to think that we ought to copy Germany. Nobody can feel more than I do the great necessity which exists for reform; but I think that our reform must be far more thorough than anything which can be regarded as a mere copying of Germany; the methods which we adopt must be English methods, invented by Englishmen for Englishmen. If our methods are to help to lead in the future to a history comparable in glory with the history of the past, there must be a great commonsense reform in education in England from top to toe. My friends, Profs. Ayrton and Armstrong, and I have so often pointed out the deficiencies of England in matters which we have carefully studied here and in foreign countries, that I hardly know whether an idea on this subject is my own or one of theirs; I do know, however, that we preach often on this subject, and that we never seem to be much attended to.

One thing that seems to be quite exasperating is that almost all the most important, the most brilliant, the most expensively educated people in England; our poets and novelists; our legislators and lawyers; our soldiers and sailors; our great manufacturers and merchants; our clergymen and schoolmasters, are quite ignorant of physical science; and it may almost be said that in spite of these clever ignorant men, and men like them in other countries, through the agency of a few men who are not ignorant, all the conditions of civilisation are being completely transformed. I do not merely mean here ignorance of the principles of science, I mean also ignorance of all those methods of working which come from experimental and observational scientific training. The great men go occasionally to popular scientific lectures (as they go to the Royal Academy), and they think that they comprehend something of the latest scientific discoveries because they have seen some fireworks and lantern slides; they are genial to scientific men when they meet them at dinner parties; but, in truth, scientific men are as much outside their counsels as sculptors or painters, or musicians or ballet-dancers. Among these great men a few visits to Albemarle Street are sufficient to create a reputation for science. I wish to show that this ignorance of our great men tends to create ignorance in our future leaders; is hurtful to the strength of the nation now, and retards our development in all ways.

These great men really direct the building of ships of war, and the creation of munitions of war; that is, they select the men who have to do these things, and they also lay down the unscientific rules which prevent their selected men from doing their work scientifically.

I will give an example. They order that the building

of five line-of-battle ships shall be started immediately. The scientific constructor knows that he ought to throw away—waste—100,000*l.* in making experiments to find out how the older type of ship may be greatly improved. But his superiors have made the rule that for money expended there must be something to look at. Hence no experiments may be made, and the constructor starts at once to expend five millions of pounds on building ships which are nothing like so good as they might be made.

Other examples. For many years huge guns were built of tubes. It was known to the few scientific men who can calculate about such things—the men who are never consulted—that it was not possible to turn and bore those tubes with the accuracy required by the theory. It happens that nature applies a correction to a wrong method of manufacture, and so these guns are not useless. It is quite well known that a little science and expensive experiment would cause the present wire method of manufacture of guns to be discarded for a simpler, quicker, better, cheaper system. The water-tube boilers, so numerous in our Navy, have proved as worthless as the best scientific men thought them from the beginning, and possibly now it is absurdly assumed that all water-tube boilers are useless. The construction of efficient submarine boats was possible thirty years ago. Many electrical and mechanical engineering appliances that might be very useful to an army or navy have never yet been tried under the direction of competent engineers. Above all—and this includes everything—men of scientific training are not chosen for the Government, civil, and naval and military posts where such training is necessary.

If our leaders were merely unscientific—if they were merely like Boers, and had no scientific knowledge—it would not be so bad, for they would probably appoint scientific men to posts in which a knowledge of physical science is needed, and they might accept the opinions of scientific experts. Even if they were like savage chiefs there would possibly be equal chances among all candidates for posts; but, unfortunately, it is as if our leaders possessed great *negative* knowledge of natural science, and as if a man's chances of being appointed to a scientific post, or of having his advice listened to, were in inverse proportion to his scientific qualifications.

Scientific men look around them and see that everything is wrong in the present arrangements, but they also see that it is useless to give advice which cannot be understood by our rulers. And, indeed, I may say that when by accident a scientific man is appointed on a committee, there is a negative inducement for him to do anything.

Many men enter the services by examination. In some cases the examination is supposed to be in science. In truth, the scientific habit of thought, the real study of science, the very fitness of a boy for entrance to the service, would unfit him for passing these abominable unscientific examinations. For some posts—the Royal Artillery and Engineer services, for example—further scientific food is provided by the Government after a man enters. If one wishes to hear how evil this system of pretended education is, let him ask the opinion of some of the professors who are condemned to help in carrying it out. The whole system is foolishness from bottom to top, and the men prepared by the system cannot see how abominable it is even when they are afterwards trying to improve it.

But however harmful the present state of things may be for the Government services, I think that it is much more pernicious for the country at large. We see that the greatest intellects of our time have been developed through an education other than scientific; and as nobody can commend it for the mere knowledge given at school, it is commended for its importance in mental training.

It has been so often asserted by parrots, that many people do really believe that only mere mental training need be given until a boy is sixteen years of age. When one hears such a statement for the hundredth or thousandth time, he sometimes wonders if anybody ever does think for himself. Why, the early period of a boy's life is the time when he is not only getting mental training, but also collecting the largest part of all the knowledge that he ever will possess of the world into which he has come. So great is this stock of facts and theory, that when he looks back upon his life in old age he can hardly find that he has added much to it in the intervening years. Is he a musician in after life? then he certainly learnt his skill, acquired his touch, trained his ear, and learnt thousands of airs in early youth. Is he a poet? it is to his earliest efforts that he looks back most fondly, and it was in his early youth that he learnt off by heart all the poetry that he really knows well in after life. He learns to read and write and cypher with ease and readiness; is this mere training of the mind? This craze for mind-training is really the worst thing that has happened to the hurt of children. It does not seem to be known to the mind-trainer that a child's mind grows most healthily when let alone—when the child is picking up knowledge in his own way. Give a boy a chance of seeing things for himself, and direct him as little as possible. Is there any kind of knowledge likely to be needed by him in after life? let him, when quite young, have some chance of picking up something of it for himself. He learns about people; he cannot help it, as he lives among people.

I take it that whatever kind of knowledge the race has been in the habit of picking up in youth is more easily picked up than any other by a boy himself. A boy takes to thinking for himself so naturally that the greater parts of some vile systems of education seem to be the destruction of this habit. Yes, education often means merely training a boy out of the way he *would* go into the way that we poor creatures think that he *should* go. And hence it is that the boy whose education is neglected, but who has chances of seeing things for himself, has often a much better chance in life than the well-trained prig.

Now there is a kind of knowledge greatly needed in life, that knowledge which is enabling us to fight with and use the powers of nature as they never were fought with or used before our time. The race is not accustomed to picking up this kind of knowledge, and so there is this one case in which artificial help to the child is absolutely necessary. Natural phenomena are complex; let him have a chance of using apparatus that will simplify these phenomena for him. It seems to me that natural science is almost the only study in which instruction from a father or teacher will not obstruct a boy's own natural method of study. And see how many ways of study are offered by it to a boy. Some of the sciences are greatly observational. If he is fond of abstract reasoning, he attacks things from the mathematical side. If he is fond of fireworks, he can attend popular lectures. If he loves to make and fiddle with apparatus, and use it quantitatively, he has an altogether new method of study. He may choose which method he pleases; the study is utterly unlike a series of tasks; he does not get to think of a duty as something disagreeable; and, above all, he is encouraged to think for himself. Instead of constant correction, criticism, and reproof or punishment because he will think for himself, he is encouraged to consider that opinions which he disagrees with are to be criticised by him. If he feels that it is quite hopeless for him to follow abstract reasoning, say about a whole being greater than its part or the ratio of two incommensurables, or justification by faith, we reply to him—Yes, my boy, you have a good healthy mind like 98 per cent. of

all English boys; it is quite impossible for us to make a seventy-year-old Alexandrian philosopher of you, thank God! time enough for you to do that for yourself when you have finished your educational course.

I say that this observational and experimental kind of study is almost the only one in which it is possible for a teacher to guide and instruct without doing harm—and it is very important that a boy's studies should be guided. Take the very clever boy who dislikes the study imposed upon him, and who takes earnestly to something else, his own choice, in which he has no guidance. See how he becomes a "crank." A man who might be of the salt of the earth if he could only co-ordinate his opinions with those of other people, a leader among men of thought; he loves to differ from all other people, and wastes a valuable life in disputation.

I know that many readers will find it difficult to consider this question; they will find it impossible to see things from a new point of view. As a rule a man has no point of view of his own, he never thinks for himself except about certain matters that only concern himself. Even a learned man thinks, not on the subject of his learning, but about his special methods of cataloguing his knowledge, and of course it is only from this that he can get any mental enjoyment. The dullest boy thinks a good deal, and even the average man, although thinking for himself has been repressed in him all his life. We ought to call all such people pedants, because they never really think about things of general interest to the world. It is extraordinary how general is the impression of everybody that he really does think for himself and comprehends what he says. At the age of fourteen I wrote an excellent little essay on Chaucer; I recollect now that my knowledge of Chaucer was confined to a few of the well-known extracts.

The opinions of educated young men change with the moon, or rather with the period of publication of the monthly magazines. A mathematical teacher uses the same fallacious logic in some demonstration year after year, and at length finds out his mistake from somebody else. Learning seems to destroy all power to think. From 500 A.D. to 1453 A.D. the scholars of Constantinople, with all the learning of Greece and Rome, produced not one original work.

I think that for a very clever boy any subject of study is good enough, although not so good as natural science. But Sanscrit, Chinese, or any other language and literature, or astrology or divinity, is just as good a medium as Greek or Latin, if all the best men of his own time happen to use the same medium, and if it enables him to come into mental contact with great men. But what of the other 98 per cent. of all boys—the average boys?

The men who frame schemes of education really frame them for boys such as they themselves were. Anybody who cannot follow such a scheme is said to be stupid, and he is so often called stupid that he actually gets to think himself stupid. In this nineteenth century we do not wish, as in the time of Erasmus, to produce merely a few learned men. At all events, if parents pay largely for education, we do not think it fair to send back 98 per cent. of their sons with the contract unfulfilled on our part. Think of 100 boys being sent to a bootmaker who had only one kind of ready-made boot of one size. He sends ninety-eight of the boys back with feet so hurt by trying on that they can never wear anything but slippers all their life after; he keeps their money, and compels the boys and their parents to take all the discredit of the transaction. Christ's curse is on the schoolmaster when he calls a boy a blockhead.

It is a very curious thing that when a boy has been called a dunce a number of times he actually gets to think himself a dunce, and in after life never blames his schoolmaster; he has only praise for the system of education. Men who have never been able to do more than quote tags from the Latin grammar, or get beyond the Asses' Bridge in Euclid, are usually quite enthusiastic about the value of the orthodox education in the training of the mind, and so we find engineers and other illiterate persons advocating classical education. A donkey might just as well brag of the enormous advantage it was to him in having once been kept about a racing stable. But a much more curious thing is the praise given by clever mathematical physicists to the wretched system of teaching of Euclid which wasted their youth. A well-known and exceedingly able and ingenious scientific man praises the school teaching in physics and chemistry which he had as a boy from a certain master of his, and yet everybody who knew master and pupil knows that the pupil became a scientific man in *spite* of, and not through, the teaching of his master. Even if such clever men were right as to suitability of a system of training for themselves, they have no right to assume that it is right for the other 99 per cent. of boys at school.

Classical education gets all the credit that ought to belong to the other kinds of education that usually accompany it. A boy is at a good public school at which healthy, moral, manly training of all kinds is given to the usual manly type of boy. All the best masters are probably good in classics. The boy's own prizes are for classics, because there are not often scholastic prizes for anything else. Success in classics has been always put before him as the highest kind of success. The boys whom he worships are all good in classics. Of course, classics gets the credit for everything, including those things that are good in *spite* of the classics. Even good manners and tact and amiability, and I might almost say good batting and bowling and fielding, are thought to be due to the classics. The defenders of classics are numerous, and miss no chances. A scientific friend of mine, before a royal commission, commended the study of Greek, because the Greek alphabet is so much used in mathematics. Surely for such a purpose Chinese is ever so much more valuable, as there are many more letters. Again, it is said that the study of classics helps one greatly in the study of modern languages. These defenders forget that Russians and Japanese are the best of linguists, and yet they seldom learn any Latin or Greek. It is strange also to find so many English boys, trained for years in Latin and Greek, who seem to find insuperable difficulties in learning a modern language. In any case, I am inclined to think that there is too much inclination to force boys to learn modern languages. Some boys learn easily; for them the study may be good. Others learn with extreme difficulty. Had they not better study something else?

Everybody is aware of the enormous difficulty of introducing a new invention, however valuable, if it involves the "scrapping" of much existing machinery. Thus, electric methods of working the District Railway have not yet been introduced. The comfort of railway passengers everywhere is only slowly being attended to. For this reason electric lighting proceeded slowly in England and quickly in America.

Now all the machinery of a school head master is fitted for the teaching of Latin and Greek. Every master is able to teach Latin well to clever boys, and everything good for mental training for clever boys in such teaching is well known to him. These men with capital so invested look with alarm on every new footing gained by science in schools, and with a wisdom gained by experience they introduce what *they* call science teaching, adopting methods which are such as can only disgust boys and their parents with the new study, and then they point to their want of success as a proof that the study of science affords no good education.

The prospect is very dismal; for the capitalists whom we fight against, whose interests we directly attack, are

not only some of the very cleverest men of the country, but they have the ears of nearly all the other clever men.

In the time of Henry VII. the new learning fought and conquered the schoolmen, and England soon became covered with good grammar schools. Then mathematics came gradually in, fighting a hard fight till it has made its way and established itself—not on equality terms, but on terms of sufferance and recognition. To meet modern wants, to equip our men for the fight of to-day, we find that it is absolutely necessary to introduce the study of physical science, and lo! we have opposing us the combined forces of classics and mathematics, each with its own kind of weapon. The weapon of the mathematical pedant is the more dangerous, for he says that he already represents science.

This teaching of pseudo-science in schools has created a manufacture of teachers. At all the universities we are now manufacturing science B.A.'s and B.Sc.'s because there is a new profession where money may be earned by the holder of such a title. This manufacture is called scientific education, and our real scientific men, pleased with the name, pleased at any experiment in scientific education, afraid that if they object there will be no education whatsoever in science, weakly give their countenance to it. To illustrate what I mean:—At the greatest of our universities there is an examination in which experimental physics plays an important part. A friend of mine coaches men for this examination. He tells them: "Listen to my coaching, read the books as I tell you, take care *not* to attend the physics laboratory. For in one day's reading you will get to know all that there is in thirty pages of the book; you may spend a month at the laboratory and you will have gained practically nothing to fit you for any possible kind of examination. The laboratory does not pay." Of course he is right, but if mere learning, if mere knowledge of certain facts, mere power to pass an examination, are what is aimed at, surely there is no scientific education here. My friend asserts that the system by which he earns his living is abominable. The whole thing is so wrong that one wants an earthquake or a fire, one prays for wholesale destruction of the easily working examination machinery.

I remember teaching physics at a school in which the time for science was so limited that only one half-hour's lecture per week could be given to the best men in the school. There were about 100 of them, from the sixth and fifth forms. Some of them are now leaders of English thought. Well, they were actually examined once a fortnight—a paper examination, lasting an hour. Of course, they were not examined on the two lectures; they were really examined on two chapters of the text-book. I am told, and I believe, that in many of the best girls' schools science is supposed to be taught by a teacher reading things from a text-book, the girls taking notes. I should think it an excellent system if girls are required to pass the usual examinations.

