THURSDAY, JULY 9, 1896.

PROFESSOR ROUX'S COLLECTED WORKS.

Gesammelte Abhandlungen über Entwicklungsmechanik der Organismen. Von Wilhelm Roux. Vol. i. Pp. xiv + 816. Vol. ii. Pp. iv + 1075, 10 plates and 33 woodcuts. (Leipzig: W. Engelmann, 1895.)

ALTHOUGH Prof. Roux must be regarded as the founder of that branch of zoological research called "The Mechanics of Development," which has recently become so popular, yet his works are comparatively little known to zoologists in this country; and it will probably occasion a mild shock of surprise to the English reader, to see the two huge tomes which bear Prof. Roux's name.

When, however, one peruses these works, it soon becomes clear, from the numerous complaints on the subject which Prof. Roux makes, that the writer's own countrymen have not been in the habit of reading his publications with that care which their imposing size would seem to demand; and whatever wonder one may feel at this in the first instance, is soon removed when one becomes acquainted with the contents of the volumes. It may be said, we think with truth, that next to the recording of careless observations, the most deadly sin which a zoological writer can commit is prolixity, and it must be confessed that in this respect Prof. Roux sins very badly. The quantity of literature which is pouring in on us is stupendous; it is becoming more and more difficult for a zoologist to keep himself abreast of the times in more than an exceedingly limited department of the subject, and it seems to us that it is the first duty of every writer to put his results as briefly as is consistent with clearness. In justice to Prof. Roux, it should be mentioned that there is in this, as in every "complete edition of works," a good deal of unavoidable repetition, since of course the volumes are made up of separate papers, in several of which the same or similar subjects are treated; but when every allowance has been made, one is obliged to confess that the proportion of theory to fact is enormous, and that no effort is made to put matters in a compact and terse manner.

The first volume may be said to contain Prof. Roux's theory of organic evolution, as well as several applications of it in specific cases. The proper place to commence the perusal is with the second paper; the first paper contains an account of the laws of branching of blood-vessels, which laws are regarded by Prof. Roux as special instances of the general principles deduced in the second essay from a general survey of biological facts.

Prof. Roux first shows the extreme difficulty of accounting by simple natural selection for the innumerable adaptations, carried out into the finest detail, which are met with in all the organs of the vertebrate body. According to this theory, a variation, in order to be preserved, must be of such decided advantage or disadvantage to its possessor as to settle the question of survival. When we find, however, that all over the body secondary blood-vessels are given off at such angles that the blood-current encounters no frictional resistance, that in bones the meshes of the spongy ossification are disposed so as to strengthen the structure only in those directions in which it is apt to be bent, and thus effect the maximum of economy consistent with efficiency; that the fibres of fasciæ are arranged parallel to the directions of tension; how are we to picture to ourselves such arrangements arising from the accumulation of irregular variations? Are we seriously asked to believe that a slight alteration in the direction of the fibres of one of the tendons, or in the angle which a small artery makes with the larger one from which it springs, would determine the survival of an individual? Is it credible that animals are so tremendously hard-pressed for food that such a trifling economy in material would appreciably affect them? Even if we are capable of such confiding faith in the theory, we are met by further difficulties. Suppose, for example, that a better arrangement of the skeletal material in a given bone will save the life of an animal, what right have we to assume that this variation will be accompanied by similar advantageous changes in other organs? Are not the chances a thousand to one, that the advantage which one animal possesses in one organ will be balanced by the advantages which another possesses in another respect, so that natural selection will have no opportunity to heap up variations? It is to be observed that even if we assume that "related parts" vary together, it will help us. For the question s not one of a general change in the character of bones, for instance, all over the body, but of the special adaptation of each bone to the local needs. Further, if we say that at one period in the existence of vertebrates, one organ was of relatively great importance and improved by natural selection, and then another, how are we to suppose that the change from an aquatic to an air-breathing existence took place? Here, as Prof. Roux points out, we must have had simultaneous modifications in almost all the organs of the body: the respiratory and circulatory organs, the limb muscles, the eye and other sense organs, must all have changed at the same time.

It must be admitted that Prof. Roux has brought together a most powerful case against the doctrine of the "all-sufficiency of natural selection," and we feel sure that his arguments will awaken a sympathetic chord in the minds of many, if not most, zoologists, amongst whom there is a general feeling that we want something more than natural selection.

Destructive criticism is, however, always easier than constructive hypothesis, and it seems to us that the hypothesis which Prof. Roux puts forward as supplementary to the ordinary doctrine of natural selection is not by any means satisfactory. Briefly it is as follows. Every cell, he assumes, is made up of various parts capable of assimilation and reproduction (the biophores of Weismann), and it is infinitely probable that the rates of assimilation and reproduction of these parts will not be alike. Hence those which thrive best under the stimuli which are pouring in upon the cell, will increase faster than the others, and gradually squeeze them out of existence, and by this means the most useful cell qualities will gradually be evolved. The same reasoning applies to the cells themselves. We know that in many organs the old cells are gradually worn out and replaced by new ones. The cells of the formative layer (such as the Malpighian layer of the epidermis) will not be precisely equal in their qualities, and those whose assimilation and reproduction is furthered by the "functional stimuli" (that is, the stimuli, such as light, contact, chemical action, which call forth the performance of the function of the organ as a response) will flourish at the expense of others. The same argument is only capable of a limited application to the case of organs, since different organs fulfil different functions, and one function cannot preponderate at the expense of another without upsetting that balance which is essential to the continuance of life. Nevertheless, that there is some such tendency is shown by the fact that if an organ ceases to perform its function properly (such as occurs, for instance, in the case of the kidney in Bright's disease), it is apt to be pressed upon, and eventually destroyed by, the hypertrophied connective tissue.

It will thus be seen that Prof. Roux's theory, which he calls "the Conflict of the Parts within the organism," is a new explanation of the well-known effects of use and disuse. He points out that it completely differs from the crude mechanical hypothesis put forward by Herbert Spencer in his "Principles of Biology"; this latter, distinguished by Roux as the theory of "Functional Congestion," attributed increase in bulk, due to use, to the increased blood-supply mechanically brought about by increased function. Apart from the fact that increase in bulk in an organ only takes place in those dimensions in which it is called for by its function (thus the epidermis increases in thickness, a muscle in breadth, &c.), whereas increased blood-supply should cause uniform increase in all dimensions, Herbert Spencer's theory is inconsistent with the fact that if the nerves which convey the ordinary stimuli to an organ (such as a salivary gland) are cut, we may have congestion accompanied by degeneration, rather than increase in size.

It must be confessed that there is much about Prof. Roux's theory which induces one to wish that it were true. Apart, however, from the minor circumstance that the assumption of competing parts within the cell is an absolutely unsupported hypothesis, this theory utterly breaks down when we come to consider the question of heredity. Let it be granted that the liver consists of several kinds of cell, some of which perform their function better than others, and thus survive—how are these survivors to impress their peculiarities on that portion of the ovum which is destined to produce the liver in the young animal? It seems to us that before the question of "direct functional adaptation" can be even entertained by zoologists the question of the possibility of the inheritance of acquired variations must be grappled with, and decided one way or the other.

Prof. Roux next passes on to some general considerations on the nature of life and the origin of life and consciousness; he points out that life is not capable of being statically defined; it is, he says, essentially a process, not a series of chemical attributes, and hence it is absurd to suppose that a slight chemical difference is all we have to assume, in order to account for the difference in properties of living and dead protoplasm. The speculations as to the origin of life and consciousness are as fatuous as such theorising usually is, and we think that a little study of elementary psychology would have prevented Prof. Roux giving vent to his extraordinary ideas as to the origin of consciousness.

The remaining papers in the first volume deal chiefly with special cases in which Prof. Roux has elucidated the wonderful functional adaptation which is seen not only in the finest details of structure (such as the arrangement of the connective tissue in the tail-fin of the dolphin), but also in the makeshifts which the organism produces to make up for injuries to its original structure (as, for instance, the structure of the bone in the case of knee anchylosis).

The huge second volume is devoted to the subject of the "Mechanics of Development," of which study Prof. Roux may, as we have said before, be regarded as the founder. A considerable portion of the volume is taken up with replies to the successive publications of Driesch and Hertwig, who have pursued this branch of zoology with such brilliant success. Prof. Roux has only himself to thank if more attention is paid to the publications of these observers than to his work; for he has carried in this subject theorising and prolixity to an intolerable excess. The main difference between Driesch and Hertwig on the one hand, and Roux on the other, may be briefly stated: the former maintain that in the segmentation of the egg, we have a process which is essentially a mere multiplication of nuclei, all of which are similar to each other; the relative position of these nuclei determines what organs of the body they will eventually help to form; if their relative positions are altered by pressure or other mechanical means, their respective fates will be altered; or if one of the first eight segments of the egg be separated from all the rest, it is still able to form all the organs of the adult. Roux, on the other hand, maintains that by the formation of the first four segments of the frog's egg, the materials which are capable of differentiating themselves into the right and left sides and anterior and posterior halves of the animal are separated from each other, and that if one of the first two segments of the egg be severely injured, the other will develop into a half blastula, and eventually a half gastrula, and even further; the missing half will, however, be regenerated by the "reanimation" of the wounded blastomere by the migration of nuclei from the developed side.

It is of course extremely probable that in the normal course of development, the first segmentation furrow may coincide with the future long axis of the embryo, and if this is the case, the second furrow being at right angles to the first, will necessarily divide the egg into halves, one of which will be anterior and the other posterior. The question, however, whether this coincidence is essential or accidental, can only be settled by forcing the egg into such positions that the direction of the furrows dividing the segments is altered, and then observing whether the developmental history undergoes a corresponding alteration. Driesch and Hertwig have done this, and laid a strong foundation for their view, that the segmentation nuclei can be shaken together like a bag of balls, and still normal development ensue; and in the case of echinoderms and amphioxus, their theory, it seems to us, has been proved up to the hilt. Hertwig has written also a paper on the development of the frog, in which he denies altogether the interpretations which Roux puts on his observations; he maintains that all which happens when one of the first two blastomeres of a frog is injured, is that the wounded side is delayed in its development. If the two segments are nearly separated from each other, each pursues its development as if it were a complete ovum. Roux's answers to these statements are two-fold: first he affirms that Hertwig, through not exercising continuous observation, missed the semigastrula stage, and only saw the embryo after the "post-generation" or "reanimation" of the wounded half had set in; and with respect to Driesch's work on echinoderm eggs, he suggests that by separating the segments or subjecting the egg to pressure, the normal machinery for bringing about the development is upset, and a special regenerative machinery, the reserve "idioplasson," brought into play; this occurs at a later period in the frog, but from the very beginning in the echinoderm.

It seems to us that with regard to the first point, Roux still holds the field; although we await with interest further observations on this subject from such a distinguished zoologist as Hertwig. It is *à priori* clear that in the ordinary course of affairs one blastomere gives rise to half the embryo; and as there are a large number of gradations conceivable between completely killing one blastomere, and only slightly checking its growth, there must be some point at which it is determined whether the remaining blastomere shall develop as a whole egg or in its normal manner. We cannot avoid the suspicion that Roux's semigastrulæ are conditioned by the contact of an actively developing half, with a stunned but not killed blastomere, whose influence is sufficient to prevent the other half acting as a whole egg. On the other hand, Roux's reply to Driesch seems to us extremely feeble. To assume that by slightly altering the conditions of a developing egg an entirely new machinery is brought into play, is not only an altogether unproved gratuitous hypothesis, but it is an attempt to discount any evidence which may be gathered from physiological experiments on eggs which behave differently to those of the frog. When the hypothesis of "mosaic development" or "self-differentiation" requires bolstering up in this fashion, it must be in a bad way.

The second volume contains a considerable number of papers, comprising the whole of Roux's work on the frog's egg. Besides the important and fundamental points we have mentioned, we find Roux's contribution to the vexed but still unsettled question of the nature of gastrulation, also some extremely interesting observations on the effect of alternating electric currents on the unsegmented and segmented egg. As the conclusion of the whole matter, Roux takes up a position decidedly opposed to the theory of epigenesis; he is in the main an evolutionist, though he admits that for the complete development of the organs from their embryonic rudiments the functional stimuli are necessary. Driesch has also proclaimed himself an evolutionist, though he points out (what Roux seems to us to forget) that in dealing with the facts of biology we must proceed inductively, and not set out with preconceived ideas as to the constitution of living matter. E. W. M.

THE INDIAN CALENDAR.

The Indian Calendar, with Tables for the conversion of Hindu and Muhammadan into A.D. dates, and vice versâ. By Robert Sewell, late of her Majesty's Indian Civil Service, and Saukara Balkrishna Dikshit, Training College, Poona. With Tables of Eclipses visible in India, by Dr. Robert Schram, of Vienna. Pp. (including index) 169; tables, &c., cxxxvi. (London: Swan Sonnenschein and Co., Ltd, 1896.)

ALTHOUGH to many persons the chief interest of this publication (which must have cost the authors an amount of labour simply enormous) will be in an antiquarian and historical point of view, it has another aspect, judicial and practical, which was the immediate cause for its appearance. Documents bearing dates prior to those given in any existing almanac are often produced before Courts of Justice in India as evidence of title; and as forgeries, many of which are of great antiquity, exist in abundance, it is necessary to have at hand means for testing and verifying the authenticity of such documents when brought forward. Prof. Jacobi, Dr. Schram, and others, have within the last ten years thrown much light on the subject of the Indian methods of time-reckoning; but as their labours are only to be found scattered in scientific periodicals, the results are not readily accessible to officials and others to whom they are of importance in enabling them to determine questions in which the calendar, or rather calendars, observed in different parts and amongst the different peoples of that vast territory known as India, play an important part. Hence the Government of Madras requested Mr. Sewell to undertake the formation of a summary of the subject, accompanied by tables for ready reference. That gentleman not only accepted the task, but enlarged the scheme (which rendered it of a kind only to be called herculean) so as to make it include in its scope the whole of British India; and it has received the recognition of the Secretary of State for India. But besides containing a full explanation of the Indian chronological systems with the necessary tables for the conversion of their dates into ours, and *vice versa*, the volume is enriched by a set of tables of eclipses, most kindly furnished by that great authority on the subject, Dr. Robert Schram of Vienna. In the earlier stages of his undertaking, Mr. Sewell had the assistance of Dr. J. Burgess, late Director-General of the Archæological Survey of India. Afterwards he entered into correspondence with Mr. Saukara Balkrishna Dikshit, of the Training College at Poona, and it was agreed that the work should be completed under their joint authorship. The elaborate introductory treatise is mainly by Mr. Dikshit; several explanatory paragraphs, however, particularly those relating to astronomical phenomena, having been added by Mr. Sewell, who acknowledges the assistance received from Prof. Turner of Oxford, Prof. Kielhorn of Göttingen, and Prof. Jacobi. The tables of the latter were published in numbers of the *Indian Antiquary*, and Mr. Dikshit states that his calculations were, to a large extent, based upon these, though the original scheme had been propounded by M. Largeteau. We do not propose to enter into details here, which cannot be made interesting to the ordinary reader.

A great French astronomer once remarked that the only thing which made his head ache was the lunar theory; and scarcely less tiresome are calendar investigations. All honour, then, to those who do not shrink from these calculations. The last part of the work before us contains Dr. Schram's tables (formed by his own "Tafeln zur Berechnung der näheren Umstände der Sonnenfinsternisse" from the late Prof. Oppolzer's well-known "Canon") of the circumstances of all the eclipses visible in India and its immediate neighbourhood from A.D. 300 to 1900. It had been intended that these should be accompanied by maps, showing the centre-lines, across the continent of India, of the phenomena in question; but it was not found possible to complete these in time, owing to the numerous calculations that had to be made in order that the path of the shadow might be exactly marked in each case. Dr. Schram hopes, however, to be able soon to publish the maps separately, as they will form a very useful guide to the tables.