Examinations are said to be in mechanics or dynamics, or mathematical physics, or mechanical or civil engineering. They are not; they are fraudulent substitutions of the stupidest kind of mathematics for these sciences.

Assume something or other to be true, that the co-efficient of friction is constant, for example, or that a specific heat is constant, and, after covering the paper with easy mathematical exercise work, arrive at mathematic expressions which are as worthless as the mental training is bad. What a wonderful and useful weapon one possesses in mathematics! In the hands of a man like Rankine, or Kelvin or Maxwell, it removes mountains of difficulty. What a stupefying and useless weapon it is in the hands of a skill-less person who cannot think! And our examination systems and methods of education seem framed to cultivate one Kelvin to 10,000 of the pedantic non-thinking users of mathematics.

My theme has been the necessity for a complete change in our system of early education of everybody. The necessity is specially great in the case of the captains of industry. Many people think that if men are to be taught the scientific principles underlying the proper conduct of business or manufacture, it is only necessary to establish Technical Schools for them. When I was young I remember that there were many agricultural colleges in Ireland; they have all but one been failures. Why? Because the entering pupils were not fit to receive instruction. Instead of their having been prepared for instruction by their earlier education, this had done as much as possible to unfit them. We have just this sort of experience in our Technical Colleges. Great boys enter them, and it is difficult to find out what are the scraps of Euclid and mechanics known to these boys on which one has a chance of building technical instruction. It would almost be better to send such boys direct into practical work; they would probably do as well as the average workman; their fathers' influence and money would get them superior positions, and in a country like England they would do as well as their competitors in business. Yet there can be no doubt that it is of the utmost importance to our country, if we are to retain our supremacy in manufactures, that all managers of works, and many of the superior persons employed in large works, should be scientific men, who are also well experienced in the applications of science to their particular industry. But this is not all. I have heard it said, quite truly, that for a great mechanical engineering works what is needed are well-trained managers and foremen, the best labour-saving tools, and an army of negroes as workmen. I am inclined to think that this statement is true; but there is something to be said for the employment of well-educated, intelligent workmen. First, because they are citizens of the country having votes; second, because I believe that all invention comes up from the common workman These men make thousands of observations, which somehow get to their superiors, and it is through these that inventions come unconsciously; an inventor makes use of ideas received from hundreds of men; the invention is truly his own, but he receives suggestions, unconsciously, from the men who work with their hands at the bench and in the machine shop. If then, I am right, the manufacturing country that depends upon a few good managers and an army of unintelligent slaves will fall as the Roman Empire fell.

Now a workman's intelligence must come through his trade, else he cannot be happy; and if he is unhappy in his trade he cannot be a good citizen or an efficient workman (from the above point of view). At present we pitchfork many boys into a factory, and depend upon the good nature of the workmen for their learning their trade. It used to be that a master taught such a boy his trade as a member of his own family. This personal teaching is no longer possible; but nothing has taken its place. Attendance of apprentices at evening classes after a hard day's work is quite out of the question for all but a small number of very clever young martyrs who sacrifice, not merely their own health and comfort, but the comfort of their families and their duties as citizens. I have myself publicly suggested several times a remedy for this state of things, which has been praised by competent persons, but it seems to me that it is hopeless to expect any adequate remedy to be applied until the influential people of this country are made to see the gravity of the present position.

The great remedy for all our troubles lies in convincing all influential people in this country that we really must make great radical changes. I have known the subscribers of money to a large technical college in England (the members of its governing board) to laugh, every one of them, in private over the idea that such an institution could do any good to the trade of their town.

How could it possibly do any good when there was such a spirit of unbelief among such people? We must create in England what already exists in Germany and France, and to some extent in America—a belief in the importance of scientific training everywhere. At present there is utter unbelief, and it is due to a bad system of education, which keeps everybody out of sympathy with everything scientific. It is terrible to hear our designers of bridges and steam engines and dynamos and great engineering schemes laugh at science and calculation, especially when one knows that foreign engineers are sneering at our best men; but it is well to know that, in spite of their laughter, our engineers are doing their very best to make use of all the true science that they have ever learnt; it is like gold leaf—very thin, but it serves a useful purpose. What they see clearly is the uselessness to God or man of such a so-called scientific training as they themselves had; they do not dream that there is a real scientific training possible by which useful mathematical and other weapons for solving all sorts of practical problems, handy to use and always ready, may become part of the mental machinery of the average man.

Four hundred years ago, reading, writing and cypher-ing were taught badly, and practical men looked upon them as things good to forget, things good for priests. If a layman could read or write, he was probably a useless person who, because he could not do well otherwise, took to learning. What a man learnt was clumsily learnt; if he learnt much, he was fit for nothing but learning; usually he learnt little with great labour, and made no use of it; therefore reading, writing and cyphering seemed useless. Do they seem now so very useless; now that everybody can learn them fairly easily? It is not so easy now to say that a man is useless merely because he can read, write or cypher. When I was an apprentice, and no doubt it is much the same now, if an apprentice was a poor workman with his hands, he often took to some kind of study, which he called science. In fact, science got to be the sign of a bad workman. But if workmen were so taught at school that they all really knew a little science, science would no longer be laughed at. When a civil engineer or electrical engineer fails because he has no business habits, he takes to calculation and the reading of so-called scientific books, because it is very easy to get up a reputation for science. The man is a bad engineer in spite of his science, but people get to think that he is an unpractical engineer because of his scientific knowledge.

Germany has an enormous advantage just now in this, that all thinking Germans, all influential men, believe that their great success in commerce and manufacture has come through physical science. Every manager and foreman, every captain of any kind of industry in Germany and Switzerland, has passed with honour through the science classes of a great technical school. The money that used to flow towards religious institutions now finds its way towards the greater and greater development of scientific education, so that Germany is getting covered with universities of science.

The open-hearth process has enabled German ores of iron to be used in steel manufacture. The war-earthquakes have stirred up the German people to new life, have produced enthusiasm, and made all kinds of ambition respectable. Any one who knew such a tumble-down, poverty-stricken town as Hanover forty years ago would not recognise it now. There are miles of streets of the brightest shops in Europe; at any time of the day or night one can read a small print newspaper in these streets; the streets throng with traffic, and the electric tram-cars have extended the city far into the country; and so it is in hundreds of towns, and manufactures flourish in thousands of places where the hare and partridge used to have the scenery to themselves. I do not think that the progress of Germany would have been half so rapid had it not been for the scientific education of the German leaders, but it is absurd to say that all this progress is due to science. The fact is that the whole world is developing its natural resources. England had the start; every country that has coal and iron, or their equivalents, is competing with England. The countries of greatest natural resources can afford to neglect their scientific education longer than others; but, sooner or later, knowledge and method and character must tell. If countries are equal in their natural advantages, victory must remain with that one in which there is the best education.

I have hitherto been reviling only the higher education in England. Until quite recently there was no primary education to revile. Let me put before my readers a true contrast. In Scotland, at any time during the last 100 years and more, if in the very poorest parish there was a boy of promise, a boy who showed a fondness for reading, for learning, for taking in what then and now goes under the name of education, a fondness for coming into contact with great minds through books—the success of that boy in life was absolutely sure. However poor his parents might be, however remote his humble home might be from civilisation, he was sent to the university, and got his chance. His nation gloried in his success, even if his own poor country had to be left by him for the richer field of England. Of all the great doctors and ministers and scholars of Scotch blood now to be found in London, only a very few can say that they were not exceedingly poor in their youth. Now contrast such a boy's chances with those of a clever English boy some years ago. Why, until the ever-to-be-praised Science and Art Department gave him a chance, a poor English boy, however promising, was compelled to eat his heart out in unavailing regret, was taught that it was a sin to think of bettering his condition, was taught that a decent education was as remote for him as for the cattle he tended.

I believe that this difference was due to the fact that in Scotland everybody thinks well of a good education, of knowledge, of mental power, because he himself can think, whereas in England education is looked upon with contempt, because there is not one labourer in a thousand who can think.

I do firmly believe that the Prince Consort saved this nation from utter defeat, and that if we are not yet to be defeated we must do as he would have continued to tell us to do. Had he lived till now, this country would not merely have the beginnings of a development of art and science; it would be covered with educational institutions whose most important object would be scientific study, a secondary leaning to literature not being neglected. As it is, we have the merest dust of his mind expanded into a wonderful Science and Art Department, which is criticised adversely only by the very ignorant or the very prejudiced. Only people like myself, whose whole life has been a pæan of gratitude for what that department has done for me and mine, who have seen in thousands of cases that it has redeemed otherwise wasted lives with enormous benefit to our industries, are really in a position to imagine how much that great man might have done for us if he had lived.

For one thing, just as the Science and Art Department is the envy and admiration of foreigners; just as it is an English institution, made to fit England and no other country, so he would have developed scientific education in England on lines utterly different from the soul-destroying system of Germany or its imitation in America.

Consider a scientific German as you know him. Say that he is twenty-three or twenty-five years of age, and he is about to enter business. From the age of seven or less he has trudged to school, perhaps at 7 o'clock in the morning, with a bag of books of half his own weight. He had a short interval for dinner, and went on to

6 o'clock at night. And he went on like that till now. There is no fact in all his school books that he has not heard a thousand times. He has had Goethe's maxims so drilled into him that he is "thorough" in every detail. I can imagine one Englishman in a hundred, after such a training, patiently turning over the muck heap of his knowledge; his eye would not gleam with any enthusiasm, but rather would glaze with envy and jealousy at the undeserved success of quite ignorant persons. And yet he would have knowledge, and know in his way how to use it; and it is because Germany has so many thousands of men trained in this way that she is certainly beating us to-day. They may be rather heavily loaded with learning, and I know that decently taught Englishmen who spent less than half the time at studies twenty times more interesting would beat them hollow in manufacture or research, would be the reverse of dull, and would be good citizens; yet the Englishmen I want only exist as yet by ones and twos, and such Germans are numerous. But just think of it! Here we are, a hard-headed, obstinate, cool race of men, who have had no end of chances in our safe little island, whilst our enemies were fighting among themselves, with coal and iron and the influx of good foreigners to set us first in the new field, and we have more than half of all the wealth of the world, and all that is needed for our keeping our good things is that we should believe them to be possibly evanescent; that there really is a chance that some better equipped nation may take them away from us, and therefore that we ought to prepare ourselves to fight for them. We have many chances in our favour and we hardly use them; the competing foreigner is very energetic, and cultivates his smallest chances. JOHN PERRY.

HUMAN BABIES: WHAT THEY TEACH.

AN investigator anxious to obtain information as to the relationship of a particular species puts the question "What characters do the young stages exhibit?" and in order to answer that question he makes a study of the developmental phases exhibited by those stages. He may argue that if he finds certain characters in the young stages indicative of, and adapted to, habits of life which the adults do not possess, then there must have been a time in the ancestry of the species when such habits of life were of particular value, otherwise they would never have been developed. Or he may simply give, as the reason for his method of research, the concise statement "ontogeny repeats phylogeny," or he may hold to the theory of acceleration of development—which is more than a theory, because it is an actual fact of palæontology—that the characters of adult ancestors tend to become the characters of youthful descendants, thus producing specific diversity, without the necessity for a theory of natural, or any other form of selection, merely by inequality in the rates of developmental acceleration in different stocks. Wherefore *vice versâ* the characters of youth must at one time have been adult characters; and their differences from those of the adult indicate the degree of different environment under which the adult ancestors lived.

The manner of expressing the reason for a method of research may vary; the method itself remains the same. To know the past history of an organism, study the young. That is a method of universal application. It is the guiding principle of all researches into the past history of organic beings. It becomes then equally applicable to man himself; and in that way the human baby becomes an object of scientific attention. To study the human baby in this manner, the aid of photography is important; it gives a permanent record of what would otherwise be forgotten.

The early attempts of a baby in the matter of progression are particularly instructive. The bipedal gait is not attainable, indicating that the bipedal ability of the human being is of quite recent acquirement. What the child does show is either a truly quadrupedal method of progression, as in Fig. 1, which is also said to be common among children of uncivilised parents, or a kind of falsified quadrupedal progression on the hands and knees, which obtains generally among children of civilised parents, owing no doubt to impediments of clothes, and to over-coddling. Both methods of progression point to the same conclusion, though, of course, the former is the better illustration—that the ancestors of man were animals accustomed to a quadrupedal gait.

The influence of this quadrupedal gait of the ancestors is very strong. The child really has to unlearn it, and to readapt its hind limbs before it can attain the bipedal method of progression. The necessity for such readaptation, and the difficulty of acquiring the balance which progression on hind limbs demands, make the child's early efforts at walking so difficult. Observe a child just able to balance itself momentarily on its hind limbs. The insecurity of the position is shown by the attitude of the arms—outspread to help the balance, and by the feet being planted widely apart. The imperfection of the hind limbs for a bipedal gait is particularly noticeable.

FIG. 1.—Child ten months old, on garden path.

The legs are not straight, but they are considerably bent at the knee. That bending is incorrect for a bipedal gait; but it is a necessity of a quadrupedal progression, and it is just the feature seen when a four-footed animal, such as a cat, is induced to stand on its hind legs. In learning to walk on its hind legs the baby has to make many alterations in the anatomy of its hind limbs to fit them for their new function; and the human ancestors, in order to pass from quadrupeds to bipeds, must have had to do the same.

There is another feature noticeable in regard to such a child in its first attempts at walking—the semi-clasped position of the hands. That is natural, it may be said. Certainly it is, but nevertheless a natural feature requires an explanation, and may be of particular significance. Such is the case here; the semi-clasped position of the hands is naturally and instinctively assumed because the human ancestors had for so many generations been bough-grasping animals, quadrupeds who lived among trees, who particularly used their hands for grasping boughs. Had they used the hands in a manner which always produced extension, then the extended position of the fingers would have become habitual.

Further evidence of the particular character which generations of bough-grasping ancestors have given to the hands of children may be obtained in this way. Get

a series of school-children and ask them to hold their hands out straight. The failure of the majority of them to put out the fingers without some indication of the bough-grasping curvature will be very interesting. In some cases, especially among the younger children, the inward curve of the fingers will be very noticeable; and their inability to fully extend the fingers will be marked. A record of this inward curvature of the fingers may be obtained by photographing the extended hands when held against a dark background.

Even better evidence of the inherited bough-grasping instinct is afforded in Fig. 2. The child, about twelve months old, has picked up a flower-pot, and it has done so by dabbing the hand down upon it in the manner in which a monkey would catch at a branch. It has not made use of the thumb as an adult would do; but it has caught the rim of the flower-pot between the fingers and the palm of the hand, and in that manner has raised it up to its mouth. The sympathetic grasping attitude of the other hand may not be without significance; for although an arboreal animal like a monkey can sustain its weight by one hand, yet there would generally be a tendency to grasp with both hands at the same time in order to relieve the one arm of all the weight.

FIG. 2.—Child grasping a flower-pot.

A sympathetic action of this kind is very noticeable among children in regard to the use of the legs, and similarly it may be referred to the habits of arboreal ancestors. If a young child be put to hang on to a rope, which it will do very well long before it can support its weight in the ordinary human manner on its hind legs, or if it be merely lifted up by the hands, it will at once show a disposition to swing up its legs as if to catch at something. And this would be very natural in an arboreal quadruped. As soon as it grasped a bough with its arms, it would swing the legs up in order to grasp with the hind hands (the feet) either another bough, or in many cases the tree-trunk.

The inherited effects of grasping tree-trunks, or limbs with the hind hands are particularly marked in a young child. There is first of all, common to most babies, more or less of the bow-legged character which such trunk grasping would produce in arboreal animals. And then if a quite young child be held up so that its feet touch the ground, it will be seen that the outer portions of the feet rest on the ground, while the soles of the feet are not in position for being put flat, but are more or less opposed to one another in the manner suitable for trunk-grasping. Often, too, when the baby is lying down, the great flexibility of the ankle joint may be noticed; and the child will be seen to do, without an effort, what it would be very difficult for an adult to accomplish—it will, without bending the knees, bring the soles of the feet flat, opposite to one another. It is quite a common thing for a baby to turn the sole of its foot so that across the sole is in a straight line with the inside of the leg.

One habit after another, one action after another which a child performs may be seen to be quite out of keeping with what may be called human instincts, but exactly in accordance with the habits of arboreal animals. And so there is an accumulation of evidence, on the ontogeny repeating phylogeny principle, that the human ancestors were monkey-like animals, arboreal in their habits. One of the first things that the human baby does is to climb, and to climb persistently. It will climb its crib, or a footstool, or the fender, and particularly the stairs. Given a fair chance, and it will develop a perfect mania for stair-climbing and a bump of locality as regards the position of the stairs in the household geography—if such a bull may be permitted. Then it will make for the stairs on all occasions, to climb with crows of pleasure. It may experience tumbles, when it will lie and howl, not so much on account of injury as at the unexpectedness of the catastrophe. But on recovering it will at once make for the stairs again, showing how strongly the climbing instinct is developed.

And the climbing instinct lasts till later in life. Young boys, and girls too, must climb. The stairs themselves have become too small for their efforts then, but the bannisters remain, and they must climb up outside these, and hang on from various points which give any facility for arm exercise. The disposition for arm gymnastics is very marked in children who are not repressed in the unnecessary conventional manner. And it is a pity that it does not receive more systematic encouragement, because it would be beneficial for chest expansion in growing children. As matters stand now such exercise as is permitted favours leg development only, while all school work promotes contracted chests and rounded backs—at any rate with the girls. Boys are rather more fortunate. They are not troubled by an ever-rampant Mrs. Grundy preaching lessons on deportment. They retain the monkey habits of tree-climbing and bird-nesting. If any one reflects how important a prize to a hungry monkey a bird's nest of eggs must be, then he will understand how the inherited instinct can be so strongly developed among boys.

However, I am wandering somewhat from the human baby, and I will return thereto by asking consideration for what should be commonly observed in any family, a child with a pleased expression. There is one point in such expression which has not received due consideration, namely, the raising of lumps of flesh each side of the nose as an indication of pleasure. Accompanying this, though difficult to bring out in a photograph, may be seen small furrows, both in children and adults, running from the eyes somewhat obliquely towards the nose. What these characters indicate may be learnt from the male mandril, whose face, particularly in the breeding season, shows coloured fleshy prominences each side of the nose with conspicuous furrows and ridges. In the male mandril these characters have been developed, because being an unmistakable sign of sexual ardour they gave the female particular evidence of sexual feelings. Thus such characters would come to be recognised as habitually symptomatic of pleasurable feelings. Finding similar features in human beings, and particularly in children, though not developed in the same degree, we may assume that in our monkey-like ancestors facial characters similiar to those of the mandril were developed, though to a less extent, and that they were symptomatic of pleasure, because connected with the period of courtship. Then they became conventionalised as pleasurable symptoms.

Darwin's idea of Antithesis with regard to the expression of emotions does not commend itself. There is not

space now to consider the subject fully ; but it may be broadly stated that methods of expressing pleasure have all arisen from habits and actions employed in self-gratification—the satisfaction of the bodily requirements—either in self-nutriment or in procreation. But they may not be the actions employed by members of the species under its present-day conditions. And in the young they would certainly not be so ; they would be the crystallised epitome, if such a term be allowed, of the habits and actions which proved successful with ancestors when they lived in a very different environment. Striking coloration of the face with ridges and scar-like markings would not now give pleasure to the sexes of the human species in their civilised condition ; but the face of the male mandril is evidence of their having done so and still doing so among monkeys, and the practice of face painting, perhaps also of tattooing among savages, is evidence of the monkey habits having been inherited by the human species, and still finding favour among its members.

In the matter of pain, the idea that the expressions which indicate it go back to ancestors living under very different conditions is excellently brought out. Expressions would be the special muscular actions performed under the stimulus of a feeling of injury—such actions as were necessary to alleviate the pain, those necessary to

FIG. 3.—A child crying.

prevent further pain, or to escape from the danger indicated by the pain, and those which were employed in revenge on the inflicter of pain, on the principle that destruction of the cause of injury would be the surest method of prevention.

Therefore, one of the first things that pain prompts an animal to do is to exhibit and prepare its weapons of offence. In the case of the human baby such weapons of offence would be those which would have been employed by the pre-human ancestors. The picture of the crying child, Fig. 3, illustrates this. The peculiar squareness of the open mouth, caused by retraction of the lips at all four corners, is on purpose to exhibit the fighting weapons, the canine teeth ; although, as a matter of fact, the canine teeth have not yet been developed. But the instinct to open the mouth so as to show canine teeth has been inherited from pre-human ancestors who habitually made use of these teeth in order to fight.

There is another feature in this picture, the tight closing of the eyes. This is to protect the eyes from injury during fighting. I photographed a cat which I pretended to strike. There was the same closing of the eyes ; and, for a similar reason, a throwing back of the ears out of harm's way ; and besides there was the paw ready to strike the assailant. I photographed another cat being teased. There was just the same opening of the mouth as in this picture of the baby, and the canine teeth, which were then disclosed, showed exactly what the cat's intentions were, that they were just the same as that expressed by the throwing open the portholes, and the running out the guns which we so often used to read of in accounts of men-of-war.

The lessons which the human baby can teach as regards the past history of its race are very numerous. I have only been able to glance at some of the more important ; but they are sufficient to show that the subject is one of wide range and considerable interest.

S. S. BUCKMAN.

NOTES.

LAST Thursday a combined meeting of the Royal Society and Royal Astronomical Society took place at Burlington House, when the observers who went away for the recent eclipse communicated the results of their observations. As the reports have not yet been published, we are unable to give an account of them. We have received from Prof. Langley a preliminary account, which we hope to print next week, of the expedition which went under his direction to Wadesboro, U.S.A., to observe the eclipse. The photographs he has obtained surpass any that have ever been taken at an eclipse, and speak volumes for the employment of instruments of great focal-length.

THE new physics laboratory of Owens College, Manchester, was opened on Friday last by Lord Rayleigh. Particulars as to the ceremony and the equipment of the laboratory will appear in our issue for next week.

THE Conference on Malaria, which was to have been held under the auspices of the Liverpool School of Tropical Medicine at the end of the present month, has been postponed in order to avoid clashing with the celebration of the Centenary of the Royal College of Surgeons of England and other gatherings.

WE regret to notice the death, at Manchester, on Monday last, of Dr. Daniel John Leech, a well-known physician, and professor of Materia Medica and Therapeutics in Owens College. As chairman of the Pharmacopœia Committee of the Medical Council he had charge of the publishing of the last edition of the British Pharmacopœia, and his name had been recently mentioned as the probable president of the British Medical Association. Dr. Leech was in his sixty-first year.

THE death is announced of Prof. Corrado Tommasi-Crudeli, secretary of the class of mathematical, physical and natural sciences in the Reale Accademia dei Lincei. Tommasi commenced his career in 1859 as demonstrator of pathological anatomy at Florence, after studying with Claude Bernard, of Paris, and Duchenne In 1862 he went to study pathology under Virchow, at Berlin ; the next year he delivered a course of lectures on pathological histology at Florence, and in 1865 he was appointed professor ordinarius of anatomy at Palermo. During an outbreak of cholera in the following year, Tommasi rendered valuable services by his study of the disease and its mode of propagation, and published a well-known memoir on the subject. In 1870, Tommasi was called to Rome, where he was first appointed head of a newly-formed department of pathological histology. Later, he carried out extensive researches on the propagation of malaria. While his researches, conducted in conjunction with Klebs, have been superseded by recent discoveries, the general conclusions to which he was led have not only been substantially confirmed, but have received their true explanation in the new doctrine of the propagation of malaria by mosquitoes.

DURING the past week the summer meeting of the Institution of Mechanical Engineers has been held in London, and proved a successful gathering, interesting not only because of the various papers read (the titles of which, excluding an additional one,

by Mr. E. Goffe, on "The Construction of 'Long Cecil,' a 4·7-inch Rifled Breechloading Gun in Kimberley during the Siege 1899–1900," have already been given by us), but from the fact of a number of members of the American Society of Mechanical Engineers being present. To these a most hearty welcome was accorded.

THE thirty-second annual convention of the American Society of Civil Engineers was opened on Monday last at the Institution of Civil Engineers. The proceedings were inaugurated by an address of welcome from Sir Douglas Fox, the president of the Institution of Civil Engineers, and the presidential address was delivered and several discussions took place.

THE Audiffret prize, of the value of 15,000 francs, has been awarded by the Academy of Moral and Political Sciences of Paris to Dr. Yersin for his discovery of the anti-bubonic serum. The prize is awarded at regular intervals for the "greatest devotion to scientific discovery."

THE Pharmaceutical Society announces that the Salters' Company Research Fellowship is now vacant. The subject of the Fellowship is chemistry considered especially in its relation to pharmacology, that is, the application of the newest methods of scientific chemistry to the elucidation of pharmacological problems. The Fellowship is of the annual value of 100*l.*, and is tenable in the Research Laboratory of the Pharmaceutical Society for one year, but may be renewed under certain conditions, and the holder is expected to devote his whole time to original investigation. Candidates need not necessarily be pharmaceutical chemists or members of the Society. The last day for receiving applications is Saturday next.

THE Balbi-Valier prize, of the value of about 120*l.*, has been awarded by the Venetian Institute of Sciences to Prof. Grassi, of Rome, for his work on the mosquito and its relation to malaria.

A PRIZE of the value of 1000 marks is offered by the Scientific Society of Danzig, in connection with its 150th anniversary, for a paper on the geology of North Germany.

THE German Society of Mechanical Engineers offers a premium of 60*l.* and a gold medal to the designer of the best system of high-speed electric railways for heavy traffic. Designs must be submitted by, at latest, October 6 next.

THE Lavoisier Monument which is being erected on the Place de la Madeleine, Paris, in close proximity to the house in which the famous chemist lived for many years, will, according to the *Chemist and Druggist*, be formally inaugurated on July 27 by the French Minister of Public Instruction. The statue has been erected by international subscription under the auspices of the Paris Academy of Sciences. The sculptor is M. Barrias, and the monument will consist of a bronze statue of Lavoisier, on a pedestal, bearing on two sides bas-reliefs showing Lavoisier working in his laboratory with Mme. Lavoisier writing under his dictation, and Lavoisier expounding the result of his experiments at a meeting of the Academy of Sciences. The scenes have been created from authentic documents.

A MONUMENT has been erected to the memory of Dr. Jean Hameau, the obscure general practitioner of the Gironde, who, in 1836, published a study on viruses, in which he partly anticipated the discoveries of Pasteur. The statue was unveiled recently at La Teste de Buch, where Hameau practised. Addresses were delivered by Dr. Laude, the Mayor of Bordeaux and President of the Medical Syndicates Union of France, Prof. Lannelongue, of Bordeaux, and others. Hameau was born in 1779, and died in 1851. His claim to be considered a precursor of Pasteur has been publicly acknowledged by Prof. Grancher, and it is probable that had he been possessed of the laboratory accommodation and means of investigation available at the present day, the microbe theory of disease would have been established fifty years sooner than it was.

PROF. H. F. OSBORN, of Columbia University and the American Museum of Natural History, has, according to *Science*, been invited to succeed the late Prof. Cope as vertebrate palæontologist of the Geological Survey of Canada.

MR. W. E. D. SCOTT, curator of the ornithological department in Princeton, announces, says *Science*, that the British Museum has presented to the University two thousand mounted birds, specimens from India, Australia and the Malay Islands. Some time ago the University presented the British Museum with 250 sets of North American birds' eggs.

IT is announced that the repairs to the Arctic steamer *Windward* have now been made, and the vessel was expected to sail by about July 1. The *Windward* will proceed directly, with a call at Disko, to Etah, North Greenland, Lieut. Peary's winter quarters, where instructions from him will doubtless be found, or if not, will be awaited. The vessel will take with her the maximum quantity of coal, additional lumber, oil, sugar, arms, ammunitions, provisions, scientific instruments and everything necessary for Lieut. Peary's work, including two new whale-boats, specially built at New Bedford, and thoroughly equipped in every detail. Upon the arrival of the *Windward* at Etah, Lieut. Peary will assume command, and further movements will be subjected to the conditions of his work and to his instructions. No passengers will be taken on the *Windward*, the Danish Government having qualified their permission to land at the Greenland ports, with conditions that tourists should not be carried. If Lieut. Peary has succeeded in carrying out his plans, that is to say, if he has discovered the North Pole, he will, says the *Scientific American*, return with the ship. If not, the supplies will be landed. It is possible that the *Windward* will bring back the Robert Stein party, which was landed near Cape Sabine by the *Diana* in August last.

A BOTTLE has, it is reported, been found on the shore at Roundstone, co. Galway, containing a printed card directing the finder to forward the contents to Captain Ernest André, Polar Expedition Company, Sweden, and stating that it was thrown from Major André's balloon in the Arctic regions with a view to testing the ocean currents. The bottle has been forwarded to the Board of Trade.

SETS of volumes on naval architecture, and on the history of the British Navy, have been presented by the Institution of Engineers and Shipbuilders of Scotland to Prof. Arnold, of the Sheffield Technical School, as a token of appreciation of the lecture delivered by Prof. Arnold on "The Internal Architecture of Metals."

A MEETING was held in the rooms of the Royal Meteorological Society some time ago to consider the question of a memorial to the late Mr. G. J. Symons, F.R.S., when it was resolved unanimously that the memorial should take the form of a gold medal, to be awarded from time to time by the Council of the Royal Meteorological Society for distinguished work in connection with meteorological science, and an executive committee was appointed to take the necessary steps for the raising of a fund for the purpose. The committee now appeal to the fellows and members of the societies with which Mr. Symons was associated, to the rainfall observers, and to all who have in any way benefited by his advice and assistance, to contribute to this memorial fund, which it is hoped may reach the sum of at least 750*l.* Contributions should be paid to Mr. W. Marriott,

70 Victoria Street, Westminster, S.W.; or to the "Symons Memorial Fund," Bank of England (Western Branch), Burlington Gardens, W.