The different eras adopted in Hindu chronology form a somewhat troublesome subject. Those of Vicramaditya and Salivahana are largely used in the northern and southern provinces of India respectively, the former commencing in B.C. 57, the latter in A.D. 78 of our reckoning. But in Bengal, and some other parts, eras are used, the epochs of which seem to have been derived from that of the Hegira, or, as our authors prefer to spell it, Hijra; but by preserving solar time and the sidereal year preferred by the Hindus, the dates of these differ from those actually employed in the Muhammadan calendar. This is, however, of course itself now one of those used in many parts of India since the Muhammadan conquest, and is therefore included in the work before us. It is, as is universally known, reckoned from the flight of Muhammad from Mecca to Medina, which took place, by our chronology, on July 15, A.D. 622. In principle it is essentially lunar, the year being made to consist of twelve lunar months, or about 354 days; by the use of common and intercalary years (nineteen of the former and eleven of the latter in a cycle of thirty years), the length of a year is, in fact, maintained at 354·367 days. As this is 10·875 days short of a true tropical year, the Muhammadan year retrogrades through all the seasons in about thirty-three years. Had its length been the same as that of ours, the year of the Hegira would now be 1274, whereas their year 1314 commenced on June 12 in the present year (1896). We must demur to one statement (p. 40, note) of our authors: that in Christian chronology it is somewhat uncertain whether the years are current or expired. No doubt those who have not studied the matter are sometimes confused in the backward and forward reckoning by there being no year 0, which is neither B.C. nor A.D. But there is no uncertainty as to what is really meant. The years are reckoned from Christ's birth, supposed originally (but erroneously) to have taken place at or near the end of B.C. 1. At the end of A.D. 1, therefore, one year had expired, and at the end of 1895 that number of years. Ordinary people are sometimes puzzled by the simple question when a given century ends, but there is no real doubt or uncertainty in the matter; the present century will end at the end of December 31, 1900, and the twentieth will commence on January 1, 1901.

W. T. LYNN.

DOMESTICATED ANIMALS.

Domesticated Animals: their Relation to Man and to his Advancement in Civilisation. By Nathaniel Southgate Shaler, Dean of the Lawrence Scientific School of Harvard University. Pp. 264. Illustrated. (London: Smith, Elder, and Co., 1896.)

THOUGH the literature upon domesticated animals is of immense extent, we are unable to call to mind any work in which the subject is approached from quite the same general standpoint as in this suggestive book of Prof. Shaler's. The greater part of the volume consists of a series of essays on the dog, horse, poultry, &c., and even insects, so far as any insects can be said to be domesticated, reprinted with some amplifications from *Scribner's Magazine*, and written in a far more philosophical manner than is customary on such a subject. The leading idea, the connection between the practice of domesticating animals and social evolution, has of course not been neglected by sociologists; but it is discussed, together with the causes which have led to the selection of forms for domestication, and their consequent mental and physical modifications, in a manner well suited to attract the general reader who is a lover of animals, and to give an idea of the important part which their domestication has played in human progress. It is for him, rather than the man of science, that the work is intended; it is not detailed in treatment, and is in part covered by the writings of Darwin and Romanes. A good example of Prof. Shaler's method is afforded by the line of argument in which he points out that the invention of the horse-shoe made possible the disciplined use of the horse in Western Europe, and its differentiation into breeds. This led to the development of the war-horse, which played an important part in the warfare between Christian and Mohammedan States, as at the Battle of Tours, and promoted the institution of organised armies, and consequently of centralised States. Referring to the necessity of horses in military operations, he makes the curious deduction that China is unlikely ever to become a menace to outlying countries, because she cannot, and may never be able to, provide the horses necessary for the use of invading armies.

There is no mention in the book of the reindeer, surely a very important factor in the economy of the races which use it. On the vexed question of the origin of the dog, it is noteworthy that the author does not recognise it as the descendant of any surviving wild form.

The closing chapters on "The Rights of Animals" and "The Problem of Domestication" are published for the first time. In the former, the author, a strong and genuine sympathiser with animals, defends the practice of vivisection within proper limits. "So far from natural science tending in any way towards cruelty, it has been the very guide in the development of the modern affection for living beings. By showing something of the marvels of their structure and history, it has increased in a way no other influence has ever done the conception which we form as to their dignity and the wonderful nature of their history"; a point both true, and usually disregarded. Like every naturalist, Prof. Shaler deplores the rapidly advancing extermination of animal types, particularly among the larger kinds, and offers various suggestions, both as to increasing the number of domesticated forms and the conservation of wild species in reservation-areas, such as the Yellowstone Park. Valuable as many of his proposals are, it is to be feared, in the present relation of natural science to bodies politic, that they are somewhat of an utopian character. It is not easy to maintain such areas under entirely natural conditions and free from interference, administrative or otherwise. To take a small instance: it is notorious that in the New Forest, perhaps our nearest approach to such an area, the insect-population has greatly diminished during the last thirty years, and many rare and retired species are on the point of extinction.

In the artistic, though somewhat unequal, illustrations, and the excellence of printing and paper, the book is worthy of high praise. W. F. H. B.

OUR BOOK SHELF.

A Geological Sketch Map of Africa South of the Zambesi. By E. P. T. Struben, F.R.G.S. (London: Edward Stanford, 1896.)

THE chief object of this new map, and accompanying pamphlet, of South Africa is to show that the Witwatersrand beds occur over a large portion of Africa south of the Zambesi. The band of dolomite, already described by Mr. Draper, is used by the author as a means of identifying the various scattered portions of sandstones, conglomerates, &c., occurring in South Africa, and which in many localities have proved to be auriferous. That the auriferous strata of the Rand occur outside the Transvaal is an established fact; but Mr. Struben hardly brings forward enough evidence to show that the sandstones, conglomerates and dolomites, recognised by him as identical with the Witwatersrand beds, are really all of one age.

The table of strata is very meagre in detail; the formations recognised being "Granite, Carboniferous beds, Sandstones, Shales and other stratified rocks, and Limestone." The formations are too much lumped together to be of much service, and there remains a doubt that the dolomite limestone mentioned by Mr. Struben is of various ages. A strip of crystalline limestone is represented near the coast north of the Umzimkulu River, and coloured similarly to the dolomite, but no mention is made of the cretaceous rocks of the east coast. There is no attempt made to show the relationship of the Rand beds to the Dwyka conglomerate, the Zwaartebergen quartzites, and the older rocks of the Cape. The metamorphic schists underlying the formations of South Africa are not mentioned. The relation of the Rand beds to the coal-bearing strata is also not clearly stated. In Natal the relationship is drawn as one of perfect conformity; but it is certain that in the Transvaal the coal-bearing rocks are unconformable to the Rand beds, and of much more recent date.

Mr. Struben's map, as showing the localities in which the minerals occur in South Africa, is valuable, but it does not approach in scientific value to Dunn's map of South Africa. The stratigraphy of South Africa is extremely complex, and a solution can only be arrived at by a survey, such as was commenced by Dunn, Griesbach and Stow.

Wayside and Woodland Blossoms. A Pocket Guide to British Wild Flowers for the Country Rambler. (Second Series.) By Edward Step, F.L.S. Pp. 170. (London: Frederick Warne and Co., 1896.)

WE are glad to know that the first volume published under the same title as this has met with the success it deserves, and we hope the present pocket-book will have a similar welcome extended to it. Four hundred species of flowering plants were described and illustrated in the first series, which Mr. Step now supplements with descriptions of 325 species, 130 being represented upon coloured plates, while 23 are shown in black and white. The plates render the identification of a plant a comparatively easy matter, and the clear descriptions of the plants are worthy accompaniments to them. Mr. Thiselton-Dyer should rejoice at the opportunity which the book affords every one to learn something about botany from "wayside and woodland." It will be remembered that as president of the botanical section of the British Association last year, he condemned the system of botanical teaching followed in many schools for examination purposes, and pleaded that the subject should be developed as an educational instrument. In the course of his address he said: "The modern university student of botany puts his elders to blush by his minute knowledge of some small point in vegetable histology. But he can tell you little of the contents of a country hedgerow; and if you put an unfamiliar plant in his hands, he is pretty much at a loss how to set about recognising its affinities." Mr. Step's book provides such students with the materials to make up their deficiencies; it is a book which will develop the observant faculties in young students of natural history, and one which will make more lovers of botany than all the examination syllabuses and text-book formulas yet devised.

LETTERS TO THE EDITOR.

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

A Fine Shooting-Star; and Heights of Meteors in August and November 1895.

A REMARKABLY bright shooting-star was seen here on Saturday, June 13, at 10.59 p.m., under such favourable conditions of a clear sky and warm calm air on that evening, that it may possibly have happened that other notes were kept of its appearance, in the South of England, by astronomical observers. It was not a large-sized fireball, but in its course of about 30° it increased quickly from the brightness of a 1st mag. star to that of Sirius and of Jupiter, and just before its disappearance it shone with a short white flash as bright as Venus, which lit up the sky quite distinctly to about 20° or 30° from its final bright expansion. The head was white, free from sparks, and left along the greater portion of its course a yellow streak of light, of which a portion 8° or 10° in length was visible 10 seconds, while a shorter piece, 3° or 4° long at the end of that, where the bright flash occurred, growing white and misty by degrees, remained visible for 40 seconds. Duration of the flight about 2 seconds; from 230°, + 20° to 208°, − 4°; the patch of long-enduring streak extending about from 212°, ± 0°, to 209°, − 3°.

This track is directed from the head of *Andromeda;* and albeit the meteor greatly resembled a bright August Perseïd in appearance, of which shower first members have been traced as early as the beginning of July, proceeding from radiant-points in much lower R.A. than the chief centre of the system, yet the displacements of this meteor's course in time and in position from the main stream of the Perseïds are too considerable to allow an explanation of its appearance of that kind to be proposed as a probable conjecture. But there are no less than four ordinary radiant points, all active at this time, as Mr. Denning has informed me, in *Cygnus*, *Lacerta*, and *Honores Frederici*, in the "List of 918 Radiant-points" which he has published in the Astronomical Society's *Monthly Notices* (vol. 50, p. 410, May 1890), at distances back along the line of flight, of 55°, 70°, 80°, and 100°, from which its flight was directed accurately; and it is from the last of these slender meteor-sources (No. 174 in his List), at 354°, + 39°, about 5° south of ι, κ *Honorum*, a centre of swift, long-pathed, streak-leaving meteors in June and

July, with a fine Venus-like shooting-star just similar to this present meteor (its streak remaining visible 5 secs.), observed at Bristol on June 14, 1887, among them, that Mr. Denning considers it most probable that the real course of this bright meteor was directed. Its path and that of the just similar one observed at Bristol, prolonged backwards, intersect each other at 354°. + 36°, close to this well-marked shower-position; and if additional notes of the meteor have been obtained at other stations, it will be an interesting question to examine if they bear out this conclusion.

I take this opportunity of the returning abundance of meteors of the August period to beg to correct some errors of calculation and projection in my letter on "Heights of August Meteors" in NATURE of September 5, last year (vol. lii. p. 437), which gave confused descriptions, without, however, tripping (except slightly in the case of the second meteor) in the real values of the heights there found, of two meteors doubly observed at Tring and at Slough on August 11, 1895. The places over which the meteors were vertical when first seen, and at disappearance, were laid down in proper relation to Tring and Slough on a map of England, but from left to right instead of from right to left of the Tring and Slough meridian; so that although both their radiant-points were really easterly, their paths were described as from Oxfordshire to Middlesex, and from west to east across the northern part of Buckinghamshire, in my letter. The corrections applied to the observed paths of the second meteor were somewhat incorrectly chosen, and gave thereby resulting heights and a length of path which were somewhat faultily arrived at; while the radiant-point of this meteor (α Persei), given by the observations directly was a little departed from, and its altitude and azimuth were also given as 45°, 34° north of east, instead of 35°, 44° north of east. As uncertainties from errors inherent in meteor-observations (rarely very small ones) are unavoidable in comparing them together, a recalculation of both paths will, it seems probable, serve better to correct this maze of errors and mistakes, than to try to rectify individually the above principal ones, and a few lesser faults which the paths deduced last year contained.

Two other accordances, of a Perseïd shooting-star between Tring and Slough, and of a small fireball between Tring and Sydenham, in August last, and one of a rather notable fireball in November last, have afforded, since the path-descriptions in my former letter, some fairly good materials for height-determinations, although the data of the two fireballs' paths are of a little looser kind than those of the two foregoing and the one now newly-added shooting-stars. In the accompanying table I have grouped together what appear to be the real courses (including the two shooting stars' recalculated paths as Nos. 2, and 3, in the table), of all the meteors found here to have furnished accordant observations in last August and November; and I may add, in gladly expressed acknowledgment of the aid supplied abundantly by accuracy of the original observations to the general certainty of these determinations, that nearly all the present list of meteor-heights (only excepting those of the fireball of November 9) is due to some weeks' actively continued watch, with careful records of descriptions and well-mapped courses by the stars, successfully maintained at Writtle and at Tring by Mr. J. A. Hardcastle in order to obtain them, on the Perseïds and occasional meteor-members of other showers more or less conspicuous during the period of the display from Perseus, in August last.

In cases of loose, and of partially inconsistent descriptions, much latitude of choice is left to adjust the observed tracks to each other; but the limits of this choice become, in general, narrowly restricted if the ordinary descriptions and characters of meteor-flights are kept in view, and if any wholly improbable results, as of rising upwards, or of paths abnormally at variance with the usual heights, and not reconcilable with the acknowledged astronomical velocities of meteors, are rejected. The course of the fireball No. 5, of November 9, descending almost vertically in E.N.E. at each of the stations, Peckham, Slough, and Reading, where it was observed, along nearly the same apparent path (but beginning at those stations at nearly equal, and ending at very unequal altitudes), was situated so unfavourably for determining its radiant-point by the observed paths' mutual intersections, that only the ordinary conditions of meteor-flights (attained to here by trial and error combinations of more and more appropriate paths to satisfy them and the tolerably accordant observations also) could be usefully resorted to as the sufficient additional criterion needed to define the radiant-point, or the line of real direction of the meteor's course.

The observed paths at Writtle and at Slough of the Perseïd shooting-star, No. 1, are also in the unfavourable position of nearly "fore-and-aft" conjunction, but deviate sufficiently from it to yield the radiant-point noted in the list, by their mutual intersection, and from the heights, and meteor-speed given in the list, which are computed from it, this position of the point appears to stand in no further need of very material amendment by the proof test of the atmospheric and astronomical criterion.

In the case of the small fireball No. 4 (if the same meteor, as assumed from their resemblance, was really referred to in both the observations), besides a pretty large divergence from parallax direction between the two path-positions, making a rather considerable reconstruction of them both essential, a nearly lengthwise conjunction (as in Nos. 1, and 5) also once more occurs, introducing a large uncertainty, scarcely less than in the case of the fireball No. 5, into the position of the radiant-point, and into the consequent heights and length of path computed from it; which could only be overcome, as is done, it is to be hoped successfully, by the same tentative method of proceeding as that which was used to fix the real path and radiant of that latter fireball. With heights not far removed from sixty miles, and speeds not far from parabolic ones admitted, the construction's freedom becomes so greatly narrowed in these two fireballs' otherwise most equivocal-looking cases, that nearly as great, though (by unadjustable differences in the observations) still questionable dependence

P, Peckham; R, Reading; S, Sydenham; Sl, Slough; T, Tring; W, Writtle.

may be placed on these two fireballs' real paths and radiant-points as on those ascribed to the Perseïd and Piscid shooting-stars in the present list.

The position thus found in *Gemini*, near *Castor*, of the radiant point of the fireball of November 9 last, perhaps affords a clue to the striking dark green light, not unlike the "signal green" colour of ships' lights and railway lamps, with which the fireball was seen to shine at Slough in the end-half of its course; since large-sized meteors of the "Geminid" shower diverging between the end of November and the middle of December from the immediate neighbourhood of the fireball's radiant-point position so determined, are notable for frequent occurrence of green hue in their nuclei. The low height of eight miles assigned to the meteor at its disappearance would nearly break record[1] of a fireball's deep penetration towards the earth before extinction, if the extraordinarily bright detonating fireball of December 14, 1890, had not been shown undoubtedly to have ended its shining course at not more than seven or eight miles above the earth, and that, too, by a curious coincidence, like the present meteor's end-point, over Billericay or some place close to Billericay, in Essex! Should observers in that latter county, or in any of the adjacent East Coast districts, have noted particulars of its appearance on November 9, which happened on a clear night during a prolonged display of a widely-observed and rather fine aurora (and, though the memory is a sad one to recall, especially on a date which was an annual one of rejoicing

[1] The fireball which accompanied the fall of aërolites at Weston, Connecticut, in the United States, on December 14, 1807, was found by Dr. Bowditch to have remained luminous in its descent until only about three or four miles above the places on the earth's surface where the aërolites were scattered.

Table of observed Paths and Real Heights and Radiant Points of Meteors doubly observed in August and November 1895.

No.	Place; observer.	Date. 1895.	Hour. p.m.	Mag. by Stars, &c.	Colour.	Duration. Secs.	Length of path.	Apparent course and (do. corrected). From α	δ	To α	δ
1	Writtle, Essex; J. A. Hardcastle.	Aug. 6	11.26	>1	Blue	Swift	10° (10)	170° (162	+ 70° + 72	187½° 186	+ 62½° + 63½)
	Slough, Bucks; A. S. Herschel.	6	11.26	>1	White	0·7	6 (7)	97 (97	+ 68 + 69	117 120	+ 71 + 71)
2	Tring, Herts; J. A. H.	11	9.53	1; streak	—	2 or 3; slow	33° (35)	332½° (327	+ 39° + 41	287½° 279	+ 42½° + 40½)
	Slough; A. S. H.	11	9.53	1; streak 3 secs.	White	1·2	37 (35)	331 (335	+ 53 + 50	268 277	+ 51 + 54)
3	Tring; J. A. H.	11	11.3	Streak	—	—	12° (16)	345° (337	+ 58° + 57	325° 315	+ 53° + 49)
	Slough; A. S. H.	11	11.4	3	—	0·6 ±	10 (9¼)	350 (359	+ 72 + 71	312 324	+ 70 + 71)
4	Tring; J. A. H.	19	9.32	>Vega	Blue	2 ±	22° (24)	317½° (310	+ 37 + 42	320° 322	+ 15° + 18)
	Sydenham.*	19	9.25 ±	Very bright star	Blue, then red	5 ±	Almost stationary (4)	¼ (Zen. ζ Urs. Maj.) 248 (273	 + 63 + 65	 248 262	 + 63 + 66)
5	Reading; G. T. Davis.	Nov. 9	10.45 ±	>3′ diameter; = ¼ ☽	Orange-yellow	3 ±	12° in sight (17)	113° towards β Cancri (further) to (115	+ 26° + 27	120° 122 122½	+ 15° + 10 + 11½)
	Peckham; H. Lawton.	9	10.40 ±	Bright fire-ball	—	—	10 ± (11)	From a little left of α, β Gem. acr. ⅓ (β Gem., ♃) (112	 + 34	 120	 + 23½)
	Slough; A. S. H.	9	10.47	10 × ♀ ±	Orange, then green and red	2¾ or 3	22 (17)	113 (112½	+ 31 + 30	119 118½	+ 9 + 13½)

No.	Radiant-point (corrected) α δ and Az Alt. and by nearest stars.	Real heights in miles at first appearance and disappearance.	Places vertically under the points of appearance, and disappearance.	Length of sloping path, in miles.	Observed speed; miles per second.	Parabolic speed; miles per second.
1	59° + 49° 42 E. fr. N. 34 λ Persei	72 59	½ (Spilsby and Kirkstead), Lincolnshire Near Gt. Ponton (by Grantham), Lincolnshire	29	42	39
2	23° + 9° 11 N. fr. E. 5 ο Piscium	82 76	Colford, near Chelmsford, Essex Great Marlow, Bucks	53	44	41·5
3	48 + 50° 43 N. fr. E. 31 α Persei	53 43	Hitchin, Herts Near Berkhamstead, Herts	19·5	32 ±	40
4	286 + 62° 10 W. fr. N. 78 ½ (ο, π) Draconis	60 26	½ (Barnet and Watford), Herts Sudbury, Middlesex	35	17	20
5	110° + 36° 19 N. fr. E. 34 α Gemin., 4° north	68 8	In the North Sea, 45 miles E. from Hollesley, Suffolk Billericay, Essex	107	39	39

* The *English Mechanic*, August 23, 1895, vol. lii. p. 13.

in England and for the metropolis, only a few minutes before the occurrence of the terrible railway accident at Grantham on that night), I would be glad to know if they confirm the near approach to earth over the Brentwood Hills (as the end-point), and the position near Castor (as nearly the point of first appearance), assigned by this discussion to the meteor's flight; or if, as seen much sideways from its plane of fall, in counties north of Essex, the meteor's apparent line of flight may have been but little accordant perhaps, or even, quite possibly, not at all conformable with these sky-positions?

With regard to Mr. Denning's identification of the course of the above described bright meteor of the 13th inst., with a radiant-centre near *Honores*, I may mention in concluding that on the 19th inst., at 11.56, I noticed here a long-pathed streak leaving, 2nd mag. meteor shoot swiftly (about 30° in $1\frac{1}{4}$ sec.) from 195°, + 68°, in *Draco*, to 181°, + 39°, in *Canes Venatici*, leaving a thin white streak for $2\frac{1}{2}$ seconds along its whole track. This course prolonged backwards about 60° proceeds from 350°, + 37°, only 3° or 4° from the place at 354°, + 39°, of the radiant No. 174 of Mr. Denning's list; and like the brighter shooting-star of June 13, it evidently belonged to this same June "Honorid" system. Mr. Denning's outline of the shower's duration, through the latter half of June and the first week of July, with a date of maximum on June 26, would thus seem, for this year's return of its meteor-period at least, to be in a fair way to be realised.

A. S. HERSCHEL.

Observatory House, Slough, June 20.

Purification of Sulphur.

It is never a very pleasant or gracious task to reply to criticism. When that criticism, however, is based on a misapprehension of the facts, and is consequently wrong and misleading, and is, moreover, enforced by whatever weight "authority" may carry, its correction is simplified down to a plain matter of duty. The criticism to which I refer is contained in Prof. Armstrong's address to the Chemical Society (*Chem. Soc. Journ.*, vol. xxxix. p. 1160), which has just come before me.

The passage to which I refer runs as follows. "To return to sulphur, an abstract account has recently been published in the *Proceedings* of the Royal Society (1894, lvi. 32) of observations by Threlfall, Brearley and Allen, on the electrical properties of pure (*sic*) sulphur, *i.e.* sulphur from the Chance recovery process purified by distillation and exhaustion in vacuo. Such a process cannot be accepted by any means as an exhaustive one, and it appears almost to be a case of 'love's labour lost' to apply to such material the infinite care which the authors appear to have taken in making the electrical measurements. Yet they arrive at the important conclusion that so long as a single modification be dealt with, such sulphur does not conduct while solid. A mixture of two modifications, however, does; but in view of the possibility of changes taking place during the production of the mixture, of conducting impurities being introduced or generated, it is difficult to regard this latter conclusion as established; the more so as the authors in question have found that, as the temperature was raised the conductivity of the sulphur increased slightly up to the melting point, when there was an enormous increase."

Prof. Armstrong prefaced the paragraph which I have quoted above, by some rather ungenerous remarks as to the supposed attitude of physicists towards the question of chemical purification of material. It is now eight years since I began to endeavour to purify materials, so that I can, at all events, agree with Prof. Armstrong on one point, viz. that it is much more difficult to purify a substance up to the furthest limit of chemical discrimination, than it is to determine its physical properties afterwards. In the passage to which I now allude —and which I do not intend to quote, for I feel sure that Prof. Armstrong will, on consideration, agree with me that it is better forgotten—the "tongue of the scorner" is thrust out at those physicists who take no thought as to the condition of material examined by them. However true this may once have been, I am sure that nowadays it is a mere superstition to suppose that physicists, as a body, are callous on the subject of purification. A great deal of modern work in this domain of chemistry has been done by professed physicists; and indeed, though I have myself known several physicists enormously interested in questions of purification, I have only known one chemist whose life-long endeavour was to get things pure, and that was the late Prof. Josiah P. Cook, of Harvard. Passing to the immediate point, Prof. Armstrong objects to the use of the word "pure," made by myself and my co-workers. With regard to this, I may say that Prof. Armstrong labours under the disadvantage of only having an abstract under his notice. In the paper (if it ever gets published) he will find that this very matter is discussed at, perhaps, too great a length, and the conclusion arrived at that the word "pure" ought to be kept for substances in such a degree of purity that existing chemical or physical means fail in discovering any foreign substance. "Pure," therefore, as we have used the word, has no meaning except in connection with the existing state of the art of chemistry, and was adopted by us rather than the word "purified," as the result of some consideration, in which a desire to avoid pedantry had some weight. Since Prof. Armstrong refers eulogistically to Stas—as who would not—I may perhaps refer him to the following passages by Stas himself (*Bulletin de l'Académie Royale des Sciences, &c., de Belgique*. 2 séries, vol. x. p. 253), than whom no one could be more careful as to the use he makes of the word "pure."

"Jusqu'ici, il n'y a que M. Dumas qui ait tenté de faire la synthése du sulfuré d'argent. Pour déterminer le rapport proportionnel de ses éléments, il a sulfuré directement l'argent par *du soufre pur* qu'il faisait passer en excès." . . . "En suivant cette méthode, j'ai fait deux séries d'expériences: la première, comprenant trois synthèses par *du soufre pur* amené en excès." Stas gives no details as to the preparation of his "soufre pur" (which he would certainly have done had elaborate precautions been taken); and as a matter of fact, Stas' sulphur was probably far less pure than mine, for in those days there was no "Chance" sulphur. So much for the word "pure."

Prof. Armstrong considers that the process of purification employed by us is "by no means an exhaustive one," &c. A process is, we take it, exhaustive when it exhausts the resources of physics, including chemistry. Now, we spent four years in trying all likely and many unlikely methods of purification. We finally, by sheer good fortune, received some Chance sulphur, and our methods of discrimination at once revealed to us that, when dust and water were removed, it was purer than any we had been able to prepare hitherto by the most elaborate means; and we adopted it as our source of sulphur in consequence of this discovery. On the other hand, there are doubtless degrees in the purity attained by the commercial product. The first lot we received (a present from Mr. Chance) was much purer than some afterwards purchased; and with this later sample the process we employed for purification would probably not have been sufficient.

With regard to the question of the adequacy of the purification—for this is the important point—we arrived at a stage at which no chemical means enabled us to detect any impurity whatever, and the specific resistance (if one may so misuse the term for a body which does not obey Ohm's law) rose above 10^{28} C.G.S. units; our limit of discrimination, and probably the furthest hitherto *certainly* attained.

As we had found that the purer the sulphur the better it insulated, as with this sulphur we could absolutely find no impurity at all, and as all our means of purification (except by repetition) were exhausted, we felt that we had done all that could possibly be done.

The conclusion at which we arrived—viz. that so-called mixtures of crystalline and amorphous sulphur conduct, whereas pure crystalline sulphur does not—seems to us to be of considerable importance, and we therefore spared no pains to assure ourselves of its truth. For this purpose we prepared crystalline sulphur films, ascertained their property by non-conductivity, and then converted them into the conducting mixture by appropriate heating and cooling. Conversely, we caused conducting "mixtures" to become non-conducting by annealing. Prof. Armstrong's criticism, therefore, is wrong, and the uncertainty, which he assumes, does not exist. It is as certain that crystalline sulphur is at least about a million times more non-conducting than "mixed" sulphur, as that copper conducts better than glass. We spent some years in assuring ourselves of the truth of this proposition, and we feel that we should be shirking our philosophical duty were we to allow this conclusion, so laboriously reached, to be set aside, or rendered nugatory, by a criticism based on a misapprehension, and enforced by all the weight which Prof. Armstrong's utterances so rightly carry.

I confess I am unable to reply to that part of Prof. Armstrong's criticism in which the above conclusion is supposed to

be in some way dependent on the fact that any variety of sulphur increases in conductivity with rise of temperature. Unless it is suggested that we did not know one temperature from another, I fail to understand this criticism. RICHARD THRELFALL.
University, Sydney, N.S.W.

I SEE no reason to recall what I have said regarding the general attitude of chemists and physicists on the question of the influence of minute traces of impurity; and when I come across the remark in Messrs. Threlfall, Brearley and Allen's paper in the *Phil. Trans.*, that "it is not too much to say that the electrical action of most bodies in a pure state is entirely unknown at present," I feel there is not much difference of opinion between us.

Then, as to my being guilty of that unpardonable crime—pedantry—it has always seemed to me that those of us who undertake scientific work should also strive to be scientific, *i.e.* exact, in their use of language. Those who had the great good fortune to be present a year or so ago at the NATURE dinner, and to hear Huxley's marvellous speech—almost, if not the last he delivered—will recollect how strongly he insisted on the importance of greater care being taken in the writing of papers describing scientific inquiries. In a conversation I had with him afterwards, he greatly lamented the careless manner in which such work was too frequently done.

Now if *pure* mean "free from mixture," a pure substance must, as I have said, ever remain an ideal conception; the purist must ever regard all things as impure. Prof. Threlfall tells us that "the word pure has no significance except with respect to a definite state of the art of chemistry." I would rather accept the meaning which is to be found in the dictionary, *pace* Stas even; and would prefer to assert that the word too frequently has no significance except with reference to an indefinite state of the mind of the person—chemist or physicist—using it. To my mind, there can only be degrees of impurity—not of purity.

Whatever time Prof. Threlfall and his colleagues may have spent in seeking to purify sulphur, the fact remains that their experiments were made with sulphur which they obtained by chance, and that the only method of purifying it they adopted was to distil it several times in vacuo, after filtering it while molten through glass wool and platinum gauze, and then to fuse it in vacuo—in order, they tell us, to get rid of gases (probably water vapour, they say) given off even from the purest samples. But distillation in vacuo, even when followed by fusion in vacuo, can scarcely be regarded as a process which "exhausts the resources of physics, including chemistry."

"Chance" sulphur is prepared by burning sulphuretted hydrogen. It is probably impossible to burn sulphur without producing some sulphuric acid. Messrs. Threlfall, Brearley and Allen, however, do not even refer to the possibility of its presence, and apparently took no precaution whatever to eliminate it, if present.

They tell us that on breaking up such sulphur after it had been strained while molten through glass wool and platinum gauze, it emitted a horrible smell of gas-lime, "which shows that it requires to be distilled if sure results are to be obtained." I imagine, therefore, that the sulphur they used initially was by no means so remarkably "pure"; as they also state that gases were given off even from the purest samples when fused in vacuo after distillation, it may well be doubted whether so simple a process as mere fusion could suffice to effect the necessary final purification.

Prof. Threlfall's statement that conducting "mixtures" were caused to become non-conducting by annealing, is apparently a good answer to my criticism; but by no means finally disposes of it. The structure of the two materials may have been very different, and such in the one case as to allow an impurity to act, which in the other case might be inoperative. By my reference to the conductivity of sulphur at temperatures above its melting point, I meant to imply that the behaviour described afforded indication of the presence of impurity; for I do not believe that even molten sulphur is a conductor. Of course, at present, this is but an opinion, but it may not be inappropriate to direct attention to the recent most remarkable observations of Dewar and Fleming on bismuth, showing that an amount of impurity altogether beyond detection by chemical means may entirely alter electrical properties.

I still, therefore, regretfully retain my opinion, and fear that, notwithstanding the great care lavished on the work of Prof. Threlfall and his colleagues, it will be necessary to repeat it, perhaps over and over again—a possibility which they apparently themselves foresee in the introduction to their paper—before so remarkable a conclusion as that they have arrived at can be regarded as established.

H. E. ARMSTRONG.

Increasing the Efficiency of Röntgen Ray Tubes.

MR. J. C. PORTER, in a letter in NATURE of June 18, describes a method of increasing the efficiency of a Crookes' tube. I have for some weeks used another very simple method to obtain the same result. This consists in placing the flame of a small glass spirit-lamp in the angle formed by the Crookes' tube and the wire passing to the kathode, and allowing a series of small sparks to pass to the flame from the wire.