AN Anti-rabic Institute for India is, says the special Indian correspondent of the *Lancet*, at last an accomplished fact. After numerous delays, Government have stepped in and practically settled the difficulties. The Royal Army Medical Corps having an officer in Major D. Semple who had studied in Paris and Lille, determined to utilise his experiences, and the annual expense for sending soldiers to Paris was diverted for the new institute. The central committee of the proposed Pasteur Institute saw their opportunity and took over its control. With a capital of 70,000 rupees and a yearly grant of 19,500 rupees, the expenses of the new institute ought to be fairly well met. Residents in India may be congratulated that at last means are provided whereby European and native patients alike can be offered the best available treatment for the terrible disease of rabies.

DR. L. SAMBON AND DR. LOW, the two medical men entrusted by the British Government with the perilous task of testing the possibility of guarding against malarial infection in the Roman Campagna, have, according to the *Lancet*, at length found a favourable place for their purpose. After rejecting various other localities as being for one reason or another unsuitable, they have selected a spot about two miles distant from Ostia, between Castel Porziana and Castel Fusano, and within five minutes' walk of the latter place. The site of their hut is on the edge of a "stagno," or swamp, forming part of the royal hunting demesne of Castel Fusano, and left undrained in order to preserve the wild boar, water fowl, &c., which frequent it. The hut will stand close to a canal containing a luxuriant growth of algæ and other aquatic plants, and within a stone's throw of a clump of pine trees, which forms the outskirts of the Castel Fusano pine forest. The few dwellings near are inhabited by peasants who constantly suffer from malaria and are infested by mosquitoes of the anopheles variety. Situated thus in the heart of the swamps surrounding the mouth of a large river, among the haunts of innumerable mosquitoes of the malarial variety, and in a locality notorious as one of the most deadly of the fever-stricken centres of the Roman Campagna, this dread and unhealthy spot appears to offer ideal conditions for the carrying out of the interesting but dangerous experiment now about to be begun. The two daring investigators hope to have everything in readiness early in the present month; in the meantime, their time is profitably occupied in studying the animal and insect life of the Campagna, collecting and examining frogs, lizards, bats, spiders, mosquitoes, and the like. They have already made some interesting observations, as, for example, that although the larvæ of anopheles are at this season apparently very few, the adult mosquitoes are collected in the houses in great numbers, being especially numerous near byres and stables. The King has graciously given his consent to the erection of the hut in the royal preserves, and the municipality of Rome are doing everything in their power to help the enterprise.

THE annual general meeting of the Jenner Institute of Preventive Medicine was held on Friday last, when Dr. Macfadyen, the director, was able to state that the Institute's work had continued to progress. Among the new features added during the year were a physiological room, a room for incubating purposes, a laundry, a workshop, and a cold storage room. A Hansen apparatus for yeast culture had been presented, and considerable additions had been made to the library. Three papers were communicated to the Royal Society upon the influence of the temperature of liquid air and hydrogen upon bacterial life. Systematic investigations are being carried out in the bacteriological department upon enteric fever, tuberculosis, and the etiology of cancer. Special investigations were carried out for public authorities during the year, *e.g.* upon tubercle in milk, glanders, anthrax, &c., and investigations in a number of other directions have been and are being prosecuted with vigour.

THE recent case of the Jenner Institute of Preventive Medicine *v.* Assessment Committee of St. George's, Hanover Square, was the means of raising once more the important question of the rateability of scientific societies. The Jenner Institute has unfortunately failed to establish its claim to exemption from the payment of rates. The Divisional Court decided that the Institute did not fulfil the conditions of the Act of Parliament exempting "any Society instituted for purposes of science, literature, or the fine arts exclusively." The preparation and sale of preventive and curative medicines was held by Mr. Justice Grantham to be the main object of the Institute, or as Mr. Justice Channell put it, "its main object was to dispense to the public the benefits of science." The Institute was not, therefore, "exclusively" devoted to the advancement of science. The Institute has, as a matter of fact, dispensed for the benefit of the public, and at a considerable loss, certain antitoxins which require the highest scientific skill in their preparation. The preparation of these substances has been at the same time a means of studying and improving the methods for producing immunity to given diseases. The aims in this respect have been of a purely scientific character, and in accordance with the main objects of the Institute, which are not, despite the Court's ruling, of a dispensing nature, except in so far as opportunity is afforded to medical men to test the value of certain antitoxins in the treatment of disease. The eminently useful aims of the Institute, which are carried out at great cost, might have been thought to bring it well within the intention of the Act, but the judicial interpretation of the word "exclusively" has formed the stumbling-block. It is to be feared that the expense of litigation may prevent the Institute from proceeding to an appeal. In any case, it is to be hoped that some steps will be taken to amend an Act, apparently devised for the benefit of scientific societies, but which, as interpreted by the Court, has little or no practical value. It is quite conceivable, as the law stands, that a claim for exemption might be defeated on the ground that a daily newspaper had been admitted to the reading-room of an institute, and that it was not, therefore, "exclusively" devoted to purposes of science.

THE annual general meeting of the Marine Biological Association was held in the rooms of the Royal Society on June 27. The council reported that arrangements had been completed for the supply of sea-water, obtained from the open sea beyond the Plymouth Breakwater, for special experiments on the rearing of sea-fishes and other marine animals. Through the kindness of Mr. J. W. Woodall, the Association has had placed at its disposal a small floating laboratory, which is at present stationed at Salcombe. The periodical surveys of the physical and biological conditions prevailing at the mouth of the English Channel have been continued by Mr. Garstang at quarterly intervals for an entire year. Observations were taken at four fixed stations. They included serial temperature determinations at all depths, filtration of a definite column of water from bottom to surface with a "vertical net," and collections of the floating life at surface, mid-water and bottom, by means of a specially devised closing net. Mr. Garstang has also carried out a series of preliminary experiments on the rearing of sea-fish larvæ under different conditions, with a view to a solution of the difficulties hitherto encountered in regard to the practical work of sea-fish culture. The investigation of the fauna and

bottom deposits of the shallow water grounds in the neighbourhood of Plymouth, upon a systematic plan, has been continued during the year.

A SUCCESSFUL trip has at last been made with Count Jeppelin's navigable balloon at Friedrichshafen on Lake Constance. On Saturday evening the ascent was prevented by an explosion of one of the segments of the balloon, and a similar accident is stated to have befallen one of Count Zeppelin's benzine motors. On Sunday evening, Count Zeppelin and four others made their first ascent, and after drifting with the wind, turned and tried to make headway against it; but the wind appears to have been too strong, and the balloon was quietly lowered to the lake, where the cars floated and the occupants were brought to shore without any damage. From another telegram dated July 2 (Monday) we learn that a successful ascent was made that evening. This must have been a second attempt, and it is stated that the ship travelled safely to Immenstadt, thirty-five miles from Friedrichshafen, and landed all well.

LONDON was again visited by a sharp thunderstorm about midday on Tuesday; the rainfall and hail during the storm amounted to 0·23 inch in Westminster. The weather has continued in a very unsettled condition, but, nevertheless, the mean temperature in the neighbourhood of London for the month of June exceeded the average by about 0·05. This result has been caused chiefly by the amount of cloud which, while making the days cool, has kept the nights relatively warm. The rainfall for the month was 0·66 inch above the average, and in some parts of England it was double the average.

THE *Lancet*, quoting from a Buenos Ayres review of hygiene, entitled *La Salud*, gives some interesting particulars concerning the plague. Formerly, according to a tradition common amongst certain tribes of South American Indians, wide-spreading fires used to sweep over the land. The inhabitants were in the habit of taking refuge in caves and dens of the earth. From time to time they poked out the branch of a tree, and if this when pulled in again showed no signs of burning they considered it safe to come out. So formerly when plague ravaged and desolated various countries the inhabitants shut themselves up in the cave of isolation and did not come forth until they learned that plague had disappeared. Nowadays, however, just as the Indian tribes possess herds of horses which they did not formerly possess, and are able by these means to stamp out pampas fires, so that there is no need to take refuge in a cave, so also modern cities possess hygienic knowledge and conditions which render isolation unnecessary, and a general dissemination of plague throughout Europe and America is as impossible as a fire which should affect the whole pampas. In India and in China only those persons succumb who live under grossly unhygienic conditions. With reference to the recent outbreak of plague in Argentina, *La Salud* says, "It would be greatly to the honour of the Argentine Republic if she would invite other countries to a conference to consider the question of meeting plague, if not actually by abandoning all international action yet by leaving commerce perfectly free and by treating the disease wherever it appears exactly like any other infectious disease which assumes endemic characters."

THE annual report of Sir George Nares, F.R.S., acting conservator of the Mersey, has just been issued, and shows that considerable work has been done by the sand-pump dredgers *Brancker* and *G. B. Crow* at the Queen's Channel Bar and at certain shoals in the Queen's and Crosby Channels, at the entrance to the river. For several months the surveys show considerable improvement, many of them having no soundings less than 27 ft. below low water spring tides within the dredged cut. Though there has been slight shoaling at the outer end or the north side of the channel, several good lines of sounding run the full length of the cut with not less than 27 ft. During the year 2,067,000 tons were dredged in Queen's Channel, 1,839,000 tons taken from shoals in that channel, and 2,735,000 tons from shoals in Crosby Channel, making a total of 6,659,000 tons, while since the commencement of the operations 45,148,860 tons of sand have been removed. The number of inward and outward bound vessels passing through Queen's Channel last year was 45,158, against 44,376 in the previous year, and 35,932 in 1893. The daily average of last year was 124 against 98 in 1893. The total using all the channels increased from 41,439 in 1893 to 50,964 in 1898, and 52,216 last year. The sand removed from the river between Liverpool and New Brighton in 1899 was 1,374,670 tons. In the same period 1,375,272 tons of silt and detritus were raised from the Manchester Ship Canal and deposited at sea.

THE idea of substituting electricity for horse-traction on canals has not been so widely developed as one would have expected to see, but some experiments of an instructive nature (*Engineering*, June 22) have been made by a German firm on behalf of the Prussian Government, wherein electric locomotives were employed for this purpose, and the mode of working may be briefly stated as follows:—A section of the Finow Canal, which forms a portion of the waterway between Berlin and Stettin, was chosen, embodying as it does physical difficulties with reverse curves, &c. On the towing-path a meter-gauge track of special design with overhead conductor was laid, on which the electric motor tows the barges; and owing to the deficiency of adhesive weight a steel rack is bolted to the permanent way, and the rack-rail system is adopted. In spite of many difficulties the experiments proved that the system was capable of meeting all requirements, and worked with apparent ease. This is very satisfactory, the more so because in one place, we are told, the line was raised 9 feet 6 inches above the towing-path with approaches of 1 in 8½ gradients. The electric motor used, we are informed, developed from 14 to 15 horse-power, much more than was necessary; but this was intentionally provided in view of further experiments to deal with the possibility of electric traction for barges of a heavier type.

IN NATURE for September 1, 1892, Prof. D. Kikuchi announced the foundation by an Imperial ordinance of an earthquake investigation committee in Japan. The objects of the committee were to study the nature of Japanese earthquakes and their distribution in time and space, to discover any means of lessening their disastrous effects, and if possible to ascertain laws by which their occurrence might be predicted. During the eight years of its existence much successful work has been done by the committee in two of these directions. They have accumulated and discussed many series of observations and records, and have conducted numerous experiments on the fracturing and overturning of columns and on the type and material of building best suited to resist a strong shock. The results are printed partly in Japanese papers; partly, we are glad to see, in their "Publications in Foreign Languages," the third and fourth numbers of which have appeared this year. If abstracts of the former could be given either in English or French, the debt we already owe to Japanese seismologists would be greatly increased.

THE Verein zur Förderung des Unterrichts in der Mathematik und den Naturwissenschaften held its annual meeting at Hamburg in the first week in June. This association, which numbers some 900 members, includes many teachers in the higher schools of Germany among its ranks, and it has taken part in the preparation of reports on physical apparatus suitable for teaching purposes. The programme included, among other subjects of papers, the teaching of geometry of position, wireless

telegraphy, experiments with liquid air, flight of birds, the International Catalogue, and the preservation of natural objects of interest in Germany.

WE are indebted to Prof. P. H. Schoute for a paper on the locus of the centre of hyperspherical curvature for the normal curve of n dimensional space. In a previous paper the author pointed out that the characteristic numbers of the locus of the centre of hyperspherical curvature are lowered if some of the points of the given rational curve lying at infinity coincide. At present Prof. Schoute traces for a special case the amount of these lower numbers, namely, for the case where the given curve is the "normal" curve of the n dimensional space in which it is situated. According to the final result, the characteristic numbers of the locus of the centre of hyperspherical curvature for the normal curve are respectively $2n-1$, $3n-3$, $4n-7$, $5n-13$, $6n-21$, ... $2n-1$, from which it follows that they do not change if taken in reverse order.

A REPORT on dietary studies of Harvard and Yale University boat crews, conducted by Prof. W. O. Atwater and his assistant, Mr. A. P. Bryant, forms *Bulletin* No. 75 of the U.S. Department of Agriculture. These studies were undertaken primarily to secure data regarding the food requirements of men performing severe muscular work, and they lead to the conclusions that the actual food consumption of people in general is regulated more or less by the supply at their disposal and their tastes and appetites; but that it is justifiable to suppose that in a general way the difference between the food of athletes and that of other people represents a difference in actual physical need, even if neither is an accurate measure of that need. The energy of the food consumed per man per day in the dietary studies of university boat crews was found to exceed by 400 calories, or about 10 per cent. the amount found, as the average of fifteen dietary studies among college clubs in different parts of the country, while the protein in the studies of the university boat crews was 48 grams, or 45 per cent. larger in amount.

IN the *Rendiconti del R. Istituto Lombardo*, Dr. Benedetto Corti briefly describes the results of a study of the Diatomaceæ of the lakes of Brianza and Segrino. Of a total of eighteen species of diatoms observed in the lake of Montorfano, two (*Synedra lunaris* and *Stauroneis platystoma*) were Alpine in character, and were supposed by the author to represent the remains of a quaternary diatom flora. This view has been confirmed by a more extended study of the other lakes of Brianza and Segrino, which revealed the presence of fifteen species of diatoms peculiar to the Alpine zone out of a total of seventy-two. Of the Alpines, however, only one, viz. *Navicula firma*, was found in the lake of Sartirana. There is a decided affinity between the diatom flora of these lakes and that of the lake of Palù in the Malenco valley, and that of Poschiavo in the Engadine.

NO. 17 of the "North American Fauna," now in course of publication by the Biological Division of the U.S. Department of Agriculture, is devoted to a revision of the North American voles, or "field-mice," of the genus *Microtus*, by Mr. V. Bailey. As the work is based on the examination of between 5000 and 6000 specimens, including typical representatives of every species, from more than 800 different localities, it ought to be exhaustive. The genus, which is divided into nine subgeneric groups, is taken to include no less than seventy distinct specific and sub-specific modifications, three of which are described for the first time. It is noticed that the development of oil-glands and musk-glands is most conspicuous in the aquatic members of the group, and least so in those inhabiting the driest regions. Those forms which are most exposed to light and dryness are the palest, while the deepest and richest tones of colour are developed in those from damp and shaded localities. Attention is directed to the importance of placing every possible check on the increase of these little mammals, and of reducing their numbers when they become unusually abundant.