Burnley, June 29. T. G. CRUMP.

THE POSITION OF SCIENCE AT OXFORD.

WHILST the study of natural science has been progressing rapidly in other universities and colleges during the last ten or fifteen years, it is a matter of common knowledge that it has progressed very slowly indeed in the University of Oxford. It would be incorrect to say that it has not progressed, for there has been during the last few years a steady, though very gradual, increase in the numbers of men reading for honours in the final school of natural science. In 1885 twenty-two men obtained honours in sciencce, in 1895 there were forty-three names in the class list, and a rather larger number in 1894. The school has just doubled itself in ten years, but for all that the numbers are still small, and out of all proportion to the provision that has long existed for science teaching in the University. It must be understood at the outset that the University, considered as a body separate from the colleges which compose it, has not dealt ungenerously with science. The staff of professors, and the emoluments attached to their chairs, compare favourably with those of any other university in Great Britain; and Oxford actually set the example, at great cost to itself, of building a museum and equipping laboratories for educational purposes. Moreover, the opportunities of scientific study in Oxford are greatly enhanced by the existence within the precincts of the museum of a first-rate scientific library, such as is not possessed by any other college or university in the kingdom. It is a strange thing that when it has so many advantages, Oxford has allowed itself to be completely outstripped in this particular path of intellectual progress.

It is the purpose of the present article to discuss the possible causes of comparative failure of the science school at Oxford. A complete failure it is not, for, however poor its numerical results may be, it has long been recognised that the attainments of the limited number of scientific men which it turns out compare well with those of men who have been educated in other places.

It is commonly supposed that the prime cause of the insignificant numerical result is the small encouragement given to scientific study in the shape of fellowships and scholarships; and those who hold this opinion believe that if the colleges were to do what is conceived to be their duty in this respect, the science school would progress by leaps and bounds.

With respect to scholarships and exhibitions, it is apparent, from an analysis of the figures, that science does not get what may rightly be held to be its due. The *University Calendar* for 1896 shows that there are in Oxford some 500 scholarships of an annual value of £80 a-piece, and in addition some 225 exhibitions, the annual value of each of which may be placed at £40. These figures apply only to college scholarships and exhibitions, and so it appears that the colleges, apart from the University, exercise an intellectual patronage to the extent of nearly £50,000 per annum. How is this patronage exercised, and what share of it falls to natural science?

It is not unreasonable to say that bare justice would be done if the number of scholarships allotted to science bore the same proportion to the number of men reading for honours in that subject as the number of scholarships allotted to literary subjects bears to the number of men reading for the literary schools. This bare measure of justice is not done. In 1895 one hundred and fifty-three men were classed in the honour school of Literæ Humaniores (a number beyond all previous precedent); eighty-seven were classed in Modern History; sixty-six in the honour school of Jurisprudence; forty-three in Natural Science; thirty-seven in Theology; twenty-three in Mathematics; and one in "Literis Semiticis"; in all four hundred and ten. Deduct twenty from this number to exclude those who took a second final school, and there remain three hundred and ninety, of whom forty-three, or one-ninth of the whole, belonged to the school of Natural Science. Science, on this reckoning, should claim fifty-five out of the five hundred existing scholarships. It is not very easy to ascertain the exact number of science scholarships, but there are certainly not more than forty. It appears from the *University Gazette* that in the academical year 1894-95 only ten out of twenty-one colleges offered scholarships or exhibitions in Natural Science, and that those ten have offered science scholarships for some years past. The ten are Balliol, Merton, New College, Magdalen, Christ Church, Trinity, Corpus Christi, Jesus, Keble, and Queen's. The scholarship at the last named, though in fact awarded to a candidate who offered Natural Science, was equally open to candidates offering Classics or Mathematics. In addition, St. John's offered and awarded a scholarship in mathematics and physics, either separately or in combination. As each of the ten colleges gave one science scholarship, and as the tenure of a scholarship is four years, it follows that there are only forty science scholarships in the University, or if St. John's be added, forty four—at the lowest computation ten less than there should be.

The paucity of science scholarships has been a frequent subject of comment; but the colleges have a ready and a very plausible answer, which is best illustrated by the fact that in November last Balliol did not award a science scholarship because no candidate of sufficient merit presented himself. It is a fact that the candidates for science scholarships are not only few in number, but also of low average merit; there are, of course, brilliant exceptions. It is not easy to fix a common measure for the intellectual acquirements of classical and scientific students, but as far as a comparison can be instituted, it is vastly to the advantage of the classical scholar. He is a better classic than his scientific confrère is a man of science, and is in addition more widely read and has a greater knowledge of subjects of general interest. The most that can be said is that the science scholar knows a little of classics, a classical scholar as a rule is profoundly ignorant of science. But in powers of expression, in the ability to handle an unfamiliar theme, and in range and variety of knowledge, there is simply no comparison. Hence the colleges justify themselves by saying that they award scholarships to candidates of the greatest intellectual merit, and it is their experience that the greatest merit is found in those who have had a classical education. As for science scholarships, the competitors, they say, are not worthy of the prize, and the prize is accordingly withdrawn, with the result that the number of science scholarships tends to diminish rather than to increase.

This is true, and it is a lamentable state of things, pointing to a serious deficiency in the secondary education which precedes and leads up to a University education. It is, however, remarkable that Cambridge, which gives plenty of science scholarships, finds no difficulty in getting candidates of sufficient merit. The explanation of this is probably somewhat as follows. At Oxford scholarships are nearly exclusively awarded to boys who are still at school; very few are open to undergraduates who have been in residence for more than one University Term. At Cambridge many scholarships are open to men of one year's standing, giving an opportunity to those who have come up to the University with a fair general education and only a moderate acquaintance with science, to learn enough science in their first year to bring themselves up to the standard of a scholarship; many at Oxford would be glad of such a chance, but it is not open to them. In the second place, the science school at Cambridge has acquired such a prestige that the best boys go there, and only the second best to Oxford; and thirdly, Oxford draws its undergraduates more exclusively from the great public schools than Cambridge does. Taken on the whole the teaching of science in public schools is bad. There are, of course, some exceptions, but they are rare, and in many science can hardly be said to be taught at all. It may be objected that every public school has one or more science masters of tried capacity, and that science is a compulsory subject in nearly all. It may be so, but the inducements offered to the study of science in public schools are very few; in most of them there are not only no inducements, but the study is openly discouraged. Boys are not generally inclined to give themselves unnecessary trouble over their studies, and are only too ready to neglect that which may safely be neglected; the science masters have no chance with the majority of them, and have to resign themselves to giving as much trouble and time as school regulations permit to the few enthusiasts who care to add science to their classical burdens. For all the pretence that public schools make of teaching science, the average schoolboy comes up to the University destitute of the most rudimentary scientific ideas. If, as is sometimes the case, he wishes to take up science on his arrival there, he has to begin with ideas and facts which he might well have learnt in the nursery; if he prefers a literary course, he remains to the end of his life as ignorant of the alphabet of science as any baby. There is room for considerable difference of opinion as to how far the technicalities of any branch of science should be taught to schoolboys, but it must be admitted that in this age, which is above all things an age of science, an understanding of the fundamental laws of at least physics and chemistry ought to form a part of that vague but cherished ideal "a good general education." But are the public schools altogether to blame? In our system of education the universities call the tune, and the schools may be excused if they only play what is called for. The universities do not call for science. They say in effect, "before you can be of us you must know Latin and Greek, and you must know a certain minimum of arithmetic and of algebra or of geometry, but of any knowledge of science you may be as innocent as a babe. We care nothing for it, and we will confer our highest distinctions on you without asking you for one syllable of it."

The gates to an Oxford career are the University examination, responsions, or more familiarly "smalls," which takes no cognisance of science, and the college matriculation examinations, which in only a few cases give it a bare recognition. So long as this is the case, science will not be seriously taught at the public schools, and there will be a dearth of adequate candidates for science scholarships. The justification of the colleges amounts simply to this—that by their system they have discountenanced the teaching of science in schools, so that the schools cannot send them candidates fit to hold science scholarships, and therefore the scholarships are not awarded.

Oxford fosters the exclusive study of classics in the public schools, and it also does its best to shut its gates against those who have received what is called a modern education in other schools. The burden of matriculation and responsions is not a very heavy one to a fair classic, but it is sufficient to keep out many who have had an exclusively classical education, and is quite prohibitive to most "modern" boys. They go either to Cambridge, where the burden, especially as regards matriculation, is much lighter, or to one of the newer universities. In intention Oxford is possibly right. The product of a modern education is often wofully illiterate. He has the credit of knowing an extensive range of facts, and of having clear ideas about a large number of phenomena; but he is often incapable of stating his facts in plain English, and is so deficient in expression and in the power of arrangement, that clearness is the very last epithet which can be applied to his expositions on paper. His orthography and grammar are too often villainous. This sort Oxford has determined to have nothing to do with, and no true friend of science would wish to shake the determination. It may be doubted, however, whether the particular means of exclusion which are adopted, viz. insistence on a knowledge of Greek accidence, are altogether appropriate. It is quite possible for a man to have plenty of miscellaneous information, a good literary style, and originality of thought, without knowing as much of the Greek irregular verbs as would enable him to pass the ordinary college matriculation examination or responsions. The fact is tacitly admitted; for, with a strange inconsistency, the same section of the University which shudders at the idea of abolishing the Greek test for men, has lately opposed the admission of women to the B.A. degree for this reason, amongst others: that it would involve their having to go through the same Greek course as men, instead of being exempt from it as at present. But if it is asked why Greek is essential to the culture of men and unessential to the culture of women, no answer is vouchsafed.

The amount of Greek required for responsions is only acquired by some—probably by the majority—of boys at the cost of an amount of time utterly disproportionate to the results obtained. For in the end, though they may scrape through examinations, they really know no Greek worth mentioning, and what little knowledge of it they may have acquired is so fugitive that in a year or two after the examination they could not conjugate a Greek verb, and would be lost if they attempted to construe the easiest passages from Xenophon. It is idle to say that this modicum of fugitive knowledge is essential to culture. The Greek test is in a great number of instances a complete failure, and the imposition of it serves only to prevent many boys from attaining to culture by means suited to their natural aptitudes.

It is largely due to Greek that the numbers of the science school at Oxford are kept in check. If the University seriously wished the school well, it would allow elementary science, together with a modern language, to be offered as an alternative to Greek in responsions, and colleges would follow suit in their entrance examinations. Were this done, a large number of boys, freed from the trammels of a study which is repellent to them, would be able to learn enough of science to qualify for a science scholarship, and would in addition be able to acquire a knowledge of English and French or German literature sufficient to entitle them to the designation of scholar in the widest sense of the term.

To turn to the question of fellowships. They may be regarded as possible encouragements to science in two ways—prospective and actual. No doubt the prospect of obtaining one out of a considerable number of fellowships in any given subject will attract clever undergraduates to that subject. The actual holder of a fellowship may be supposed to exercise considerable influence in his college in favour of the subject which he professes. Nearly all the science professorships are attached to fellowships in one college or other, and in addition there are thirteen scientific Fellows receiving emolument in various colleges. Therefore it would appear that, in point of influence in college counsels, Oxford is not so very badly off. But the outside world is apt to over-estimate the influence which a Professor-Fellow or an ordinary Fellow exercises in educational matters, unless indeed he be a man of exceptional force of character. Educational questions rarely come before a full college meeting. The control of studies in each college is vested in the few Fellows who are tutors, whose function it is to exercise a general supervision over the moral and intellectual well-being of undergraduates. This supervision has been formed into a system of which it is not too much to say that it is in the highest degree inimical to science. It is quite unlike the system which exists under the same name at Cambridge, and exercises a much greater pressure on undergraduates.

Every freshman on arrival is assigned to a tutor, whose business it is to set him on a course of study, to see that he goes to the proper lectures, that he is punctual in his attendance at them, and attentive to his reading. A tutor may or may not, as the case may be, undertake also the private instruction of his own pupils. Since there are many avenues to the art's degree, it might be supposed that the tutor would point out to each freshman the various courses of study open to him, would give him the choice of any one of them, and the necessary information as to the proper mode of following up his choice when made. Were this done, there is reason to believe that a much larger proportion would select natural science. But the freshman is not invited to make a selection. Scholars, whether classical, mathematical, or scientific, are sent at once to their respective subjects. A commoner, if of more than average ability, is told that he must read for honours in classical moderations, and afterwards for "greats"; if of average capacity, then law or history is indicated; if of lesser ability, the prescription is pass moderations with two pass classical schools, and probably political economy for the third. Neither honour men nor pass men hear of science unless they make particular inquiries about it; and if they do, they are as often as not told that it will not give them the breadth of education necessary for their future careers. Instances can be cited of freshmen anxious to read science having been ordered to take a classical school instead.

Obviously this state of things would not exist if science were adequately represented on the tutorial staffs of colleges. It is most inadequately represented. Christ Church is the only college which shows to advantage in this respect. By reason of special endowments, it maintains three science lecturers, known as Lee's Readers, and of these the two senior are also tutors. There is a science tutor at Keble. (It is interesting, by the way, to note that the two most distinctively religious foundations in Oxford are those which give the most substantial recognition to science: it has not been discovered that their religious character suffers thereby.) In no other college is there a science tutor. There are lecturers, but the powers of a lecturer are not those of a tutor, either in theory or in practice. In some cases, indeed, the individuality of the lecturer may give him an influence coequal with that of the tutors, as is the case at Balliol and Trinity, and elsewhere, as at Merton, New College, Magdalen, and St. John's some considerable freedom of action is conceded to science lecturers; but in other cases, the duties of the lecturer are limited to the arrangement of the work of such men as the tutors may send to them. Speaking generally, it may be said that the tutors propose and dispose the courses of study; lecturers carry their behests into effect. The initiative is in the hands of the tutors who, with few exceptions, are classical, some few being mathematical, and only three scientific. By excluding scientific men from tutorships the Oxford colleges keep science at arm's length.

Three causes, then, militate against the increase of the scientific school at Oxford: the absence of any test of scientific acquirements in responsions and in most college entrance examinations, the severity of the Greek test, and the exiguous number of science tutors in colleges. These causes might easily be removed, but Oxford does not remove them, and, as a whole, it is unwilling to do so. At the bottom of it there is the wish that it should remain in the present what it has been in the past—the home of classical studies and of metaphysical philosophy. There may be those who would maintain that a university has the right to determine what courses of study should be characteristic of it. But it may be urged that the function of a university is not to be exclusive. Should it not rather be its duty to recognise and bestow its approval on the intellectual movements which have done, and are doing, most for the advancement of mankind? He would be singularly blind to what is going on around him who would deny that natural philosophy has been the great intellectual movement of this century, and that its methods and conclusions have been forced, willy-nilly, on every form of study that exists. But blindness seems to be prevalent among the majority at Oxford, or if not blindness, then wilful obstinacy. For its graduates, in their capacity as members of the University, have been obliged to give public sanction to science, and to spend large sums of money in making provision for teaching it. But in their more private capacities, as Fellows of Colleges, they stultify themselves by stopping the stream at its fountain-head. The endowments of colleges were given for the advancement of religion and sound learning. In times gone by sound learning meant Greek, and why? Because Greek literature contained not only all the metaphysical, but also all the natural philosophy known to the world. It is long since Artistotle has ceased to be the authority in natural, that he still is in metaphysical, science. But in the course of change the authorities have clung to Aristotle, and the endowments which originally were devoted to all sections of his work are now confined to only a part of them. The schoolmen, Duus Scotus amongst them, argued with as much subtlety about the scientific as about the logical teachings of Aristotle, and in so far imitated the spirit as well as the letter of the Greeks. Nowadays the letter remains, but the spirit is lost to the classicists, and has gone over, deprived of its material endowments, to science. How much longer will Oxford cling to the belief that it is the language in which they wrote, rather than the spirit in which they worked, which made the Greek philosophers the fathers of thought? It is indeed a curious satire on a modern classical education that the very things in which the Greeks were most interested are those which the Greek student of to-day most disparages.

It is to be hoped that Oxford will become awake to the unreasonable attitude which it has adopted towards natural science, unreasonable alike from the point of view of modern requirements and of the purposes of the philosophers whom it professes to venerate. For its own sake it is to be hoped that the awakening will come from within; if it does not, it will assuredly come from without. The University has just had a reminder of the dissatisfaction which was felt with the place assigned to science in its local examinations, and it has made haste to repair the defect. The dissatisfaction with its external examinations is as nothing compared with the growing dissatisfaction with its internal system, which, if left unremedied, must prejudice its reputation and destroy the influence which it possesses in the intellectual world.

Let it be said, in conclusion, that there are many at Oxford who are classical to the core, yet would willingly do all that is required for the advancement of natural science. They are mostly to be found among the middle-aged, not among the younger graduates. If certain actions of classical Oxford have been condemned in what precedes, exception is of course made of the more liberal minority, whose actions, if left unfettered, would be all that the most bigoted man of science could desire.

NOTES.

WE are informed that notification of the following additional delegates to the International Conference on the Catalogue of Science has now been received at the Royal Society:—Austria: Prof. Ernst Mach, Prof. Edmund Weiss. Germany: Prof. Walther Dyck (Munich), Prof. Van 't Hoff (Berlin), Prof. Möbius (Berlin), Prof. Schwalbe (Berlin), Oberbibliothekar Wilmanns (Berlin). Norway: Dr. Jörgen Brunchorst. The list of delegates is therefore now a remarkably complete and full one.

SIR GEORGE BADEN-POWELL has completed his arrangements for taking an observing party to Novaya Zemlya to observe the forthcoming solar eclipse. He will be accompanied by Dr. Stone, of the Radcliffe Observatory, Oxford, and Mr. Shackleton, of the Solar Physics Observatory, South Kensington.

AMONG the Civil List pensions shown in a return just laid upon the table of the House of Commons, we notice a pension of £200 to Mrs. Huxley, one of £120 to Mr. James Hammond, and one of £120 to Mr. Oliver Heaviside.

PROF. VAN DE SANDE BAKHUYZEN, Professor of Astronomy in the University of Leiden, has been elected a Correspondant of the Section d'Astronomie of the Paris Academy of Sciences.

DR. SAMUEL WILKS, F.R.S,, President of the Royal College of Physicians, has been appointed one of her Majesty's Physicians Extraordinary, in the place of the late Sir George Johnson.

THE death is announced of Prof. A. G. Stoletow, Professor of Physics in the University of Moscow. Prof. Stoletow was the author of several important memoirs on magnetism and electricity, the velocity of sound, the critical state, and other physical subjects.

SIR JOHN PENDER, who was for many years prominently associated with the promotion of submarine telegraphy, died on Monday. It was largely due to his enterprise and faith in the practicability of laying a submarine wire between England and America, that the capital required to lay the Atlantic cable of 1866 was subscribed. He also took a leading part in the organisation and development of the Mediterranean, Eastern (India and China), Australian, South African, and Direct African cables. It is stated that the cable mileage of the submarine telegraph companies over which he presided at the time of his death amounts to 73,460 nautical miles.

NOTHING is safe from syndicates of speculators. From a question asked in the House of Commons on Tuesday, it appears that an attempt is being made to exclude the public from right of way to the Giants' Causeway. Unfortunately that great natural wonder is not public property, and cannot, therefore, be protected from the syndicate which proposes to interfere with the right of access to it.

THE distribution of prizes to the students of the Charing Cross Hospital Medical School will take place next Tuesday, July 14. The Hon. Mr. Justice Vaughan Williams will occupy the chair.

THE geological collection at Peel Park, Salford, which some years ago was withdrawn from public view, has been entirely rearranged, and was reopened last week. The process of re-arrangement has been carried out by Mr. Herbert Bolton, of the Manchester Museum. The collection is now in a condition which will make it of service to students, and it will doubtless become an important factor in the educational progress of the borough.

A TELEGRAM from Sir Walter Sendall, High Commissioner for Cyprus, reports that incessant earthquake shocks have been felt there for several weeks, causing great alarm and interruption of business. A Reuter telegram from Larnaca, dated July 6, says: "Violent shocks of earthquake continue to be felt in the island. A general panic prevails at Limasol, and the Government and military authorities are providing tents for the people. Permission has also been given to families to take up their quarters in the commissariat huts and camp at Polymedia. The town is deserted, and the Government offices, the bank, and the telegraph office have been installed under canvas."

MR. JOHN MILNE writes us, that between June 23 and 31 he recorded several earth disturbances, which from their character had apparently originated at great distances. One commencing at 9h. 2m. 35s. G.M.T., on June 29, is probably identical with the earthquakes which on that evening shook Cyprus. With regard to the records of Prof. Vicentini of Padua, which in Japan mean time occurred at about 8.30 p.m. on June 15, and 5 and 9 a.m. on the following morning, he remarks that he only recorded the former of these on the 16th—his instrument being dismantled for adjustments to correspond with those of a second instrument which that day was installed at Carisbrooke Castle. Certain telegrams tell us that the sea waves on the coast of Japan took place on June 17; but this information, which, it will be observed, does not accord with what was noted in Europe, has not yet been confirmed.

THE highly poisonous nature of acetylene has suggested to M. Chuard the possibility of employing carbide of calcium as an insecticide for agricultural purposes. M. Chuard proposes to try thoroughly mixing the carbide with earth, so that under the influence of moisture acetylene would be slowly given off at the roots of plants, thus preserving them from attack. At the same time, the bye-products, consisting of chalk and a little ammonia, would have a beneficial effect on the soil. It is proposed to try this method against phylloxera. Whether this would succeed equally well in all weathers, wet or dry, is quite another question.

IN the *Annales de micrographie*, M. Miquel gives statistics for ten years of the numbers of bacteria in a cubic metre of air, both in the centre of Paris and in the park of Montsouris. In consequence of local improvements, the air in the park has gradually become purer, the number of bacteria having decreased from 480 per cubic metre in 1884 to 275 in 1893; but the air in Paris itself has increased in micro-organisms from 3480 in 1884 to 6040 in 1893. This large increase M. Miquel attributes to the greater cleanliness of the inhabitants, who, by dusting out and cleaning their houses and shaking carpets, &c., stir a large quantity of germs into the air. He even goes so far as to condemn this form of cleanliness on the ground that the germs are simply blown about by the wind, and find their way into the houses again, so that if you do not get your own germs back, those from your neighbours fly in at the window instead.

IT is nearly ten years ago that Dr. Carl Auer von Welsbach first enunciated the property of rare earths, which led to his discovery of the incandescent light. In a contribution to the *Atti della R. Accademia dei Lincei*, Signor Enrico Clerici now considers the action which takes place when vegetable tissues are soaked with solutions of certain salts, such as are used in the preparation of incandescent mantles, and the organic matter is afterwards removed by calcination. It appears that if sections of wood are treated in this manner with nitrates of certain metals, and the ashes are examined under the microscope, every detail of the original tissues is found perfectly preserved, even down, for example, to the scalariform ducts of *Pteris aquilina*. The author compares this process with the petrifaction of fossil woods, and he concludes that we have here a phenomenon of molecular interposition with which it is possible to cause certain insoluble and refractory oxides to penetrate into cell-walls and vegetable fibres, and to transform them in the course of a few minutes into true petrifactions.

THE anxiety of German municipal authorities to attract men of science to their cities and retain them there, is exemplified by a note in the current number of the *Lancet*. It may be remembered that in 1890, when Prof. Koch made his announcement respecting tuberculin, a special institution was founded by Parliament, under the name of the Royal Institution for Infectious Diseases, in order that he might be enabled to continue his researches on the treatment of such diseases on a larger scale than before, and it was placed entirely at his disposal instead of being controlled by the university, like all the other scientific institutions. It was, in fact, a special hospital in which new methods of treatment were to be tested, and it also contained a large laboratory, provided with every requisite, where not only Prof. Koch and his staff, but a number of other medical men carried on scientific work. The Government having lately announced that the Institution would possibly be removed from Berlin, the town council of Frankfurt offered to provide Prof. Koch with ample laboratory and hospital accommodation if he would agree to settle in their city. But when these negotiations became known, the medical as well as the lay press urged the Government to take measures to retain this important establishment in the metropolis, and an arrangement has now been made according to which the Institution is to be attached to the new Berlin Municipal Hospital at present in course of construction. The laboratory department will be built and furnished by the State, whilst the wards for infectious diseases belonging to the hospital are to be placed at the disposal of Prof. Koch by the municipal authority. This arrangement was strongly supported by Prof. Virchow, who is a town councillor, and it will, says our contemporary, undoubtedly have the approval of the medical men of Berlin, anxious as they are not to lose so celebrated an investigator as Prof. Koch. The spectacle of the London County Council holding out advantages to a man of science in order to dissuade him from migrating to another city awaiting to receive him with acclamation, is one which we are unable to imagine.

LAST autumn a mysterious disease appeared amongst the poultry-yards in Rome, and was of so virulent a type that it produced a mortality of about 60 per cent. amongst the fowls which it attacked. Careful investigations could not identify it with the fowl-cholera of Perroncito and Pasteur, or with the cholera of ducks described by Cornil, or indeed with any other of the diseases hitherto bacteriologically associated with feathered animals. Dr. Salverio Santori, of the Laboratorio medico-micrografico del Comune di Roma, has recently published in an Italian hygienic journal the investigations which he has carried out as to the nature and origin of this epidemic. His results are extremely interesting, for he has succeeded in isolating, not only a new pathogenic micro-organism, but one which belongs to the class of pigment-producing bacteria, the latter being but rarely associated with disease. In consequence of the splendid red colour it elaborates in artificial culture media, he has called it *Eritro-batterio.* In its microscopic appearance, and indeed in many other respects, it resembles the well-known *B. prodigiosus*, but it differs from the latter in its extreme virulence when subcutaneously inoculated in very small quantities into white rats, guinea-pigs, rabbits and fowls, death ensuing in from twelve to eighteen hours when liquefied gelatine-cultures are employed. When introduced *per os*, death is postponed for sometimes two months; but during the last ten or twenty days of the animal's existence, its extremities are completely paralysed. In both cases the microbe is found in the blood and all the organs of the body, but more especially in the fluids of the peritoneal cavity. It fails to elaborate its pigment in the absence of air, or when exposed to a temperature of 37·5° C., although it grows abundantly, and its virulence is not in the least diminished. Its pathogenic properties rapidly disappear in artificial cultures, often after a week; and the best method of preserving its virulence was found to be soaking silk threads in cultures, and letting them dry. Under these conditions, its virulence was preserved for three or four months. No immunity was induced in animals by administering gradually increasing doses of the toxine elaborated by it in broth. When exposed to the direct rays of the sun, in drops of broth enclosed in a Petri dish, it was destroyed in from eleven to thirteen hours.

"LEFT-HANDEDNESS in North American Aboriginal Art" is the subject of a short essay, by Dr. D. G. Brinton, in the May number of *The American Anthropologist*. He finds that a preference for the right hand and side has existed in the majority of mankind from earliest times, though not always in the same degree, and concludes that the ultimate reason for it is to be found in the erect posture of man. "The Anthropoids and other primates closest to men are ambidextrous, displaying no preference for either hand. But the erect posture introduces a new distribution of force in the economy; it opposes the powerful retardation of gravity to the distribution of the arterial blood above the level of the heart. The great arteries arising from the aorta carry the blood in an appreciably shorter course, and in less time, to the left brain than to the right. Its nutrition, therefore, is the more abundant, and its vitality the more active of the two hemispheres. Hence the right side of the body, which it controls, is more ready to respond to a stimulus on account of its higher innervation." There is also a short note on this subject, by O. T. Mason, in the June number of the same journal.

PROF. FRANK N. CUSHING'S expedition to explore the neighbourhood of Pine Island, of which mention was made in NATURE several months ago, proved extremely successful. Prof. Cushing has just returned laden with rare and interesting archæological specimens, and bringing the story of discoveries which demonstrate the existence of a prehistoric people in South-western Florida and the neighbourhood, who have left a multitude of mounds and other structures of couch shells, and whose works seem to furnish the key to much that was inexplicable in American archæology. He says that this ancient people differed in many ways from any others hitherto known; but that they somewhat resembled the Swiss lake-dwellers in their mode of life, and that their state of culture was quite similar and equal to that of the mound-builders and the Mayas and other builders of the ruined cities of Yucatan and Central America. Innumerable islands were found covered with shell foundations, and some with structures covering hundreds of acres, and rising fifty to sixty feet above the sea. A low mound, sixty feet in diameter, near Tarpon Springs, was thoroughly explored; more than six hundred skeletons were found, besides a large quantity of pottery, stone and other objects of art. At Marco, near the southern end of the Florida Peninsula, extraordinary painted tablets were found; also many carved wooden vessels, and implements and utensils of shell and bone. Sections of the shell islands made below the gulf level showed them to be entirely artificial, and the result of slow and long-continued building. The civilisation developed on these islands is supposed to have extended southward to Yucatan, and northward to the abode of the mound-builders. A notable collection of masks was found, put away in sets, each with an appropriate animal figure-head, designed foruse by priests performing the myth drama. The shell structures of the Ten Thousand Islands, as well as those on the mainland, are covered with peat and dense growths of mangrove, cactus and other tropical vegetation. The general plan is similar in all. There is a network of enclosures of various sizes, or ridges leading up to terraces crowned by gigantic mounds. A series of level-topped pyramids surround two or three lakes, from which channels lead out to the sea. The resemblance to the ancient cities of Yucatan is striking and instructive. The explorations made lead to the inference that the Ten Thousand Islands are nearly all artificial.

THE publication of the *Annals* of the Russian Central Physical Observatory for the year 1893 has enabled Dr. Hann to collate the mean temperature conditions of Verchoyansk, in Russian Siberia, from observations extending from nine to eleven years. The position of this place, which from the extraordinary lowness of the winter temperatures has become classical from a climatic point of view, is 67° 34′ N. lat. and 133° 51′ E. long. We extract the following remarkable records from the *Meteorologische Zeitschrift* for June. The figures refer to the lowest monthly means, and the absolute minima, respectively: November −47°·6, −72°·4; December −63°·0, −82°·8; January −71°·1, −90°·0; February −72°·0, −93°·6; March −43°·2, −77°·4. The extraordinary minimum for February has been quoted previously; it occurred in 1892, and is supposed to be the lowest reading recorded in any part of the globe. The mean yearly temperature, corrected for diurnal range, from values calculated by Dr. H. Wild, is 1°·0 F.

AT the meeting of the French Meteorological Society on the 2nd ult., M. Angot communicated a summary of five years' observations on the velocity of the wind at the top of the Eiffel Tower and at the Central Meteorological Office. These observations fully confirm results previously obtained, and show that the diurnal variation of the wind on the tower is quite different from that observed near the ground. The velocity is nearly constant during the night, slackens during the early morning, and reaches its minimum in the afternoon. Near the ground, on the contrary, it is known that it freshens soon after sunrise until early in the afternoon, and then decreases regularly during the night. These results show that this variation is only a phenomenon peculiar to the lowest strata of the atmosphere. It is interesting to note that it is only necessary to ascend about 1000 feet to meet with the conditions known to exist on mountains, viz. maximum and constant velocity during the night, and decrease of velocity during the day, under the influence of the vertical motion of the air due to the heating of the soil.

WE are glad to call attention to the publication of Part iv. (vol. iv.) of the *Transactions* of the Leicester Literary and Philosophical Society. Among the contents we notice: "Notes on the Swiss Flora," by Mr. G. C. Turner; "Note on a Dermoid Tumour from a Frog," by Mr. F. R. Rowley; and "A Comparison between the Lepidoptera of Japan and reat Britain," by Mr. W. J. Kaye.