IN its *Bulletin* No. 12, the department just mentioned publishes a useful report, by Mr. P. S. Palmer, on the legislation for the protection of birds, other than game-birds, now in force in the United States. The author states that many insectivorous birds are still unprotected; and that the laws relating to such birds in general lack uniformity in different parts of the States; this diversity in the laws being illustrated by a map. The report closes with a digest of the bird-laws of the different States. The need of further legislation is strongly emphasised.

IN this connection may be noticed a pamphlet on the food of wild birds in this country, issued by the Yorkshire College and the Joint Agricultural Council of Leeds and the East and West Ridings. In this useful publication attention is called to the fact that birds very largely affect both sides of the farmer's balance-sheet; and that while, unfortunately, the damage they do is readily detected, the great services they render can only be appreciated by those who take pains to investigate the subject. The "pros and cons" in regard to each particular bird seem to be very fairly considered.

THE July number of the *Journal of Conchology* contains an interesting sketch of the life and career of the late Mr. Lovell Reeve, the well-known conchologist, with extracts from his diary and correspondence.

NO fewer than three books dealing with the life and work of the late Prof. Huxley are being prepared at the present time. Messrs. Macmillan and Co. will issue the biography of his father by Mr. Leonard Huxley, and a volume on the professor is to be added to Messrs. Putnam's Sons' "Leaders of Science" series from the pen of Mr. P. Chalmers Mitchell; while a third work is to be contributed to Messrs. W. Blackwood and Sons' "Modern English Writers" series by Mr. Edward Clodd.

MESSRS. CHARLES GRIFFIN AND CO., LTD., have sent us the seventeenth annual issue of the "Year-Book of the Scientific and Learned Societies of Great Britain and Ireland," comprising lists of the papers read during 1894 before societies engaged in no fewer than fourteen departments of research. The serial, which is too well known to need more than a brief reference here, contains much information of service to literary and scientific men. It would be yet more valuable if the officials of certain societies, against whose entry the words "No Return" appears, could be induced to furnish the compiler with the titles of the papers presented to their respective institutions.

A NEW edition (the fifth) of "The Microtomist's Vade-Mecum," by Arthur Bolles Lee, has just been issued by Messrs. J. and A. Churchill. Considerable changes have been made in the present edition, the whole work having been very carefully revised since the last edition appeared nearly four years ago. The text has undergone condensation throughout, making it possible for much new matter to be added without increasing the size of the volume.

MORE and more space, we are glad to see, is being given in the popular magazines to articles dealing in a greater or less degree with scientific subjects, and in the monthlies for July that have reached us we notice the following contributions of this character:—In *Pearson's Magazine* Prof. Simon Newcomb explains to the lay reader in simple language, and by the aid of diagrams, "How the Planets are Weighed"; while Dr. F. A.

Cook, who was attached to the Belgian Antarctic Expedition, discourses pleasantly on "The Possibilities of Reaching the Four Poles." In *Good Words* Mr. E. W. Maunder writes on "The Lords of Cold" (the title, it may be noted, is borrowed from a line in Plumptre's "Dante"), the article being a study in stellar perspective. In the same magazine is also to be found a contribution, by Mr. Aflalo, on "How Wild Creatures Feed." *Chambers's Journal* always contains at least one article of scientific interest; the present number has in it papers, entitled "Tropical Diseases and Cures" and "Alcohol from Paper and Sawdust."

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. G. A. S. Bell, R.N.; a Ring-tailed Lemur (*Lemur catta*) from Madagascar, presented by Miss M. C. Rawcliffe; a Common Duiker (*Cephalophus grimmi*, ♂) from South Africa, presented by Mr. J. E. Matcham; five Wild Cats (*Felis catus*) from Inverness-shire, presented by Mr. George J. Bailey; a Levaillant's Amazon (*Chrysotis levaillanti*) from Mexico, presented by Mr. J. Farmer Hall; a Royal Python (*Python regius*) from West Africa, presented by Mr. Benjamin Stewart; an Alpine Newt (*Molge alpestris*), nine Black Salamanders (*Salamandra atra*), two Slowworms (*Anguis fragilis*) from Switzerland, presented by the Rev. J. W. Horsley; a Common Viper (*Vipera berus*), British, presented by Mr. G. Alan Marriott; a Common Duiker (*Cephalophus grimmi*, ♀) from South Africa, a Syrian Bear (*Ursus syriacus*) from Western Asia, a Cheetah (*Cynoelurus jubatus*) from India, two Black-faced Kangaroos (*Macropus melanops*, ♂, ♀) from Tasmania, six Wrinkled Terrapins (*Chrysemys scripta rugosa*) from the West Indies, an Amboina Box Tortoise (*Cyclemmys amboinensis*) from the East Indies, five Mississippi Terrapins (*Malacoclemmys geographica*), a Prickly Trionyx (*Trionyx spinifer*) from North America, three Annulated Terrapins (*Nicoria annulata*) from Western South America, deposited; a Three-toed Sloth (*Bradypus tridactylus*) from British Guiana, purchased.

OUR ASTRONOMICAL COLUMN.

EPHEMERIS FOR OBSERVATIONS OF EROS.—The following computed positions for July are from the ephemeris prepared by Herr F. Ristenpart (*Astronomische Nachrichten*, Bd. 152, No. 3643).

Ephemeris for 12h. Berlin Mean Time.

1900.	R.A.	Decl.
	h. m. s.	° ′ ″
July 5 ...	0 54 6·51 ...	+14 13 22·3
7 ...	57 27·78 ...	14 50 33·5
9 ...	1 0 48·24 ...	15 27 55·3
11 ...	4 7·89 ...	16 5 27·7
13 ...	7 26·71 ...	16 43 10·8
15 ...	10 44·66 ...	17 21 5·0
17 ..	14 1·68 ...	17 59 10·8
19 ...	17 17·70 ...	18 37 28·1
21 ...	20 32·62 ...	19 15 57·1
23 ...	23 46·36 ...	19 54 38·1
25 ...	26 58 84 ...	20 33 31·3
27 ..	30 9·98 ...	21 12 36·9
29 ...	33 19·70 ...	21 51 55·1
31 ...	1 36 27·93 ...	+22 31 26·5

MEASURES OF EROS.—*Harvard College Observatory Circular* (No. 51) contains the results of the measurements of photographs obtained during the years 1893, 1894 and 1896, giving the positions of the planet during those years. The complete discussion of the measures is being prepared for a volume of the Observatory *Annals*, but the numbers here published show that at the Harvard College Observatory there is the means of tracing the path of any object since 1890, during the times in which it was moderately bright, with nearly as great accuracy as if a series of observations had been taken of it with a meridian circle.

TOTAL ECLIPSE OF THE SUN, MAY 28.—M. Deslandres communicates the report of his work in connection with the recent eclipse to the *Comptes rendus* (vol. cxxx. pp. 1691–1695). His programme comprised four classes of investigation:—(1) velocity of corona; (2) ultra-violet spectrum of corona and chromosphere; (3) infra-red spectrum of corona; (4) photography of corona.

Observing visually with a powerful grating spectroscope, he found by the inclination of the corona line that on the west side of the equator the corona appeared to have a more rapid speed of rotation than the disc. The photographic spectra taken for this purpose are too faint for measurement.

The ultra-violet spectra were obtained with spar quartz prismatic cameras, ten plates being obtained showing good images down to λ 3000.

The investigation of the infra-red radiation from the corona was undertaken with a view of providing a possible means of observing the corona without an eclipse, and the results would indicate that the corona is specially rich in these calorific radiations. M. Deslandres states that at his station, Argamasilla, Spain, totality was five seconds shorter than the calculated time.

THE ROYAL OBSERVATORY, GREENWICH.

IT is customary for the Astronomer Royal to present his annual report to the Board of Visitors of the Royal Observatory on the first Saturday in June, but as it is easier to transfer such a function to another date than to change the time of a total eclipse of the sun, the usual day of meeting was adjourned until June 26 last. On this day, the weather, however, did not quite come up to summer standard; but fortunately the rain held off, and the afternoon proved sufficiently fine to allow the numerous visitors to inspect the buildings and instruments. As is customary, we give below a brief *résumé* of the report.

BUILDINGS.

The building of the new observatory so near to the boundary of the grounds has necessitated an alteration in the position of the old fence, to show the building off more effectively, so that provision has been made in the Navy estimates to put the fence further away, and the plans for this are now under consideration. This building also includes the new library rooms, and we learn that the removal of the books to their new position was completed in March last. The opportunity has also been utilised for their rearrangement and for the preparation of a new catalogue, both of which, we are told, were much needed. Not only is the rearrangement of the books practically complete, but good progress has also been made with the formation of the card catalogue, a system which is to be highly recommended.

TRANSIT CIRCLE.

The sun, moon, planets, and fundamental stars have been regularly observed on the meridian as in previous years. The number of observations made from 1899 May 11 to 1900 May 10, is as follows:—

Transits, the separate limbs being counted as one observation	10,712
Determinations of collimation error	297
Determinations of level error	684
Circle observations	10,001
Determinations of nadir point (included in the number of circle observations)	674
Reflexion observations of stars (similarly included)	637

The number of stars observed in 1899 is about 5000.

An unusually large number of observations was obtained in the three months, August–October, the average number of transits observed being more than 1300 each month. From November to the date of the report, in consequence of the cloudy weather, the average has been only half this number.

The apparent correction for discordance between the nadir observations and stars obtained by reflexion for 1899 was found to be slightly larger—namely, −0″·41—than that of last year, which was −0″·36.

The results of recent years are as follows :—

	Mean	Range in Yearly Means
	″	″
1880–1885	−0·34	From −0·29 to −0·45
1886–1891	+0·03	„ −0·12 to +0·09
1892–1898	−0·30	„ −0·25 to −0·36

Observations of level and nadir have been made, when practicable, three or more times on the same day, and diurnal changes similar to those referred to in the last report have been found in 1899. The observations of level taken within three hours of noon and midnight give corrections of +0″·30 and +0″·18 respectively, to those made within three hours of 6 p.m. Similarly the observations of nadir near noon and midnight give corrections of +0″·17 to those made within three hours of 6 p.m.

In view of this systematic diurnal movement of the instrument and of the large number of observations of azimuth stars in recent years, it seems probable that the limit of accuracy obtainable by the use of double transits for the determination of the positions of the close polar stars has been reached, as this involves the assumption that the azimuth error remains constant for twelve hours at least. It has therefore been arranged to use these stars for determination of azimuth error, by means of their tabular right ascensions, and to keep the observations for improvement of the tabular place only when the azimuth error has been determined by at least three pairs of close polar stars above and below pole on the same evening.

The correction for the R–D discordance, found for 1899, is +0″·080+0″·218 sin Z.D. The coefficient of sin Z.D. was about +0″·6 from 1881 to 1894, diminished to +0″·41 and +0″·37 in 1895 and 1896, to +0″·10 in 1897 and 1898, and has now increased to +0″·22.

The observations of the zenith distances of pairs of stars directly and by reflexion, alternately on alternate nights, have been discontinued. The observations made in the four years, 1895, 1896, 1897 and 1898, show a satisfactory agreement with the ordinary observations, reflexion and direct at the same transit, confirming the striking diminution in the value of the R–D discordance in 1897 and 1898 as compared with 1895 and 1896.

The colatitude of the transit circle, as found from observations of about 600 stars in 1899, is 38° 31′ 21″·76, differing by −0″·14 from the adopted value. The corresponding values of the correction to the adopted colatitude found in 1897 and 1898 are −0″·17 and −0″·15, and it may be noticed that the R–D discordance was very small in these years.

The mean error of the moon's tabular place (computed from Hansen's lunar tables with Newcomb's corrections) is −0ˢ·099 in R.A. and +0″·27 in N.P.D., deduced from 116 observations. These are equivalent to an error of −1″·38 in longitude and 0′·00 in ecliptic north polar distance.

The re-observation of the stars of Groombridge's Catalogue, which was the principal object of the Second Ten-Year Catalogue, furnishes material for determination of the proper motions of more than 4000 stars from observations about eighty years apart, with intermediate positions in the Radcliffe Catalogue of 1845. Provisional proper motions are given in the Introduction for 163 stars, for which the annual proper motion in R.A. or N.P.D. amounts to 0″·1 of a great circle, and had not previously been determined. It is proposed to undertake the determination of the proper motions of all the stars in Groombridge's Catalogue. Before doing this it was considered desirable to re-examine Groombridge's Observations, with special reference to the determination of azimuth error, in view of the large systematic error in Right Ascension. The original MSS. of Groombridge's Observations have been kindly lent by the Council of the Royal Astronomical Society, and the examination is in progress.

The New Altazimuth.

This instrument is now in good working order. Various repairs have been required and minor improvements have been made. The observations of transits seem quite satisfactory, the accordance in the results for clock error in different positions of the instrument (referred to the transit circle) being very good. For the zenith distance observations further determinations of flexure and division-errors are required, and these are in hand. The investigation of the division errors of both circles has shown that the accordance of two determinations is not very satisfactory, and the cause of the discrepancy is now under investigation.

Among the observations made with this instrument may be mentioned 1729 R.A. observations of the sun, planets and stars, 1418 N.P.D. observations, and 2386 observations for collimation, level, and azimuth errors, and nadir.

The 28-inch Refractor.

This instrument has been used throughout the year for micrometric measurements of double stars. 492 stars have been measured; 268 of these have their components less than 1″·0 apart, and 139 less than 0″·5. The stars whose distance apart is less than 1″·0 have been measured on the average on three nights each, and the wider pairs on two nights. The wider pairs measured consist of bright stars with a faint companion, of third companions to close pairs, and of stars of special interest.

In consequence of Mr. Newall's suggestion that the newly discovered spectroscopic binary Capella might possibly be observed as a double star with large telescopes, it has been examined on fifteen nights (from April 4 to May 10) by a number of observers, who all found the star's image to be sensibly elongated; while the position angle of the elongation changed during the period of observation (April 4 to May 29) in fair accordance with the period of 104 days given by Mr. Newall.

Thompson Equatorial.

The 26-inch refractor has been in constant use throughout the year. The occulting shutter has been found of great value in obtaining accurately measurable photographs when one of the objects photographed is considerably brighter than the other objects in the field.

Fifteen photographs of Neptune and its satellite have been obtained, of which seven have been measured. Fifty-four photographs of twenty-six double stars have been obtained, of which forty-seven have been measured. Among these stars are Algol and Aldebaran, with their faint companions of fourteenth magnitude. The measures of distance and position-angle of the photographs of double stars are published in the *Monthly Notices of the Royal Astronomical Society* for April 1900. Nineteen photographs have been obtained of Comet Swift, of which fifteen have been measured, and the results published in the *Astronomische Nachrichten*, Nos. 3584–5. In addition, photographs of Polaris and neighbouring stars have been taken for parallax, a few photographs of the moon and some of the major planets with their satellites, and others for testing adjustments and the characters of the images in different parts of the field.

The 30-inch reflector has been used chiefly for the photography of nebulæ and star clusters. The photographs of the nebulosity of the Pleiades and of the Orion nebula are very fine, and show a large amount of detail.

Astrographic Equatorial.