FOUR new volumes have appeared in the Encyclopédie scientifique des Aide-Mémoire series. In one of these—"La Spectroscopie"—Prof. Julien Lefèvre briefly describes the application of spectrum analysis to physics, chemistry, physiology, and astronomy. The different methods employed for the observation of emission and absorption spectra in the laboratory, the solar spectrum, and the constitution of radial movements of stars are described, and a chapter is devoted to phosphorescence and fluorescence. The study of prisms, spectroscopes, and the theoretical side of the subject is treated in a companion volume—"Spectrométrie-Appareils et Mesures"—in the same series. A third volume recently received is entitled "Attaque des Places," by Lieut.-Colonel E. Hennebert. In it the various methods of besieged and besiegers, in past and present times, are set forth for the instruction of military engineers. MM. H. Moissan and L. Ouvrard have contributed to the series a valuable little volume on nickel—"Le Nickel." They describe in succession the physical and chemical properties of nickel, the principal compounds, minerals containing nickel, the metallurgy of nickel, alloys, extraction of nickel by electrolysis, and the principal applications of the metal.

THE additions to the Zoological Society's Gardens during the past week include two White-tailed Deer (*Cariacus leucurus*, ♂ ♀) from Canada, presented by Mr. Richard R. Dobell; a Red-bellied Squirrel (*Sciurus variegata*) from Vera Cruz, presented by Mrs. G. Maria Pullen; a Blue-fronted Amazon (*Chrysotis æstiva*) from South America, presented by Mr. A. E. Corsbie; a Black-headed Gull (*Lorus ridibundus*), European, presented by Mr. James Boorne; a Peregrine Falcon (*Falco peregrinus*), caught off the coast of Terra del Fuego, presented by Mr. T. W. Hubble; two Spotted Salamanders (*Salamandra maculosa*), European, presented by Mr. Philip Gosse; a Chimpanzee (*Anthropopithecus troglodytes*), a Temminck's Pangolin (*Manis temminckii*) from West Africa, two Ostriches (*Struthio camelus*, ♂ ♀) from Africa, a Blood-breasted Pigeon (*Phlogænas cruentata*) from the Philippine Islands, two Hamadryads (*Ophiophagus elaps*), two Indian Pythons (*Python molurus*) from India, three Naked-necked Iguanas (*Iguana delicatissima*) from Tropical America, a Great-billed Rhea (*Rhea macrorhyncha*) from Brazil, deposited; a Crested Pigeon (*Ocyphaps lophotes*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

BROOKS'S PERIODIC COMET.—The following search ephemeris for this interesting comet is from a complete one in *Astr. Nach.*, 3361:—

1896.	App. R.A. h. m. s.		App. decl. ° ′ ″		Brightness.
July 11	22 37 59·13	...	18 8 51·3	...	1·06
15	39 0·64	...	18 9 52·8	...	1·14
19	39 35·58	...	18 12 28·2	...	1·22
23	39 43·58	...	18 16 28·1	...	1·31
27	39 24·50	...	18 21 40·9	...	1·40
31	22 38 38·45	...	−18 27 52·2	...	1·50

Following the above table, the comet should be looked for soon after midnight about 11° north of the 1st mag. star Fomalhaut, which is on the meridian about 3.30 a.m.

MAGNITUDES OF SOUTHERN STARS.—In vol. xxxiv. of the *Annals of the Astronomical Observatory of Harvard College*, a complete and graphic description is given of the expedition sent out from the observatory at Cambridge, Mass., to South America, in order to extend the work of the Harvard Photometry to the stars of the southern hemisphere. Mr. S. I. Bailey, assistant professor of astronomy at the College, was the observer chosen for this duty, and in the report gives an historical account of his journey southward, which began on February 2, 1889, his only companions being his wife and son. Guided partly by the information furnished by the inhabitants respecting the meteorological conditions of the country, he at last decided to erect a station in Peru, choosing a spot on the summit of a mountain 6600 feet above sea-level, about eight miles north of east from the Chosica station of the Oroya railway. The observations have all been taken with the meridian photometer used for the northern stars, described in vol. xxiv. of the *Annals*. The instrument has two objectives, each of 10·5 cm. aperture and 166 and 145 cm. focal length respectively. Magnifying powers of twenty-eight and twenty-four diameters were used in the measurements. The magnitudes have been obtained by comparing each star separately with σ Octantis, mag. 5·5, this being the brightest star in the neighbourhood of the south pole. The first series of observations were taken on May 24, 1889, and for several months after this the weather proved very favourable, the instrument being used on nearly every clear night. As the summer season of the southern hemisphere approached, clouds became more frequent, and at length almost every evening was cloudy. This being so, the instrument was dismounted, and the observers travelled further southwards, remounting the photometer at a mining village called Pampa Central, near Valparaiso. In March 1890, they returned to Chosica, and again mounted the instrument in its old position, but the weather not proving so suitable as in the previous year, they again removed in September, and set up the station at Arequipa. Thus the measures of the various stars have been made at four stations. Following this introductory description, comes the voluminous catalogue of the magnitudes of 7922 southern stars, arranged on the same plan as the Harvard Photometry for the northern hemisphere.

RUGBY OBSERVATORY.—From the report of the Temple Observatory, Rugby, we learn that double-star observations were continued during last year. These observations are in continuation of the series commenced by Messrs. Wilson and Seabroke in 1871, which now comprises about 5000 complete measures of distance and position angle. The measures have been regularly published. The working list of double stars, which forms part of the report, gives approximate positions and measures for purpose of identification, and will be very useful to other observers who are following the same line of research. The observatory was open on eighty-three nights for the instruction of members of the school.

HARVARD COLLEGE OBSERVATORY.—Prof. Pickering has made the issue of the fifteenth annual report the occasion for furnishing some interesting particulars as to the establishment of Harvard College Observatory, and stating the general policy of the management. One of the statutes states that "the objects of the observatory are to furnish accurate and systematic observations of the heavenly bodies for the advancement of astronomical science, to co-operate in geodetical and nautical surveys, in meteorological and magnetical investigations, to contribute to the improvement of tables useful in navigation, and, in general, to promote the progress of knowledge in astronomy and the kindred sciences." It is noteworthy that no reference is made in the statutes to teaching, and the observatory is therefore primarily an institution of research, although such teaching as does not interfere with the regular work has been undertaken. While precise measures of position have not been neglected, the policy has always been to specially study the physical properties of the stars and other heavenly bodies, since less attention is usually paid to such work than to meridian work in most observatories. Accordingly much attention is given to photography, photometry and spectroscopy. Details as to the manner in which the various instruments have been employed are also given. The revision of the stars in the Harvard Photometry has been completed and is ready for publication, and it is worth noting that as many as 322 stars were observed on one occasion in the space of six hours, roughly one a minute; 107 photographs of the spectrum of β Lyræ have been lent to Prof. Frost for investigation, and this has suggested the possibility of increasing the usefulness of all the photographs which have been taken. Prof. Pickering invites correspondence with astronomers who may desire to borrow any of the photographs, and suggests the investigation of positions, distribution and brightness of stars in clusters, distribution of light in spectra, peculiar spectra, eclipses of Jupiter's satellites, and lunar mountains.

BAKU AND ITS OIL INDUSTRY.

No city on this side of the Atlantic can show a more marvellous growth, within a short period of time, than Baku upon the Caspian; and, even apart from its petroleum industry, its natural advantages are so great, that it seems specially designed for a brilliant future as the emporium of the whole trade between European Russia, her Central Asian provinces, and Persia. So quick has been its expansion that, but an insignificant village of 1400 inhabitants thirty years ago, it can now boast a population considerably over 100,000, which is increasing yearly by leaps and bounds.

This rapid growth is mainly due to two causes: first, its magnificent harbour, well protected from the north by the extended horn of the Apsheron peninsula, and from the east by the Serpent's Island, which forms an efficient and natural breakwater; and in the second place, its immediate proximity to the main area of naphtha supply, which already rivals that of America, and promises in no distant future to become the exclusive market for all Asia, and also for the greater part of Europe. The commencement of the modern oil industry of the Caucasus dates from 1823, when the brothers Doubinin started a small works in the neighbourhood of Mozdak, which, owing to want of capital, they were forced to close in 1850. These pioneers were followed in 1836 by the engineer Voskoboinoff, who established a distillery at the foot of the mud geysers of Bog-Boga; but this effort proved likewise unsuccessful, and no trace of it now exists. Later, in 1859, M. Kokareff founded the Baku Petroleum Company, with the view of extracting the oil from the naphtha-impregnated soil; but experiment having shown in 1871 that the crude oil could be obtained by boring, this first method was abandoned, the artesian boring becoming universal, and a firm foundation was laid for the industry and for those marvellous developments which threaten an economic revolution in the lighting and fuel supply of a considerable portion of the world.

The year 1865 marks an important advance, a M. Witte having in that year established a manufactory of ozokerite on the Sviatoia Gora (Holy Mountain), and it was his engineer, M. Weisser, who, in that same year, established the first refinery in the town of Baku itself. So rapidly did the industry develop, that by 1873 the town was in danger of becoming entirely absorbed by the distilleries that rose on every hand, whilst the black, dense, and acrid smoke from the naphtha-fed furnaces poisoned the atmosphere. Baku, however, being under the influence of a despotic government, M. Staroselsky, the then governor, was enabled to effect a revolution, which, however drastic it may appear to our circumscribed democratic conceptions, was radical and efficacious. This consisted in issuing an edict that the refineries situated in the town were to be removed outside its limits, and for that purpose the corporation ceded certain town properties situated at a distance of about two versts. This land they divided into a series of blocks of from 2000 to 2500 square sargenes each (sargene is seven square feet English), and suddenly, as if by magic, eighty new works sprang into existence, their erection going forward at fever heat day and night until completed.

How intolerable the nuisance had become may be inferred from the fact that the sole firing material in use for boilers and distilling-tuns being the refuse oil, or so called astatki, and no smoke-consuming apparatus at that time being employed, not only the buildings, but the whole surface of the ground became coated with a thick layer of soot, whilst the roads were almost impassable owing to pools and ponds of oil. No wonder, therefore, that it should have received the name of the Black Town, (Tchornoia Gorod) a name which still clings to it, although through the introduction of an apparatus, by means of which steam under pressure and air are proportionately mixed with the naphtha residue, the smoke is now virtually consumed. As a result of this invention, the factories erected under the new conditions beyond the limits of the corporation land, notably Nobel's Villa Petrolia, and Popoff's Gardens, are perfectly clean, and this district in consequence has received the name of the "White Town."

Owing to the number of valuable bye-products obtainable, the refining process is complicated in its character, although the appliances used are very simple in their construction. The crude oil, fed through lines of pipes from the main sources of supply at Balachani, is stored in large iron reservoirs, from which it is drawn off to be treated in gasometer-shaped retorts. These being heated by steam coils to about 140° C., the products, having a low boiling point, such as gasoline and benzine, are separated, and passing into separate chambers are condensed. A further heating to about 150° C. in like manner separates the low-grade petroleums, which have been largely used in adulteration, and are so dangerous to the consumer. The third distillation becomes the petroleum of commerce, after having been washed and cleaned under treatment with sulphuric acid and caustic soda. The residues of heavy oils are generally treated in a separate establishment, and from them are extracted various grades of dyes, vaseline, lubricating oils, &c.; the demand for the latter constantly increasing, owing to their excellent quality and cheapness. The ultimate refuse astatki is likewise sure to become a keen competitor with coal as a fuel, a ton of this liquid being the equivalent of from two and a half to three tons of coal. To what uses it can be applied is well exemplified in the town itself: until very recently it was used for watering the streets, and not only is its employment universal in every kind of manufacture, but also for all heating and other domestic purposes. Its use is also rapidly extending on the railways in South Russia. All the steamers on the Caspian and Volga, and the locomotives on the Transcaucasian and Transcaspian lines, burn no other fuel; and when we regard its portability and cleanliness, it would seem to be but a matter of time for its advantages to be generally recognised. Owing to the abundance of the supply, at times millions of gallons have been allowed to run into the sea, or have been deliberately set on fire, and it is no exaggeration to assert that a full half of these vast supplies from nature's storehouse have been lost and dissipated unproductively.

Baku is pre-eminently a centre of commerce, and for residential purposes most undesirable, it being subject to heavy dust-storms, rainlessness, intense heat, and almost entire absence of vegetation and fresh water. The only garden is the so-called Alexander II., maintained at great expense, the shrubs and trees being planted in soil brought from Persia. A few fresh-water wells give a very limited supply, the usual sources being brackish; but the railway company supplement it by cisterns filled from the river Koura, and almost every steamer imports some from the Volga. A peculiarity in the distribution of the local supply is, that the few fresh-water wells are in close proximity to those impregnated with salt.

Varied as are the subjects of study presented by the town itself, the chief centre of interest is undoubtedly the plateau of Balachani-Sabountchi, situated about eight miles to the north-east of Baku, and connected with it by a branch line of the Transcaucasian Railway. When viewed from a distance the tall truncated towers erected over the wells seem in such close proximity to each other, that they present the appearance of a pine forest; and it is only on a closer approach, that they prove to be the derricks containing the machinery necessary for boring or the pumping of the oil. These pyramids consist of a wooden-boarded framework, and are easily removable when the bore becomes exhausted. How thickly they are grouped, may be inferred from the fact that, within the limited area of three square miles, over 400 of them are crowded. (Fig. 1.)

Not the least puzzling of the many enigmas presented by these wells, is the nature of the source from whence the oil is drawn. Enclosed in its subterranean prison it needs, in many instances, but an insignificant outlet to rise as a roaring fountain of sand and oil to a height sometimes exceeding 200 feet, continuing in action for days and even weeks, spouting forth during the time many thousands of gallons per day; yet this in no way interfering with the supply from closely adjacent wells, which continue to yield their normal quantity.

It is therefore evident that the sources are independent of each other, and that although the reservoirs may have been originally arranged in regular series, yet, through the strata having become dislocated and faulted, they now form separate and distinct chambers of varying capacity and without direct connection between them.

Small though the evidence, geology throws some light upon the probable structure of the basin, whereas chemistry reveals but little as to the origin of the oil.

Geologically the town of Baku is situated on beds of Quaternary age, which have received the name of Aralo-Caspian beds; whereas the main portion of the Apsheron peninsula, on the south side of which Baku is situated, consists almost exclusively of Pliocene and Miocene strata, subdivided locally into the Baku, Apsheron, and Balachani formations. Wherever the rocks, which consist mainly of limestones and sandstones, are exposed, it is evident from their highly inclined dips, varying rapidly from point to point, that the whole region has been subjected to great earth-movements, the presence of overthrust faulting having been specially noted by Dr. Sjögren, of Upsala. As a result of these movements, the strata have been thrown into a series of anticlinal and synclinal folds, upon whose upturned and denuded edges throughout the Balachani district beds of Aralo-Caspian age have been unconformably laid down, a most notable feature connected with them being the extreme thinness and the abundance of the layers composing them.

Chemically, numerous suggestions have been made as to the origin of the oil. Mendeléef ascribes it to the carbon enclosed in metallic iron, deep seated in the earth's crust. Daubrée and Coquand connect it with combined chemical and eruptive action; Fuchs and De Launay lay special stress upon its relation to disturbed districts, whereas Lesquereux ascribes it without reserve to the decomposition of vegetable remains, and Hofer regards it as being of animal origin. Seeing, therefore, that the geological and physical characteristics lend support to all the theories enunciated, to none of them can as yet be granted any other than a hypothetical value.

Since the introduction of boring in 1871, this system has been exclusively employed. The number of the bores in 1881 reached 375, and in 1886 490, of which, however, only 160 were in actual work, 180 having become exhausted, and 150 being plugged down as reserves. The enormous supply of the crude oil may

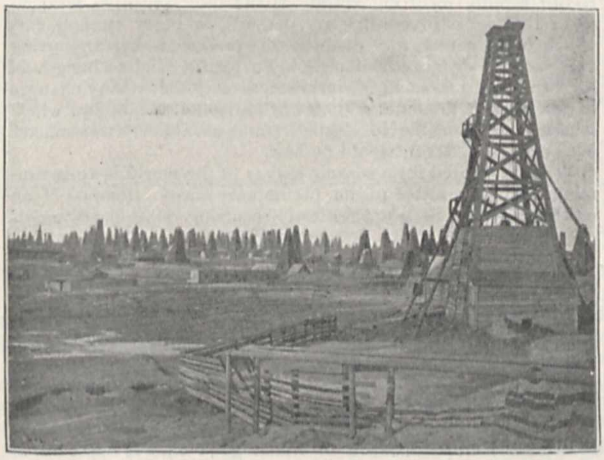

FIG. 1.—General view of the Balachani Oil-field.

be gathered from the following figures. In 1832 the yield was only 150,000 poods (pood = 36 lb.) = 2000 tons; in 1867, 999,999 poods, = 14,500 tons; in 1880, 300,000; and in 1890, 3,100,000 tons. That the supply is not inexhaustible, may be inferred from the fact that the depths of the bores are being progressively increased. We thus find that in 1871 the oil was reached at 70 feet, in 1873 this increased to 120 feet, in 1883 to 450 feet, in 1886 to 700; whilst a later bore, sunk to a depth of 1000 feet, has yielded no oil. It is evident, however, from the cellular character of the oil-bearing strata, and the immense supplies already obtained from a very limited area, that the period of exhaustion is indeterminable, and any conjecture baseless.

The means employed for raising the oil are of the simplest character; pumping, as understood in the ordinary acceptation of the term, is, owing to the depth of the bore, of course impracticable, so that after cessation of the flow consequent on the exhaustion of the gas, copper tubes called "jalonkas" are employed. These cylinders, about 12 feet long, are provided with a valve opening inwards on touching the bottom of the bore, and close on the tube being lifted filled with the oil. On reaching the surface the jalonka is lowered on to a platform, thus pressing in the valve and releasing the naphtha, which flows in a greenish-tinted stream to reservoirs connected by pipe-lines with the refineries in Baku.

It will be readily understood that in a district so saturated with naphtha oils, there must be an ever-present danger from the ignition of the exhalations of hydrocarbon gas, which escape not only from the bores, but through every fissure and cleft in the soil; and although every possible precaution is taken against such a catastrophe, many disastrous fires have occurred. Our illustration (Fig. 2) is from a photograph of one that took place in 1887, which was specially notable for its duration and devastation, all the derricks within a considerable area having been consumed, and all efforts to extinguish it failing until the volume of gas had become weakened and it burnt itself out.

These exhalations are most powerful in the district of Surachani, where the natural gas is made use of for lime-burning, for every domestic purpose, and as fuel for the boilers; in fact, it is only necessary to sink a pipe a few feet into the soil to obtain on ignition a flame of considerable length, and this is practically shown at the works of Messrs. Kokareff, where one such has been burning many years.

Adjoining this refinery, and placed by the Russian Government under that firm's special protection, is the ancient and celebrated temple of Zoroaster, which for over 2500 years was the sacred resort for pilgrimage of the Guebers, or fire-worshippers of Asia. (Fig. 3.) Formerly a flourishing monastery,

FIG. 2.—An Oil-well at Balachani on fire.

to-day it is but a decaying and deserted monument of the old religion of the Parsees. It consists of a large square courtyard enclosed by the cells of the monks, all opening inwards. A double-storied erection in the front was the dwelling-place of the chief priest, beneath which, and closely adjacent, was the chapel cell, on whose rude stone altars burned the Eternal Fires. In the centre of the courtyard is a square building, flanked with four towers, from which the flames ascended, and the arched recess in the basement was used as a crematorium wherein, by means of the sacred fires, the bodies of the faithful devotees were consumed. It is not only on land, however, that natural gas is abundant; a favourite excursion of the inhabitants and visitors being to take steamer on a calm dark night to the neighbourhood of the Baibat Point, where the gas rises through the waters of the Caspian sea in bubbling eddies, which, on being ignited with burning tow, covers the water with flames over a considerable area.

Although owing to its prominent position and natural advantages the attention of Europe has been mainly concentrated on the district and town of Baku, it must not be forgotten that this is but one out of many important petroleum fields awaiting development in South-eastern Russia. Not only are there rich deposits known to exist in immediate proximity to the sea in the Transcaspian province, but an immense area of petroleum-producing strata extends from the Crimea to the Taman peninsula, and thence across the northern boundary of the Caucasian range to Petrovsk upon the Caspian, and many centres of production in these districts are now being opened up, which must shortly come into keen competition with the Baku industry. Already during many years oil has been extracted from borings in the Kouban district, whence by means of pipe-lines it is transported to a refinery at Novorossisk; but these will

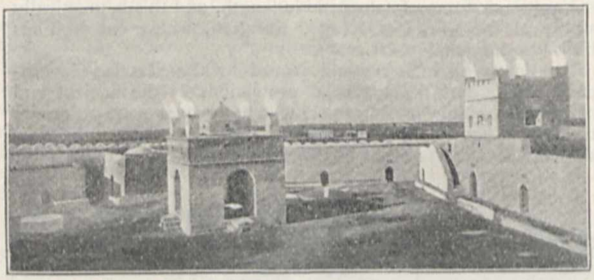

FIG. 3.—The Temple of Zoroaster.

be insignificant when (should all the reports be confirmed) the wells at Groznaia and its neighbourhood are tapped, it being considered that they will rival, if they do not surpass, Baku in productiveness. It would appear that the beds are almost identical in age to those of the Balachani-Sabountchi areas, and it would be an interesting subject for future study to ascertain if the line of petroleum productiveness to the north of the Caucasus follows that of the depression which in a former period connected the waters of the Caspian with those of the Azoff, the Black Sea, and the Mediterranean.

The accompanying illustrations are reproduced from an excellent series in *Globus*. W. F. HUME.

A SEISMIC SURVEY OF THE WORLD.

THE principal object of a seismic survey of the world is to measure the velocity with which earthquake motion is propagated through its crust, and possibly through its interior, and from the resulting figures to give to astronomers and physicists additional data respecting its effective rigidity.

It is the converse of the answer to a problem which in 1889 was incidentally worked out by Lord Kelvin, who, assuming a certain rigidity for our earth, determined the rate at which vibrations were likely to be transmitted through the same, the object of the calculation being to compare the result with that obtained from observations on an earthquake which in that year, originating in Japan, had been noted at many stations in Europe. The feasibility of the proposed undertaking and the probability of its yielding satisfactory results are based upon the existence of observations of the following nature.

For many years past astronomers, and those in charge of self-recording magnetographs, have observed disturbances in their instruments at varying intervals after the occurrence of an earthquake in some remote locality. In 1867, about seven minutes after an earthquake in Malta, M. Wagner observed at Pulkova an oscillation of 3″ in a level. One hour and fourteen minutes after the great earthquake of Iquique on May 10, 1877 (effects due to which were observed by the writer in Japan), at the same observatory M. Nyren noted oscillations in the bulb of a level of 2″ which had periods of 20 seconds. The late Dr. E. von Rebeur-Paschwitz repeatedly observed and obtained records of earthquakes which had their origin at distances equal to or more than one quarter of the earth's circumference from his observing stations. Vicentini, Agamennone, and others provided with instruments sensible to slight movements of the earth's crust, have made similar records; whilst the writer has not only shared in contributing to this class of observations, but on one occasion at least has obtained satisfactory photograms of a disturbance originating at his antipodes.

The conclusion which may be taken as well established by these observations is that suitable apparatus placed in any part of the globe will record the movements due to severe earthquakes originating in any other portion of our globe, and therefore there is nothing unreasonable in saying that every observatory throughout the world, if it were equipped with proper instruments, would be in a position to contribute to the knowledge of changes which are continually taking place, not only beneath the land, but also beneath the ocean.

For a person or a community to imagine that they reside in a locality free from earthquakes, is one of the greatest of modern fallacies. Although movements may not be felt, all places are disturbed in a manner capable of being recorded very many times per year. In addition to earthquakes the focus of which may have been some thousands of miles distant, to the recording of which the present note is intended to draw special attention, unfelt disturbances of a local origin may be recorded. Even at places where shocks are unknown, excepting as rare events recorded in ancient history, these may sometimes average two a day. Other movements taking place beneath our feet are slow diurnal tiltings, annual variations in the vertical, tremors of probably two distinct characters, earth pulsations and elastic vibrations.

To designate all these movements, which vary in their periods between the fraction of a second and twelve months, as "earth tremors," and an instrument to record them, a seismograph or a tromometer, are evidently misnomers. Although a single instrument may be obtained which will give information about each of these movements, experience has shown that it is better to have a particular instrument for a particular purpose. To record rapidly recurring vibrations the most sensitive arrangement that is self-recording is, perhaps, a Perry tromometer, which will detect the disturbance produced by a moving train at the distance of a mile. To record slight changes of level in a district, such, for instance, as may accompany changes in barometric pressure, a bifilar or horizontal pendulum, which is nearly as insensible to elastic tremors as a Perry tromometer is to change of level; would be best.

What is wanted for a seismic survey of the world is an instrument that is sensible to the preliminary elastic tremors of an earthquake, and then to the slowly recurring quasi-elastic gravitational waves by which these are followed. For this purpose it appears that our choice rests between some form of ordinary pendulum apparatus, like that of Agamennone or Vicentini, or some form of horizontal pendulum. Whatever form is selected, each instrument must be similar and similarly adjusted. If this is not the case, then at each station different instruments may commence to move with different phases of motion, and the records for purposes of comparison are without value. For example, an earthquake may originate at a known locality, at a known time, and be recorded at twenty different observatories in Europe, at each of which good time is kept, but at each of which the recording instruments are different in character.

The result of the calculations based on these observations have shown, in one instance at least, that the velocities of propagation of motion from the origin to each of these stations have varied between 2 and 20 km. per second.

The cause of this apparent discrepancy lies in the fact, that at different stations, during a disturbance having a duration of perhaps several hours, the different instruments have commenced to move with different phases of motion. This is a source of error which has been thoroughly recognised by observers in Japan for the last twenty years, and by timing the rate at which a particular vibration has travelled between given stations, the apparently conflicting results to which we are otherwise led have been greatly reduced.

When an earthquake is observed at stations far distant from each other, it is no longer possible to identify a particular vibration at these stations; but what can be done, is to note the time at which the preliminary vibrations commence and the interval which follows before the undulatory motions appear. So far as observations have gone, the velocity of propagation of the latter movements varies between 2 and 3 km. per second, which is about the rate we should anticipate to be found for motion passing through the materials constituting the earth's crust. The velocity for the former, however, appears to vary between wide limits, 10 or 12 km. per second being about the average. Because this rate of transmission is greater than that at which motion could pass through glass or steel, the inference is that it may possibly pass *through* our earth, and because it is variable the idea suggested is, that the rate of transmission varies with the depth of the wave-path. Should this be so, the next suggestion is, that as a wave proceeds downwards refraction may take place, and that a focal concentration of energy may be found at the antipodes of a seismic centre.

From these remarks it is clear that amongst the most important work with which the seismologist has now before him, is to measure the speed at which the preliminary vibrations of an earthquake are transmitted, and because this is high, the definition on the recording surface must be clear, the rate at which this is moved must be such that time intervals may be measured to within 10 seconds, and the observing stations, if they are limited in number, should be widely separated.

In the choice of stations, at all of which there must be the means of keeping fairly accurate time, the plan originally suggested by the author was to choose these relatively to districts where large earthquakes are frequent. The districts selected were the South American coast, Japan, and the Philippines, Himalaya and Central Asia. By a system of trials it was found that fifteen stations could be chosen, nearly all of which happen to be in the United States or British colonies, about ten of which would form a series approximately 2000 miles and multiples of 2000 miles distant from any of the three districts.

With a series of this description, data of a fairly complete nature respecting the rate at which motion may be transmitted round and, possibly, through our earth at varying depth should be obtainable. Any addition to this series would naturally render our information more certain, and add to the value of records obtained from centres other than those specified.

The cost of installation at each observatory would be approximately £50.

The proposal here made is similar to one published by the writer in January 1895, and does not materially differ from the one put forward by that distinguished investigator, the late Dr. E. von Rebeur-Paschwitz, and now being so warmly advocated by Dr. G. Gerland of Strassburg (see pp. 135, 136).

J. M.

THE SPECIFIC GRAVITY OF THE WATERS OF THE SEA.

IN continuation of his paper on oceanic circulation, in the concluding volume of the *Challenger* Reports, which chiefly dealt with the distribution of temperature, Dr. Buchan has published in the *Transactions* of the Royal Society of Edinburgh a series of maps showing, so far as the present state of knowledge permits, the specific gravity of the waters of the great oceans at various depths; and accompanying the maps is an extended discussion of some of the points treated in the previous memoir.

In the paper just published, Dr. Buchan has departed from the mode of representing salinities and specific gravities employed in the *Challenger* Report, and instead of charting the actual values, gives the departures above and below an average assumed to be a mean for all the oceans. It is difficult to see that anything is gained by this method; and it has the undoubted disadvantage that any future change in the assumed means will involve the reconstruction of all the maps. Even at the surface there are considerable portions of the sea of which we can only guess at the mean temperature and salinity, and the general average given by Dr. Buchan may therefore undergo modification, notwithstanding the attempts to apply a process of integration. Below the surface, the general average is simply the mean of existing observations; and while an inspection of the map shows that these are by no means perfect, the fact that there is only a single line of observations in the North Pacific, one in the Southern Ocean, none in the Atlantic north of 40°, and none in the Indian Ocean, indicates that the general averages must be mere approximations. Another unsatisfactory effect of the adoption of this method is due to the fact that values above and below the general average are thrown into strong contrast by being printed in different colours on the maps, thereby frequently exaggerating their apparent difference. In the case of the North Pacific, for example, Dr. Buchan lays great stress on the low specific gravity of the waters of this ocean at all depths. Undoubtedly the observations show that they are lighter than the Atlantic by a quantity amounting below the surface to about 0·0008; but the fact remains that a change of, say, ·0003 in the mean for the globe at 300 fathoms would throw the whole of the North Pacific *above* the average, while the observations within that area themselves show inconsistencies amounting to double that quantity. We draw special attention to this point, because it seems to lie at the root of a certain weakness in the line of argument taken up by Dr. Buchan, leading to a confusion of what we may call the statical and dynamical problems of ocean circulation, somewhat analogous to that involved in Ferrel's theory of cyclones. In drawing up any general scheme of the movements of oceanic waters, it is necessary to keep clearly in mind certain "conditions of continuity"; if the surface salinity is anywhere reduced by copious rainfall, it must somewhere else be correspondingly increased by evaporation; if reduced by melting of field ice, a corresponding quantity of salt must have been added to the deeper waters where the ice was formed; if up-welling is produced by an off-shore wind, the same force must be competent to cause a down-draught somewhere else. These considerations seem to suggest several simplifications in the scheme of circulation proposed by Dr. Buchan.

Comparing the Atlantic and Pacific Oceans, we find in the former a limited area subject to atmospheric systems of considerable intensity, the air over a considerable proportion of the surface being relatively dry. Over the Atlantic there is accordingly a relatively great amount of evaporation, producing high surface salinity, and the water carried off is distributed over an area nearly four times as large as in the case of the Pacific, allowing of its gradual return. In the Pacific, on the other hand, the winds are not so strong, the rate of evaporation is slower, and the redistribution of the moisture more local. It may therefore be possible to account for a considerable part of the low salinity of the Pacific without assuming that the high rainfall of the East Indian region produces effects so markedly in excess of those due to the immense discharges of fresh water into the Atlantic or the Indian Ocean. Dr. Schott's observations in East Indian waters support this view, indicating that the great freshening due to heavy rainfall is here, as elsewhere, largely restricted to the immediate neighbourhood of the land.

As an example of the converse of the foregoing, we may take the case of the undercurrent flowing from the Mediterranean to the Atlantic through the Straits of Gibraltar. From the observations of temperature and salinity Dr. Buchan regards it as placed "beyond dispute" that the warming effect of this outflowing water "becomes strikingly apparent at about 500 fathoms," and "beyond this depth its influence is felt over nearly the whole breadth of the Atlantic to at least about 1000 fathoms." Now at the Straits of Gibraltar the depth is something under 200 fathoms, and the extreme width at the surface a little greater than the Straits of Dover; and it is known that the loss by evaporation from the surface of the Mediterranean is not nearly compensated for by the fresh water additions from the rainfall and the rivers which empty themselves into its basin. The amount of water issuing into the Atlantic must therefore be greatly less than the amount entering the Mediterranean, and a comparison of the volumes and temperatures of the two bodies of water shows that it is almost impossible to give the outflow from the Mediterranean credit for such widespread action.