The following statement shows the progress made with the plates for the chart and the catalogue respectively :—

	For the Chart (exposure 40m.).	For the Catalogue (exposures 6m., 3m., and 20s.).
Number of photographs taken ...	243	236
„ successful plates ...	162	181
„ fields photographed successfully ...	155	175
Total number of successful fields reported 1899 May 10	1027	1030
Number of photographs, previously considered successful, rejected during the year	106	102
Total number of successful fields obtained to 1900 May 10 ...	1076	1103
Number still to be taken... ...	73	46

A comparison of this list with the one published in the last report shows that great progress has been made in this work.

It is satisfactory to note that the plates are now placed in the new observatory, where they are kept dry and not subject to the extremes of temperature as formerly. Those that were previously spoilt through damp are now being gradually replaced.

During the year 88,000 measures of pairs of images (6m. and 3m.), as well as of the diameters of the 6m. images, have been made. The number of quarter plates measured in the twelve months in two positions of the plates is 556.

At the date of the last report the measurement of the plates was completed from December 64° to 69°; and in Zone 70° from R.A. 0h. to 13h. 48m. During this year Zone 70° has been finished and Zones 71° and 72° have been measured, with the exception of thirty-six quarter plates. Subject to this exception, the measurement is complete from December 64° to 73°.

Good progress has been made with the printing of the measures. Zone 64° is finished and Zone 65° as far as R.A. 21h. 36m. It is estimated that all the measures from December 64° to December 72° will be included in one volume of about 650 pages.

Heliographic Observations.

In the year ending 1900 May 10, photographs of the sun have been taken on 180 days, either with the Thompson or Dallmeyer photo-heliographs. The former, mounted on the Thompson 26-inch refractor, was used as the regular instrument for solar photography up to March 9, when it was temporarily dismounted, the Dallmeyer photo-heliograph being substituted for it. Of the photographs taken with either instrument, 369 have been selected for preservation, besides 11 photographs with double images of the sun, for determination of zero of position angle. Photographs to supplement the Greenwich series have been received from India or Mauritius up to 1900 March 8.

For the year 1899, Greenwich photographs have been selected for measurement on 202 days, and photographs from India and Mauritius (filling up gaps in the series) on 162 days, making a total of 364 days out of 365 on which photographs are at present available.

The chief characteristic of the sun's surface, during the period covered by this report, has been the steady decline in the mean daily number and area of spots observed, August and September 1899 in particular showing a marked sub-minimum.

Magnetic Observations.

The variations of magnetic declination, horizontal force, and vertical force, and of earth currents have been registered photographically, and accompanying eye observations of absolute declination, horizontal force and dip have been made as in former years.

The regular observations of magnetic declination have been made since 1899 January 1, in the Magnetic Pavilion, alternating with determinations in the Magnet House (for effect of the iron in the Observatory buildings), the observations in the Magnetic Pavilion being made with a hollow cylindrical magnet mounted in conjunction with the large theodolite.

The determinations of horizontal force and dip have been made with the Gibson deflexion instrument and the Airy dip circle mounted in the new Magnetic Pavilion, since 1898 September.

The principal results for the magnetic elements for 1899 are as follows:—

Mean declination	. . 16° 34′·2 West.
Mean horizontal force ...	3·9947 (in British units).
	1·8419 (in Metric units).
Mean dip (with 3-inch needles)	67° 10′ 13″.

These results depend on observations made in the new Magnetic Pavilion, and are free from any disturbing effect of iron. The correction to the declination, as found in the Magnet House, is −10′·7, as deduced from the observations made with the new declinometer in the Magnetic Pavilion.

The magnetic disturbances in 1899 have been few in number. There were no days of great magnetic disturbance and sixteen of lesser disturbance. Tracings of the photographic curves for these days, selected in concert with M. Mascart, will be published in the annual volume as usual. The calculation of diurnal inequalities from five typical quiet days in each month has been continued.

The question of the regulations to be enforced for the protection of the Observatory from disturbance of the magnetic registers by electric railways or tramways in the neighbourhood is now under the consideration of the Board of Trade.

Meteorological Observations.

Consequent on the changes in connection with the new Observatory buildings, the shed containing the photographic thermometers was moved 15 feet towards the west on May 16 and 17, 1899.

The Kew Committee of the Royal Society has suggested that steps should be taken to assimilate the methods of registration of atmospheric electricity with the Thomson electrometers at Greenwich and Kew, and the question of the modifications to be introduced into the Greenwich electrometer is now under consideration.

The mean temperature for the year 1899 was 50°·7, being 1°·2 above the average for the fifty years, 1841–90.

During the twelve months ending 1900 April 30, the highest temperature in the shade (recorded on the open stand in the Magnetic Pavilion enclosure) was 90°·0, on August 15. The highest temperature recorded in the Stevenson screen in the Observatory grounds was 88°·8 on the same day.

The month of August was exceptionally warm, the mean temperature for the month being 65°·5, which is 3°·9 above the fifty years' average (1841–1890). This high temperature for the month has only been reached before on one occasion in the previous fifty-eight years, viz. in August 1857. The month of November was also exceptionally warm, the mean temperature for the month being 4°·8 above the average.

The lowest temperature of the air recorded in the year was 18°·0, on February 9. There were fifty days during the winter on which the temperature fell below 32°, a number slightly below the average.

The mean daily horizontal movement of the air in the twelve months ending 1900 April 30 was 268 miles, which is 13 miles below the average for the preceding thirty-two years. The greatest recorded daily movement was 776 miles on April 13, and the least 50 miles on October 22. The greatest recorded pressure of the wind was 27 lbs. on the square foot, on November 3, and the greatest hourly velocity 48 miles, on April 13.

The number of hours of bright sunshine recorded during the twelve months ending 1900 April 30, by the Campbell-Stokes instrument, was 1636 out of the 4454 hours during which the sun was above the horizon, so that the mean proportion of sunshine for the year was 0·367, constant sunshine being represented by 1.

The rainfall for the year ending 1900 April 30 was 21·97 inches, being 2·57 inches less than the average of fifty years. The number of rainy days was 146. The rainfall in the month of August was only 0·354 inch, being the smallest August rainfall on record in the fifty-nine years, 1841–99. The next smallest value was 0·45 inch, in August 1849. The rainfall in February amounted to 3·58 inches, being the largest February rainfall on record in the sixty years, 1841–1900, with the exception of the February rainfalls in 1866 and 1879, which amounted to 4·03 and 3·81 inches respectively.

The remaining portion of the report is devoted to the progress in the printing and distribution of the publications and chronometers, time-signals, longitude operations, &c.

In view of the large additions to and modifications in the instruments and buildings of the Royal Observatory in recent years, it is proposed to prepare a full description of the Observatory, illustrated by photographs.

It may be mentioned that the Observatory equipped and sent out an expedition to observe the total solar eclipse of May 28, having received the sanction of the Admiralty. The Astronomer Royal, with Mr. Dyson and Mr. Davidson, left for Ovar, in Portugal, on May 11, taking with them the Thompson 9 inch photographic telescope, the new 4-inch enlarging lens for large-scale photographs of the corona, a pair of photographic spectroscopes with heliostat, lent by Captain Hills, for photographing the spectrum of the lower chromosphere and of the corona, and a double camera, on one of the photo-heliograph mountings, with lenses of 4 inches and 2½ inches aperture for photographing the coronal streamers.

An examination of the fine photographs that were obtained by the party, which were shown on the day of the visitation, gave one a good idea of the success which had rewarded their efforts.

THE GEOLOGICAL AGE OF THE EARTH.[1]

WHILE, in his efforts to arrive at an estimate of geological time, the geologist himself is seriously hampered by the uncertainty of the data at his disposal, he has followed with expectant interest the successive attempts made by votaries of

[1] "An Estimate of the Geological Age of the Earth." By J. Joly, M.A., D.Sc., F.R.S., Hon. Sec. Royal Dublin Society; Professor of Geology and Mineralogy in the University of Dublin. Pp. 44. (*Scientific Transactions* of the Royal Dublin Society, vol. vii. Ser. ii. Dublin, 1899.)

kindred sciences to attain the solution of a problem so fascinating. It is true that past efforts in this direction have taught us to expect at the best a merely approximate result, by whatever method this problem may be attacked; at the same time, every attempt is welcome which shall tend to more narrowly limit the margin of approximation. In the important treatise before us, Prof. Joly proposes a novel and ingenious method of approaching this difficult question, and if his argument relies for its success on a considerable basis of assumption, he has nevertheless arrived at results of striking interest.

It is, first of all, assumed that the denudation by solution of the land surface, since the first formation of a solid earth-crust, has been on the whole a uniform process; and further, that the amount of sodium now contained in the ocean has been for the most part transported to it by rivers since the land surface first became exposed to the action of solvent denudation. The reasons which, in the author's view, render these assumptions probable truths are fully discussed in the paper. If, now, we can obtain a correct estimate of the amount of sodium at present contained in the waters of the ocean, and also of the amount annually supplied to the latter by rivers, we have the requisite data whereby the earth's geological age may be determined. Basing his calculations upon the most careful and recent estimates, Prof. Joly finds that the mass of sodium contained in the ocean amounts to $15{,}627 \times 10^{12}$ tons. In estimating the amount of sodium carried annually by rivers into the sea, Sir John Murray's analyses of nineteen rivers (including many principal ones) are quoted, and a result of 24,106 tons of sodium per cubic mile of river water is obtained. Sir John Murray's estimate of the annual river discharge into the ocean, amounting to 6,524 cubic miles, is also accepted. From these figures the mass of sodium annually carried to the sea is calculated, and this amount divided into the total mass of sodium contained in the ocean, gives a result of about 94,800,000 years, representing the duration of geological denudation. So much is set forth in the first section of the paper. In the succeeding eight sections corrections on the above estimate are discussed, and several possible objections are dealt with.

The author first enters into a speculative discussion regarding the succession of events attendant on the first cooling of the earth's surface, with the object of arriving at conclusions as to the nature of the primitive ocean. Incidentally the view is favoured which supposes that at the first condensation of water upon the surface a greater density was conferred on the sub-oceanic crust than on the sub-aërial tracts; it is deemed improbable that this distribution of pressure became subsequently seriously modified, and the author gives his support to a belief in the permanency of ocean basins. The early ocean itself is supposed "for want of other known alternative," to have contained "a quantity of hydrochloric acid roughly represented by the chlorine now in the ocean." This being admitted, it is clear that a certain degree of saltness would primarily be acquired by the early hydrosphere, and this must be allowed for in modifying the above estimate of geological time. To accomplish this Prof. Joly first quotes Clarke's average analysis, showing the probable composition of the primitive earth-crust. The action of the heated acid ocean upon such a rock mass, and the apportioning of the acid among the bases, is next considered. It is calculated that of the total amount of chlorine contained in the original ocean, only 14 per cent. could have been taken up to form sodium chloride, and in order to arrive at the actual amount of this first formed sodium chloride, Prof. Joly proceeds to estimate the chlorine of the original ocean. This is done by subtracting from the total amount of chlorine now contained in the ocean the quantity of that element supposed to have been transported to it by rivers during the course of geological time. But of the river-transported chlorine a certain proportion has been derived from the sea itself, and for this a deductive allowance of 10 per cent. is made as probably sufficient. Having estimated that a total of about 76×10^6 tons of chlorine are annually supplied by rivers to the sea, the author *assumes* the duration of geological denudation to have been about 86×10^6 years, and finds that during this period 6536×10^{12} tons of chlorine have been introduced into the ocean. By subtracting this from the total chlorine now contained in the sea (as sodium chloride and magnesium chloride), a total of $21{,}780 \times 10^{12}$ tons is arrived at, representing the original chlorine of the oceanic waters. If 14 per cent. of this would unite with sodium, then 1972×10^{12} tons of sodium were brought into solution by the action of the primitive acid ocean. This result can now be employed in correcting the original estimate of geological time, which was reckoned on the supposition that all the sodium now in the ocean had been supplied by rivers. Thus, the total amount of sodium supplied by rivers is reduced to $13{,}655 \times 10^{12}$ tons, and this deductive correction of 12·6 per cent. reduces the duration of geological time to $86{\cdot}9 \times 10^6$ years. The value of this ingenious correction appears to be lessened, however, by the necessary introduction of an arbitrary assumption for the duration of geological time. Is there any reason, too, to show that at the first condensation of water upon the earth, alkalies may not have been present to neutralise to almost any unknown extent the acid of the primæval ocean? The author believes that the amount of correction necessary in allowing for the action of acids other than hydrochloric, in the primitive ocean, is practically negligible.

By a further slight modification of the figures representing the sodium annually transported into the sea, a final estimate of 89·3,000,000 years is arrived at, a figure based, we are told, "on the most complete estimate of probabilities." But even in this estimate the author does not claim a degree of accuracy "approximating to so small a time interval as 100,000 years."

Prof. Joly then examines the significance of rock-salt deposits, as possessing a possible bearing on his theory, but having discussed the origin of such deposits he concludes that any error involved by ignoring them must be very slight. But the extent of the saline deposits surely cannot possibly be estimated, and may perhaps have been considerably underrated. Even if it be admitted, as urged by the author, that the salt basins of the present day are in great part not of oceanic origin, this does not necessarily apply in like degree to saline deposits of the past, when earth movements may have played a more vigorous part in aiding their formation as oceanic derivatives.

A point of seemingly great significance in its bearing on Prof. Joly's theory is the retention of salts in the interstices of stratified rocks, the salts derived from the waters in which the rocks were laid down. In 1856 Dr. Sorby drew attention to the soluble salts contained in certain dolomites, and Dr. Sterry Hunt has recently referred to the "fossil sea water" retained in the pores of stratified rocks.

The observations of the Rev. O. Fisher on this point, recorded in a recent review of Prof. Joly's paper (*Geol. Mag.*, March 1900) are of the greatest interest, as showing that some of the sodium of river waters may have been derived not from the rocks, but originally from the ocean itself.[1] In estimating the mass of sodium held in solution by the ocean, should not some allowance be made too for an unknown bulk of highly pervious deep-sea sediments? May not such deposits be in part of great thickness, and by reason of the sea water with which they are impregnated form a store for sodium?

In the succeeding section the potash and soda percentages of the igneous and sedimentary rocks respectively are considered. Quoting Clarke and Rosenbusch for estimates of these, Prof. Joly attempts to prove that the deficiency of soda in the sedimentary rocks (1·47 per cent. of soda and 2·49 per cent. of potash, as against 3·61 per cent. of soda and 2·83 per. cent. of potash in the primitive crust) is accounted for by the amount of sodium calculated to have been supplied to the ocean by rivers. It is claimed "that the estimated amount of sedimentary strata would, in its formation, be adequate to yield to the ocean the sodium that is in it, assuming these sedimentaries to be derived from rocks having the mean composition of the important eruptive masses now known." Allowance is made for a slight deficiency in the sodium of the ocean by the existence of the rock-salt deposits. For the success of this argument it is unfortunately necessary to assume that a correct estimate of the total bulk of the sedimentary rocks is possible. Mr. Mellard Reade's calculation is provisionally taken as a basis. Accepting also Mr. Reade's estimate of the proportion of calcareous to other sediments, the latter are found to be equal to a layer 1·6 miles in depth over all the land area. From this the mass of the detrital sediments is calculated, and the actual amount of their soda is arrived at. To this is now added the amount of sodium (reckoned as soda) contained in the sea. This restoration would bring the soda percentage of the total mass of sedimentary rocks, even allowing for the rock-salt deposits, to little above 3 per cent., and in order that the figures shall be brought into better accordance with Clarke's calculated soda percentage for the primitive crust, the estimate of the amount of detrital sedimentary rocks is ingeniously amended to equal a layer 1·1 miles thick over all the land area, with the result that an amount

[1] Since these lines were written, Prof. Joly has dealt further with this point and with the question of alkalies neutralising the primitive acid ocean (*Geol. Mag.*, May 1900).

is obtained little short of the desired 3·61. This result must appear sufficiently striking, but it may be seriously doubted whether even an approximate estimate of the total bulk of sedimentary strata can possibly be arrived at. Such an estimate must inevitably rest in great part on a basis of pure speculation. Not only are we ignorant, as regards huge areas, of the thickness of these strata, but immense tracts still remain unexplored so far as their geology is concerned. Further, the boldest guess can tell us little of sedimentary strata hidden beneath the surface of the ocean, and it may be looked upon as a lucky coincidence that Prof. Joly is able to attain the above result when restoring to the estimated sedimentary rocks the sodium of the sea. The question also of pre-Cambrian rocks of sedimentary origin appears here to be too lightly passed over, for although so little is known of their actual extent, the trend of recent researches has been to show that they may constitute a not unimportant fraction of the total sediments formed. It is scarcely necessary to recall the fact that the earliest known fossil faunas, including marine forms of comparatively high organisation, clearly indicate that a habitable ocean had already for long ages been in existence.

The unequal ratios of the alkalies in the ocean and in the rivers respectively next receive attention. The fact that the ratio of potash to soda is very much higher in the rivers than in the sea, is believed by the author, not to indicate that the rivers now contain more potash relatively to soda than in former times, but is to be accounted for by the constant abstraction of potash from the ocean, largely in the glauconite now forming on the sea floor, and so extensively distributed in the sedimentary strata. Stress is also laid on the fact that potassium brought from the atmosphere by rain tends to become retained upon the land, while the sodium is more readily returned to the ocean. In arguing for the uniformity of denudation by solution in past times, Prof. Joly brings forward some good reasons to show that the distribution of land and sea can have varied but little. As regards the greater exposure of igneous rocks in early times some interesting points on the nature of weathering and soil formation are noted, and it is concluded that the unequal percentage of sodium in the igneous and sedimentary rocks would, as regards supply to the ocean, be counterbalanced by the different rates of weathering. Sedimentary rocks, poorer in alkalies, allow of more rapid denudation.

In the concluding section of this paper the action of the ocean as an agent in solvent denudation is dealt with. Such action, the author maintains, is carried on chiefly along the coast lines, and is very small as compared with that effected by rain and river waters. Experiments are quoted to show that the power of sea-water to decompose felspar is minute in comparison with that exerted by fresh water. It is further pointed out that the volcanic *débris* of oceanic deposits have the alkali ratio of igneous and not that of sedimentary rocks. A correction of half a million years on the original time estimate is thought to be a sufficient allowance to make for the solvent denudation by the ocean. But even allowing, as held by the author, that chlorides other than sodium chloride may in past times have in some measure retarded solvent denudation by the ocean, it may be suggested that subaqueous volcanic action, at one time more frequent than at present, with its attendant conditions of exceptional temperature and pressure, may by frequent repetition through vast periods of time have played some part in aiding this process.

Prof. Joly does well in finally recognising the uncertainty attending his corrections on the original estimate of geological time, and he certainly allows no too wide a margin for error in the final result when he claims that "a period of between eighty and ninety millions of years" has elapsed since the land first became exposed to denuding agencies. For not only in the data upon which the corrections are founded, but also in the factors employed in the original calculation, there is to be found comparatively little of certainty and much that is purely speculative. In this latter category must be placed the supposed sequence of events at the first cooling of the globe. The relative intensity of geological activities in the past is also unknown to us, and the possibilities as regards the activity of the sun and the influence of the moon in modifying meteorological agencies during the earlier chapters of the earth's history appear to render hopeless the final solution of the time-problem by such a method as that here employed. But in this interesting treatise Prof. Joly has with marked ability and originality attacked a most difficult question, and his novel theory calls for the fullest consideration from all geologists and physicists.

NOTES ON SATURN AND HIS MARKINGS.

THE possessors of telescopes will welcome the reappearance of Saturn as a rather conspicuous object in the evening sky. The planet now rises at 7h. 40m. p.m., and remains visible afterwards throughout the night, but unfortunately his altitude is extremely low. His southern declination being 22½°, his position is only 16° above the horizon at Greenwich even at the time of his meridian passage. Notwithstanding these unfavourable conditions, excellent views may, however, occasionally be obtained of his general aspect. From stations in the southern hemisphere the planet may be seen under the best circumstances.

This planet with his rings, belts and moons, forms a picture quite unique of its kind. The globe is greatly compressed at the poles, like that of Jupiter, and the rate of its axial rotation similarly rapid. We recognise also in the dusky bands of Saturn another parallel to the visible lineaments of the "Giant Planet," but there is a marked difference as regards the distinctness with which the details on the two bodies may be viewed. Jupiter's large disc and superior brilliancy enable the markings and their variations of form and motion to be followed with great facility and certainty. Saturn being much smaller and fainter is more difficult, especially as regards the more delicate features. Cassini's division in the rings and the principal belt on the globe may be distinguished with a two inch refractor, but Encke's division in the outer ring is a doubtful, or probably a very variable feature, which at certain times appears to be missing altogether, while on other occasions it is described as faintly outlined as a pencil-like curve at the ansæ.

That there are occasional irregularities on Saturn is proved beyond contention. In 1790 Sir W. Herschel remarked a very dark spot on the limb, and in 1793 noticed some irregularities in a quintuple belt which enabled him to ascertain the planet's rotation period. The large white spot seen by Prof. Hall and others at the close of 1876 affords a good instance of change, and it is well-known that the disposition and number of the belts vary from year to year. We naturally conclude that these belts must occasionally exhibit irregularities like those of Jupiter.

The planet is now presented to us at an angle which permits the ring system to be seen with splendid effect. We now view the northern side of the ball and rings, and this will continue to be the case until 1907.

Perhaps there is no object upon which it is easier to exercise the imagination than upon Saturn. And there is probably no orb in reference to which more errors in detail have been made, though both Mars and Venus have encouraged a large number of observational misconceptions. Many of the abnormal results reported in recent years, and due to small instruments, may be safely dismissed, for they are not only doubtful but, when all the conditions are considered, ridiculous, and palpably the outcome of unconscious suggestions of the imagination. Yet there can be no question as to the good faith of those who are responsible for some of the wonderful seeings lately published. They honestly believe they have seen what they have drawn, and as a matter of fact it is an extremely difficult point to distinguish between real and imaginative features on Saturn. The trembling of the image, its faintness under high power or its smallness under low power encourage much fictitious detail which every observer cannot regard as illusory.

Some of those who claim to have seen many irregular markings on this beautiful planet ascribe their success to special training; but this explanation will scarcely stand, for others of equal experience and using more powerful appliances have quite failed to observe them. The difference is not one of sight, of practice, or of instrumental means. It resolves itself into a question of personal ethics. There are men who will report nothing but what they are absolutely certain is presented to their eyes, and are unbending in their regard for the truth; there are others who, though equally sincere in intention, are not so reliable in their judgment, and accept features which are apparently glimpsed, but which are in reality prompted by the imagination on an unsteady and very delicate object.

It is to be hoped that time will eliminate all the fanciful representations of Saturn which recent observations have so abundantly supplied. The period has now arrived when the planet may be telescopically surveyed with a view to obtain a really sound knowledge of such features as are portrayed in moderately powerful instruments. Those who have employed large and small telescopes in planetary observation aver that the former are more effective than the latter; but it is remarkable

that small instruments have been the means by which a large amount of useful work has been done in this field of observation. It is also an unavoidable conclusion that many of the mistakes in planetary work have been due to inadequate power and light in the appliances used. Possibly during the next few months some of the existing discordances may be cleared up, and some new facts learnt concerning this the most beautiful planet of our system.

There was an interesting occultation of Saturn by the moon on June 13, but at Bristol clouds interfered with observation. At Yeovil, Somerset, the Rev. T. E. R. Phillips watched the phenomenon with a 3-inch refractor. There will occur another event of this kind on September 3 next, when the planet will disappear at 7h. 16m. and reappear at 8h. 11m. p.m. Occultations of Saturn are somewhat rare, the last, prior to that of June 13, occurring twelve years ago, viz. on October 1, 1888.

The planet may now be studied with advantage from southern observatories, where his altitude will be considerable and conduce to that excellent definition which is so necessary for the detection of faint and delicate markings. At every opposition it seems necessary that the number and arrangement of the various belts should be noted. A dark polar cap should be looked for, and any irregular appearances, such as dark and light spots on the dusky belts or intervening zones, should be carefully recorded. It is unfortunate that the results obtained in previous years are not sufficiently accordant to be of much service. In some cases where one observer has drawn one or two belts, another, equally experienced and with more powerful means, has represented seven or eight. Certain observers see the belts and zones mottled with spots, while others describe the aspect as perfectly smooth and quite devoid of all such irregularities. The evidence is, in fact, so conflicting that new and thoroughly trustworthy observations are greatly needed to set at rest the actual character of the details visible on this exceedingly attractive object. W. F. DENNING.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—On April 27, 1899, an anonymous gift of 5000*l.* was made towards the building of a pathological laboratory. The donor now allows his name to be made known, and a decree will consequently be proposed on July 7, that the thanks of the University be conveyed to Ewan Richards Frazer, B.M., Balliol College, for his munificent donation to the pathological laboratory.

CAMBRIDGE.—The annual report of the Cambridge Observatory appears in the *Reporter* for June 30. It includes an account of valuable work done with the Newall telescope, and of the steps taken to bring to perfection the Sheepshanks photographic equatorial. The binary character of α Aurigæ was announced as discovered at the Observatory two days before the arrival of Prof. Campbell's independent publication from the Lick Observatory.

Scholarships, or exhibitions, in natural science have been awarded at the following Colleges thus :

Peterhouse : Lee.

Gonville and Caius : Cleminson, Burne, Garnsey, Lock, Macfie, Rittenberg, Thornton.

The Hopkins Prize for the period 1894–97 has been awarded to Mr. J. Larmor, F.R.S., of St. John's College, for his investigations on the Physics of the Aether and other valuable contributions to mathematical physics.

Mr. William Ritchie Sorley, formerly Fellow of Trinity College, has been chosen Knightsbridge Professor of Moral Philosophy in the place of Dr. Henry Sidgwick, who has resigned in consequence of ill health.

PROF. SIMON NEWCOMB has had the degree of doctor of laws conferred upon him by the University of Toronto.

PROF. J. H. POYNTING, F.R.S., has been elected Dean of the Faculty of Science of the University of Birmingham.

THE honour of knighthood has been bestowed upon Dr. G. Hare Philipson, president of the University of Durham College of Medicine, Newcastle-upon-Tyne.

PROF. J. R. CAMPBELL, head of the Agricultural Department of Yorkshire College, has been appointed under-secretary to the Department of Agriculture and Technical Instruction for Ireland.

THE honorary degree of D.Sc. has been conferred by the University of Oxford upon Prof. J. Mark Baldwin, of Princeton University, New Jersey, U.S.A. The new doctor is professor of psychology at Princeton, and editor of the *Psychological Review*.

HONORARY degrees were on Saturday last conferred by the Victoria University upon Lord Rayleigh, Sir William Huggins, Sir W. C. Roberts-Austen, Sir William Abney, Dr. T. E. Thorpe, Prof. J. Dewar, Prof. A. R. Forsyth, Mr. R. T. Glazebrook, Prof. Pickering, Prof. J. J. Thomson, and Mr. Henry Wilde.

A GRANT of 58*l.* from the Earl of Moray Endowment has been made by the Edinburgh University Court to Dr. J. H. Milroy for purposes of research. At a recent meeting of the Court it was announced that the late Prof. Sir D. Maclagan had bequeathed a marble bust of himself to the University, and that Miss E. A. Ormerod had presented six large volumes of drawings, chiefly by her father, to the library.

THE Drapers' Company offer for competition eight scholarships tenable at the day classes of the East London Technical College in chemistry, physics and engineering. The scholarships are of the value of 25*l.*, 10*l.* being paid during the first year and 15*l.* during the second year. They also carry with them free tuition. Particulars may be obtained from the Director of Studies, East London Technical College, People's Palace, E.

THE annual meeting terminating the session of the department of engineering in connection with University College, Liverpool, took place on Thursday last, when the William Rathbone Medal and the Rathbone Prizes were distributed by the Lord Mayor of Liverpool. The report, which was of a highly satisfactory character, was read by Prof. Hele-Shaw, after which an address was delivered by Prof. John Perry, F.R.S., upon the value of a thorough scientific education to the engineer.

THE following is a list of the members of the new Board of Education Consultative Committee :—Rt. Hon. Arthur Herbert Dyke Acland, Sir William Reynell Anson, Bart., M.P., Prof. Henry Armstrong, Mrs. Sophie Bryant, Rt. Hon. Sir William Hart Dyke, Bart., M.P., Sir Michael Foster, K.C.B., M.P., Mr. James Gow, Litt.D., Mr. Ernest Gray, M.P., Mr. Henry Hobhouse, M.P., Mr. Arthur Charles Humphreys-Owen, M.P., Sir Richard Claverhouse Jebb, M.P., Hon. and Rev. Edward Lyttelton, Very Rev. Edward Craig Maclure, D.D., Dean of Manchester, Miss Lydia Manley, the Venerable Ernest Grey Sandford, Archdeacon of Exeter, Mrs. Eleanor Mildred Sidgwick, Prof. Bertram Coghill Alan Windle, M.D., Rev. David James Waller, D.D. The draft Order in Council, giving particulars of the duties, &c., of the Committee, has been issued as a Parliamentary paper.

FURTHER munificent gifts for the furtherance of education in the United States are announced in *Science* and are as follows:—The sum of 125,000 dollars has been left to Harvard University by the late Edmund Dwight. The bequest will come into the hands of the University authorities after the death of certain persons who receive the income during their lifetime. The amount (100,000 dollars) promised by Mr. Rockefeller to Denison University, on condition that 150,000 dollars additional be raised before July, has now been claimed, the sum named having been subscribed. The sum of 50,000 dollars has been given to Colorado College by Mr. W. S. Stratton ; Mr. M. K. Jesup has given 25,000 dollars to Princeton University, and Lombard College in Galesburg, Ill., benefits in a like degree by the gift of Mr. W. G. Waterman ; while 10,000 dollars have been subscribed by Messrs. Phelps, Dodge and Co. for the endowment of the department of mining and metallurgy at Columbia University. In addition to the foregoing it is announced that Mr. L. C. Smith will build and equip a civil engineering building in connection with Syracuse University.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 14.—"The Nature and Origin of the Poison of *Lotus Arabicus*." By Wyndham R. Dunstan, F.R.S., Sec.C.S., Director of the Scientific Department of the Imperial Institute, and T. A. Henry, B.Sc.Lond.

Lotus Arabicus is a small leguminous plant resembling a vetch, indigenous to Egypt and Northern Africa. It grows abundantly in Nubia, and is especially noticeable in the bed of the Nile from

Luxor to Wady Halfa. It is known to the natives as "Khuther," and old plants with ripe seed are used as fodder. The dried plant is unusually green, and possesses the aroma of new-mown hay. At certain stages of its growth it is highly poisonous to horses, sheep and goats, the poisonous property being most marked in the young plant up to the period of seeding. Owing to the trouble which this plant has given to the military and civil authorities in Egypt, the assistance of the Director of Kew was sought in order that the precise nature of the poison might be ascertained, and, if possible, a remedy found. The matter having been referred to the Scientific Department of the Imperial Institute, Mr. E. A. Floyer, Director of Egyptian Telegraphs, collected some of the material for investigation.

It was found that when moistened with water and crushed, the leaves of the plant evolved prussic acid in considerable quantity, the amount being greatest in the plant just before and least just after the flowering period. Further investigation has shown that the prussic acid originates with a yellow crystalline glucoside ($C_{22}H_{19}NO_{10}$), which it is proposed to name *lotusin*. Under the influence of an enzyme, also contained in the plant, lotusin is rapidly hydrolysed, forming *prussic acid*, *sugar*, and a new yellow colouring matter (*lotoflavin*). The hydrolysis may be effected by dilute acids, but is only very slowly brought about by emulsin and not at all by diastase. The peculiar enzyme, which it is proposed to call *lotase*, appears to be distinct from the enzymes already known. Its activity is rapidly abolished by contact with alcohol, and it has only a feeble action on amygdalin. Old plants are found to contain lotase but no lotusin.

The *sugar* has been proved to be identical with ordinary dextrose.

Lotoflavin, the yellow colouring matter, has the composition expressed by the formula $C_{15}H_{10}O_6$. It belongs to the class of phenylated pheno-γ-pyrones, and is a dihydroxychrysin, isomeric with luteolin, the yellow colouring matter of *Reseda luteola*, and with fisetin the yellow colouring matter of *Rhus cotinus*.

The decomposition which ensues on bringing lotase in contact with lotusin, as happens when the plant is crushed with water, is therefore probably expressed by the following equation:—

$$\underset{\text{Lotusin.}}{C_{22}H_{19}NO_{10}} + 2H_2O = \underset{\text{Lotoflavin.}}{C_{15}H_{10}O_6} + \underset{\text{Prussic acid.}}{HCN} + \underset{\text{Dextrose.}}{C_6H_{12}O_6}.$$

Hydrocyanic (prussic) acid occurs in small quantity in many plants, and according to Treub and Greshof is often present in the free state. The only glucoside at present definitely known which furnishes this acid is the well-known amygdalin of bitter almonds, which under the influence of the enzyme emulsin, also contained in the almond, breaks up into dextrose, benzaldehyde and prussic acid.

Owing to the scientific interest which attaches to this new glucoside, its properties and those of its decomposition products have been very fully studied, and the characteristics of the new enzyme have also been investigated.

We are much indebted to Mr. Floyer for the great pains he has taken to collect, in Nubia, the necessary material for this investigation, and also to Sir W. T. Thiselton-Dyer for having grown the plant at Kew from seed obtained from Egypt.

"The Exact Histological Localisation of the Visual Area of the Human Cerebral Cortex." By Joseph Shaw Bolton, B.Sc., M.D., B.S. (Lond.).

Geological Society, June 6.—J. J. H. Teall, F.R.S., President, in the chair.—Mechanically-formed limestones from Junagadh and other localites, by Dr. J. W. Evans. After reviewing the conditions under which granular limestones may be accumulated by current- or wind-action, the author proceeds to describe the limestone of Junagadh, a deposit some 200 feet thick, resembling in hand-specimens the Oolites of this country, though less firmly cemented together. The deposit is situate at a distance of thirty miles from the sea, and contains no large fossils of any kind. Calcareous rocks of similar character are described from other parts of Kathiawad, Kach, the south-eastern coast of Arabia, and the Persian Gulf—some of these contain unbroken marine shells and other fossils. These beds are included by Dr. H. J. Carter under the name of miliolite, on account of the frequent presence in them of the genus *Miliola*. The author discusses the origin of these deposits, and comes to the conclusion that the grains were formed in sea-water saturated with carbonate of lime: some being deposited by currents in shallow water, and others thrown up as a calcareous beach, from which a portion were sifted out by the wind and blown inland to form æolian deposits.—Note on the consolidated æolian sands of Kathiawad, by Frederick Chapman. The name miliolite-formation was originally given by Dr. H. J. Carter to certain granular calcareous deposits occurring on the coast-line between the peninsula of India and the mouth of the Indus. The foraminifera and other organic remains in the rocks must have inhabited moderately shallow to littoral marine areas. The minute granules are worn and polished; the prevailing genera of foraminifera are roundish, and would be easily moved by wind; remains of larger organisms are absent; and the deposits are false-bedded. All these phenomena are explicable if the deposits represent the accumulation of material derived from littoral calcareous sand of marine origin, mixed with mineral detritus from adjacent hills.—On Ceylon rocks and graphite, by A. K. Coomara Swamy. Ceylon is surrounded by raised beaches, and has been elevated in recent geological times; fluviatile deposits also occur: the gems for which Ceylon is famous are obtained from gravels in the Ratnapura district. With the exception of these recent deposits, the island probably consists entirely of ancient crystalline rocks. Graphite occurs chiefly in branching veins in igneous rocks, which at Ragedara are granulites and pyroxene-granulites. The relations to the matrix are described, and are held to favour the idea of the deposition of the mineral as a sublimation-product (Walther), or from the decomposition of liquid hydrocarbons (Diersche). Analysis of several of the minerals, including manganhedenbergite, are given; and a bibliography of the geology of the island is appended.

Mineralogical Society, June 19.—Prof. N. S. Maskelyne, F.R.S., Past-President, in the chair.—Prof. H. A. Miers presented a communication from Miss Agnes Kelly on conchite, a new form of calcium carbonate. Conchite forms the material of various calcareous secretions in the animal kingdom (more particularly molluscan shells) which have hitherto been referred to aragonite; it also occurs as the fur in kettles and boilers, and in many concretionary deposits, such as those of Karlsbad. In most of its characters it is intermediate between calcite and aragonite; like calcite it is uniaxial negative, but shows no cleavage or twinning, and has higher indices of refraction; and like aragonite it is converted into calcite on heating, but the change takes place at a lower temperature.—Mr. G. F. Herbert Smith described a method for the determination of the three principal indices of refraction from observations made in any arbitrary zone. This method is intended for minerals of low symmetry of which the indices are higher than those of any liquid. Observations are made of the deviations corresponding to different angles of incidence on both faces of a prism, and curves connecting the indices and the angles of orientation are plotted out. As in the method of total reflection, three of the critical values give the principal indices.—Mr. H. L. Bowman described the occurrence of monazite at Tintagel, and gave a detailed account of the crystallographic characters of the associated minerals, albite, quartz, rutile, pyrites and calcite.—Dr J. W. Evans discussed the alteration of pyrites by underground water, a question which had arisen in connection with the erection of a dam in Mysore. From his experiments the author concludes that, provided the water contain a sufficient amount of carbonate of lime to neutralise the sulphuric acid resulting from the oxidation of the pyrites, exact pseudomorphs of limonite after pyrites are formed; and as these occupy practically the same volume as the original pyrites, the rock suffers little disintegration by the action of the water.—Petrological notes by Mr. G. T. Prior dealt with the so-called "cancrinite-ægyrine-syenite" of Elfdalen, which he refers to sussexite at the basic end of the grorudite-tinguaite series of Brögger; with a riebeckite-ægyrine-tinguaite (so-called "proterobase") from the Rupbachthal; and with melilite-basalts from Madagascar and Siam.—Mr. L. Fletcher discussed the quantitative determination of the action of hydrochloric acid and of soda-solution on the enstatite and felspar of the Mount Zomba meteorite.

CAMBRIDGE.

Philosophical Society, May 21.—Mr. J. Larmor, President, in the chair.—On a certain diophantine inequality, by Major MacMahon, R.A., F.R.S.—On rational space curves of the fourth order, by Mr. Richmond.—On the reduction of quadrics, by Mr. Bromwich.—Experiments upon the rise of temperature of fabrics when moistened, by Dr. L. Cobbett. Dr. Cobbett showed that if expired air is breathed through several layers of dried filter paper wrapped round the bulb of a thermometer, a temperature

of 10° C. or more above that of the body may be registered (Dr. Dudgeon's experiment); and that if a roll of flannel, thoroughly dried, be warmed to 96° C. and put into saturated steam at 100° C., the temperature within the roll may rise 30° C. or more above that of the steam (Dr. Parson's experiment). Further, he showed that when a roll of flannel, which has not been artificially dried is put into steam, at atmospheric pressure, heated to 200° C., though the surface of the roll becomes charred, the temperature in its interior rises rapidly to 100° C., but does not exceed this for a long time—indeed, not until all the separable water has been boiled away. He concluded that such substances when quite dry have the property of uniting with water, and of generating heat in the process, and this without becoming damp in the ordinary sense of the word; and maintained that the source of this heat is not alone the latent heat of the vapour condensed, because a rise of temperature takes place when dried filter paper is wetted with water at the same temperature, but must include also either the latent heat of water converted into the solid state—as Sir W. Roberts has suggested in discussing Dr. Dudgeon's experiment—or else the energy set free in a chemical combination between the material and the water.—Experiments upon striated discharges, by R. S. Willows. The conditions affecting the distance between the striæ were investigated for hydrogen, nitrogen and air. In the first gas, as the current was increased from a very small value, the striæ first separated, attained a maximum distance of separation, and finally approached each other. In nitrogen and air their distance apart at first increased, and finally became constant. The distance apart varies inversely as the pressure until the discharge reaches the walls of the tube. The effect of the nature of the gas, the diameter and length of the tube, and the shape of the electrodes was also investigated. Any variation due to these was found to obey no simple law. The double striæ in hydrogen, noticed by De la Rue and Müller, were found to constitute a normal part of the discharge in this gas, provided a suitable pressure were established.—A method of measuring the retardation produced by a crystal plate, by L. R. Wilberforce. The author described a ready way of approximately determining the retardation produced by a plate of biaxial crystal cut perpendicularly to a mean line. The requisite measurements could be made with an ordinary polariscope.

PARIS.

Academy of Sciences, June 25.—M. Maurice Lévy in the chair.—Problem of the cooling of a wall by radiation, reduced to the simpler case of cooling by contact, by M. J. Boussinesq.—Note on a series of abnormal contacts in the western region of the lower Pyrenees, by MM. Michel-Lévy and Léon Bertrand.—M. Giard was elected a member of the Section of Anatomy and Zoology in the place of the late M. Milne-Edwards, and M. Bazin was elected correspondent for the Section of Mechanics.—On the large sun-spot observed on June 17 with the great telescope of 1900, by M. Moreux. This sun-spot, a drawing of which accompanies the note, had a diameter of 36,000 kilometres, and furnished a good example of the mechanism of segmentation of a sun-spot. According to the author's hypothesis, the phenomena are not due to cyclones or volcanoes, but to superheated regions.—Trigonal normal curves, by M. F. Amodeo.—On the motion of a wire in space, by M. G. Floquet.—On two remarkable groups of geometrical loci, by M. E. Mathias. In his experimental results obtained with carbonic acid, M. Amagat has considered the case of the locus of points in the (p, v) plane, such that for a total weight of liquid and vapour equal to unity, the volume of the liquid is constantly equal to that of the vapour. This locus, according to M. Amagat, is a straight line, nearly perpendicular to the axis of abscissæ; but the author now shows that this locus is a curve constantly convex towards the volume axis.—On the discontinuity of the kathodic emission, by M. P. Villard. The three modes of exciting a Crookes' tube are considered, alternating currents, an induction coil and a static machine, and in each the phenomenon would appear to be discontinuous.—On the permeability of fused silica to hydrogen, by M. P. Villard. At 1000° fused quartz resembles platinum, in allowing hydrogen to pass through.—On the resistance of fused silica to sudden variations of temperature, by M. Dufour.—On the telegraphone, by M. Valdemar Poulsen. A description of an instrument for automatically recording words spoken through a telephone.—On the development and propagation of the explosive wave, by M. H. Le Chatelier. An application of the photographic method to the study of the explosive wave. Measurements are given for various mixtures of acetylene and oxygen, acetylene and nitric oxide, acetylene and nitrous oxide, and carbon monoxide and oxygen. In the last case the velocities depend upon the mode of ignition, and upon the quantity of the fulminating substance used to start the explosive wave.—On the acidity of the alcohols, by M. de Forcrand. A thermochemical paper.—Addition of hydrogen to ethylene in presence of various reduced metals, by MM. Paul Sabatier and T. B. Senderens. Reduced cobalt effects the combination of ethylene and hydrogen at ordinary temperatures similarly to reduced nickel. A comparison of the results obtained with reduced nickel, cobalt, copper and iron shows that the activity of the metals in causing this reaction is in the order given, nickel being the most energetic.—On the crystalline combinations of acetylene with cuprous chloride and potassium chloride, by M. Chavastilon. It has been previously shown by the author that two kinds of crystals, yellow and colourless, may be obtained from the same copper solution, according to the velocity of the current of acetylene. Further analyses show that the colourless crystals correspond to the formula

$$C_2H_2.(Cu_2Cl_2)KCl,$$

and the yellow crystals,

$$C_2H_2.[(Cu_2Cl_2)_2KCl.]_2.$$

By the action of ether upon the colourless compound, the yellow crystals are obtained.—Oxidation of anethol and analogous substances containing a lateral propenylic chain, by M. J. Bougault. The method of oxidation used is the action of iodine in presence of precipitated mercuric oxide, an aldehyde being obtained. Aldehydes from anethol, isosafrol, isomethyleugenol and isoapiol have been prepared, together with the corresponding acids.—On a new derivative of benzophenone, by MM. Œchsner de Coninck and Derrien.—Composition of the compounds of fuchsine with acid colouring matters, by M. A. Seyewetz.—On the kidney of *Lepadogaster Goüanii*, by M. Frédéric Guitel.—On a fayalite rock, by M. A. Lacroix. The fayalite of Callobrières presents a very remarkable and exceptional mineralogical composition. It is essentially characterised by the association of the fayalite with grünerite, apatite and magnetite.—The function of the cell nucleus in absorption, by M. Henri Stassano. The nucleus, by reason of its chemical composition, plays a predominating part in the absorption of foreign substances.—On the proteolytic diastase of malt, by MM. A. Fernbach and L. Hubert.—Action of high frequency currents upon the elementary respiration, by M. Tripet. In diseases of nutrition, treatment by high frequency currents regulates the activity of reduction of the oxyhæmoglobin.—Influence of extracts of the ovaries upon the modifications of nutrition caused by pregnancy, by MM. Charrin and Guillemonat.—The lake of Ladoga from the thermal point of view, by M. Jules de Schokalsky.—On a balloon ascent made on June 17, by M. Genty.—On an extraordinary halo observed on June 22, by M. Joseph Jaubert.

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