The two cases we have quoted, perhaps the strongest of several suggested by Dr. Buchan's papers, seem to support the results of a number of recent investigations, indicating that the effect of differences of specific gravity, while by no means a negligible quantity, is in general small compared to the dynamical effects due to the momentum of the surface currents, even at great depths.

From this point of view, we at once obtain help from the researches of Pettersson and Krümmel, noting specially their results as to the tendency of surface currents to induce *reaction* currents under them, and to divide on changing dir.ction, and bearing in mind the deflecting influence of the earth's rotation at all depths. In the Atlantic, the water driven northward along the American coast is blocked by the land, and is partly drained off by the easterly drift currents, partly sent downwards in a column separated into two parts, at least in certain seasons, by a bulging out of the cold Labrador current. Crossing towards the west coast of Europe, the easterly drift divides, a part escaping northward under regulation of the polar streams from the east of Greenland and Iceland, and a part banking up against the French and Spanish coasts and the north-west of Africa, as is shown by the "bottle charts" of the Prince of Monaco and M. Hautreux. The shape of the coast prevents all the water escaping laterally, and a part descends, carrying with it the efflux from the Mediterranean.

In the Pacific the effect is similar, subject to the difference that while the circulation is less energetic, it is also less interfered with by the configuration of the land, and except off the coast of Central America, where the south-easterly drift is again "cornered," the effect of the earth's rotation becomes more apparent. The difference due to the Pacific being closed at its northern extremity is extremely striking.

H. N. DICKSON.

THE UNIVERSITY OF LONDON.

ON Monday the Duke of Devonshire introduced a Bill in the House of Lords to make further provision with respect to the University of London. In the course of a brief statement as to the circumstances which have led to the introduction of the Bill· the Duke of Devonshire explained that the Cowper Com, mission reported two years ago in favour of London University being made a teaching as well as an examining University, and recommended the appointment of a Statutory Commission to carry out the details of the scheme. It will be remembered that a Bill dealing with the question was introduced by Lord Playfair in the last Session of the late Parliament, but it was not proceeded with in consequence of the dissolution. His Lordship is reported by the *Times* to have said: "I believe that neither University College nor King's College is altogether satisfied with the scheme as sketched out in the Commissioners' report. But still more formidable opposition has manifested itself, not on the part of Convocation of London University as formally constituted, but on the part of a considerable body of members of Convocation residing for the most part in the provinces. This opposition, I believe, proceeds from an apprehension that under the proposed constitution of the University the teachers of the affiliated institutions and colleges will exercise a large and perhaps undue influence over the examinations of the University, and that students who have prosecuted their studies in independent colleges or privately will in future be placed at some disadvantage. The apprehension is that either the high standard which, it is admitted, has always been maintained by the London University will be lowered, or else that in the examinations arranged by the new body external students will compete on unfair terms as compared with students in the recognised teaching institutions. To meet objections of this kind we give in this Bill a somewhat wider discretion and larger powers to the proposed Statutory Commission than were proposed to be given in the Bill presented by Lord Playfair last year. While the Commissioners will be directed, as in the Bill of last year, to proceed upon the proposals of the late Royal Commission, they will also be directed to inquire into and have regard to the requirements of both the internal and external students. I trust that an opportunity will be afforded, by presenting this measure in a definite shape, to those who are concerned of ascertaining the real character of any opposition which may be offered to the proposed change in the constitution of the London University. Personally I am insensible to the motives which have actuated some graduates in offering considerable opposition to those proposals. After all it is the Senate of the London University which is charged with the duty, and on which rests the responsibility of watching over the interests and upholding the character of the University, and this Bill and the proposals of the Commission which it seeks to carry into effect have, I am assured, the warm approval of a large majority of the Senate of the University of London. This is a measure which practically has been recommended by two Royal Commissions, each of which was composed of men highly competent to pronounce an opinion on such a question as this. It is, I believe, supported by a very large majority of the most eminent scientific and educational authorities in the country, and it is, in my opinion, a very great anomaly, almost approaching to a scandal, that the great City of London should alone of all the great cities in the United Kingdom—and I believe I may add alone among the great cities of Europe—have remained up to this time without a teaching University. The experience during the last ten years of abortive attempts—which I have briefly recounted to your lordships—shows that almost insuperable difficulties exist to the establishment of any such teaching University in any other way than that which has been proposed by the late Royal Commission. It has been almost conclusively proved that the intervention of Parliament through the appointment of a Statutory Commission is necessary, and is the only means by which this desirable end can be effected." The Bill was then read a first time.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE French Senate has adopted the Bill for the establishment of district universities.

THE archæological library of the Ashmolean Museum at Oxford was struck by lightning during a severe storm on Tuesday, and the roof was set on fire, but fortunately the valuable books in the library were not damaged.

DR. J. NORMAN COLLIE, F.R.S., Assistant Professor of Chemistry at University College, London, has been appointed Professor of Chemistry in the Pharmaceutical Society's School of Pharmacy.

IN answer to a question put by Colonel Lockwood in the House of Commons, the Vice-President of the Council said, some nights ago, that the Teachers' Registration Bill could, as far as he could see, only be proceeded with this session if it were made entirely non-contentious.

LORD CROSS, Master of the Worshipful Company of Clothworkers, on Friday will lay the foundation-stone of a research laboratory in connection with the dyeing department of the Yorkshire College, Leeds. The expense of the new buildings, £15,000, is being borne by the Clothworkers' Company.

THE arrangements for the transfer of the right of patronage to the chair of Natural History in the University of Edinburgh, now exercised by the Crown, to the curators of patronage in the University, and the transfer of the right of patronage to the chair of Botany, now vested in the curators to the Crown, have been incorporated in a Bill, and the Bill has been introduced into the House of Lords by the Government.

AT the annual summer meeting of the Incorporated Association of Head Masters, which was opened on Friday last at Leicester, it was moved: "That to ensure the proper organisation of secondary education it is essential that, with the exception of non-local schools, every school or department of a school providing secondary education should be placed under a county authority administering secondary education." It was further agreed that the "local authority for secondary education should in no case administer a smaller area than that of an administrative county as defined by the Local Government Board."

REFERRING to the cost of education in Switzerland, Her Majesty's Secretary of Legation at Berne points out that it is much less than in England. In 1893 there were 8390 primary schools in Switzerland, with 469,800 children, and an average of 50 pupils per teacher, of whom there were 6290 masters and 3180 mistresses. The expenses of the cantons were, on an average, 50 francs (£2) per pupil, or 8 francs (6*s*. 8*d*.) per inhabitant. In the Polytechnic School of Zürich, to which the Federal Government makes an annual grant of £36,800, there are 720 pupils, of whom 309 are foreigners. Instruction is given in architecture, civil engineering, mechanics, chemistry, forestry, and training of teachers. The fees are about £8 10*s*. per pupil. There are commercial schools in six cantons, where the average expense to the pupil is £18 10*s*. per head. There are seven universities, with a total of 3742 male and 491 female students in theology, law, medicine, &c., among whom are many foreigners. There are, moreover, technical schools of all sorts for instruction in farming, dairy work, vine culture, &c., established throughout the country. In 1893, in the twenty-five cantons of the confederation, the expenses on account of education were, by the State, £660,200, and by the communes £839,960, making a total of £1,500,160, or an average of about 10*s*. per inhabitant. Under the heading of technical instruction £1,575,000 was spent in 1894.

THE Committee of Council on Education have decided to modify the existing rules for grants for instruction in science and in art, contained in the Science and Art Directory and the Minute of August 21, 1895, as follows, except as regards organised science schools and training colleges, to which these alterations do not apply:—In place of payments on the results of examination an attendance grant, except as stated below, will be made, on the certificate of the Committee of the school, for each attendance of *at least* an hour's duration on the part of a student who has given not less than ten such attendances during the session. The minimum grant specified will be allowed if the inspector of the department reports that the teaching and equipment of the school are satisfactory, and that the class or classes are not too large for instruction by the staff of teachers. But these grants may be increased in any subject for efficiency up to the maximum specified; the efficiency being determined by the inspector's report and the success of the class in that subject at the May examination. The grants for science will be :—2*d.* to 6*d.* for each attendance in a night science class in the elementary stage, and 4*d.* to 1*s.* 4*d.* in the advanced stage; and for each attendance of 1½ hours' duration given to practical work in chemistry, physics, metallurgy, or biology, in a properly equipped laboratory, 3*d.* to 9*d.* in the elementary stage, and 6*d.* to 1*s.* 4*d.* in the advanced stage. The payments for attendance in a day science class will be at half the above rates. No student may be registered in the advanced stage of any subject until he has passed the examination of the department in the elementary stage, or has passed some corresponding examination which is considered by the department to sufficiently meet the requirements of the case. No student may be registered for more than two years for attendances in either the elementary or the advanced stage of any one subject. The grants will only be made if the student is of the industrial class as defined by the Science and Art Directory, and if the attendances for which the grant is claimed are such as can be legitimately registered under the rules. Grants for honours in the science subjects of the Department of Science and Art will continue on the same scale as at present.

AN excellent survey of the systems of technical education in Austria, Germany, France, and Switzerland, compared with what is done in England and Ireland, is contained in a pamphlet entitled "Technical Education: a National Necessity, its Uses and Advantages," by Prof. Henry Corby, published by J. Mahony, Cork. Prof. Corby shows what technical education has accomplished on the continent, and points to the comparative neglect of it in England, the result being a loss of commercial supremacy. As to Ireland, technical education is almost unknown there. There is only one technical school of note, and that has been established within the past few years in Dublin. In Cork something has been done; but it is disjointed and fragmentary. However, it tends in the right direction, and we hope with Prof. Corby that it may yet prove to be the mosaic pavement on which will be raised a large and comprehensive technical school, which will be worthy of the commercial enterprise of the capital of the South of Ireland. It is suggested that good would come if Cork were raised to the dignity of a university city. Why not have a university for the South of Ireland in the capital of the South? At present, Prof. Corby points out, there are only two universities in Ireland, both located in Dublin, while Belgium, with a population almost exactly the same, has four universities; Scotland also has four, and in scientific Germany there are as many as thirty-one universities. To show what a thorough general and technical education can do for a country, it is only necessary to refer to Switzerland, which, though only about half the size of Ireland—and, as fully one-half of its soil is entirely unproductive, it may be regarded as only about one-fourth the size of Ireland—is able to maintain three million inhabitants, whilst the population of all Ireland is little more than four and a half millions. Prof. Corby describes what some continental nations have done for agriculture, and then he asks how can the smaller farmers of Ireland—many of them poor and half-educated—attempt to compete with such rivals? It has been urged that Ireland ought to have a Minister of Agriculture, but it is suggested that a Minister of General and Technical Education, who would give special attention to agriculture, would be better. If national teachers were trained at agricultural schools, and students were given practical instruction in agriculture, if chairs of Agriculture were established in all the higher colleges, and special lectures delivered in the auxiliary sciences, such as chemistry, zoology, botany, and mineralogy, then, thinks Prof. Corby, the hope might be entertained that the vast tracts of waste land in Ireland would be reclaimed, and a large scheme for reafforesting undertaken with every prospect of success. We trust that his admirable pamphlet will be the means of giving an impetus to the cause of technical education in Ireland.

SCIENTIFIC SERIALS.

The Reliquary and Illustrated Archæologist maintains its reputation for the beauty of its illustrations. In a late number (vol. ii. No. 2) an elegantly carved wooden Egyptian toilet-spoon of the eighteenth dynasty is reproduced in collotype.—The editor, J. Romilly Allen, has carefully studied the cup-and-ring sculptures of Ilkley in Yorkshire, and gives numerous illustrations of these still mysterious markings. All that we know about them is that they are religious symbols, and that they mostly belong to the Bronze Age, although cups only may possibly have been used at the end of the Neolithic period.—The much-discussed "Dwarfie Stone" of Hoy, Orkney, has been investigated by Mr. A. W. Johnston in a very thorough manner; he comes to the conclusion that it was originally a sepulchre with a stone door.

Internationales Archiv für Ethnographie (Heft 2, Bd. ix.)—The question of alleged native writing in Borneo is discussed by Mr. H. Ling Roth and Prof. H. Kern; inscriptions in one or two scripts are known, but there is no evidence that any form of writing was known to the Dyaks. Heer M. C. Schadee, in collaboration with Herr Schmeltz, has a communication on the ethnography of Western Borneo, which is illustrated in the characteristically excellent style of this journal. In the current number (Heft 3) Schmeltz continues his erudite notes on ethnographical objects from New Guinea. In a note entitled "Prudery in Scientific Matters," the same author states, on the authority of Prof. Brigham of Honolulu, that "the Government of New Zealand has not only prohibited the importation of the well-known phallic chalk idols from New Ireland, but in the Government Museum of Auckland all ithyphallic idols and figures have been castrated and mutilated." We hope that the Curator of the Museum will state how far this is or is not the case.

IN the second number of the useful *Centralblatt für Anthropologie Ethnologie*, &c., is an article on the Necropolis of Novilara near Pesaro. According to Dr. P. Orsi the civilisation of Novilara was partly similar to and synchronous with that of Villanova. Three different culture streams have overlaid themselves, as it were, on the local substratum, and have contributed to give the Picinian culture its final form. One stream came from the north and west over the Apennines. The second came from the south, bringing with it the geometric vessels, which are wanting at Villanova, but appear in Istria; later this culture stream, which may be called the Greek one, brought Tarentinian silver coins and vases painted with black figures. The third stream is the Phœnician (partially also archaistic Greek) associated with figures of Astarte, glass beads and sepulchral steles with representations of naval war. The Necropolis belongs to the ninth to the seventh century B.C.

Bulletin de la Société des Naturalistes de Moscou, 1895, No. 4.—On adhesion of different metals to glass and other substances, by J. Weinberg, second article, in German.—On the winter flora of Nice, note by H. Trautschold.—Report on herborisation in the government of Smolensk, by A. Jaczewski.—The primary skeleton of the ventral fins of the Teleostei, by N. K. Kolzoff, in German, with illustrations; based on the study of thirty-six species.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 4.—"The Hysteresis of Iron in a Rotating Magnetic Field." By Francis G. Baily.

By deduction from the Weber-Maxwell-Ewing theory it has been surmised that the hysteresis in magnetic metals under the influence of a constant rotary magnetic field will be less than that in an alternating field in which the magnetising force passes through a zero value. It is supposed that residual magnetism is due to the combination of molecular magnets in stable magnetic arrangements, and that the energy dissipated in any magnetic change corresponds to the work done in breaking up these arrangements. Hence any movement of the molecular magnets during which the formation of new combinations is checked or prevented will take place with considerable reduction in the energy loss due to this cause. Such a condition is realised when the magnetic substance is subjected to a rotary magnetic field of sufficient strength to force the molecules to maintain a direction parallel to that of the field. If hysteresis is due only to the formation of new combinations and not to mechanical restraint, then under these conditions it will vanish altogether.

Experiments were carried out to verify this deduction. A finely laminated cylinder of iron was suspended on its axis between the poles of a rotating electro-magnet, but was restrained from continuous rotation by a spring. On rotating the magnet, the armature was dragged round until the restoring force of the spring equalled the force due to hysteresis, and the value of the latter could be obtained from the observed deflexions. At first the value of the hysteresis was higher than that in an alternating field for corresponding inductions, but at an induction of about 16,000 in soft iron and 15,000 in hard steel the hysteresis reached a sharply defined maximum and rapidly diminished on more complete magnetisation, until at an induction of about 20,000 it became very small with every indication of disappearing altogether. Soft iron and hard steel gave very similar curves, and in both the curve of hysteresis-induction cut the curve obtained from the values in an alternating field at a point just before the maximum. The result fully bears out the deduction from the theory, and proves in addition that hysteresis is not sensibly due to anything of the nature of mechanical restraint of the molecules. The form of the curve also gives clear indications of the three stages of molecular movement, the first stage giving a slowly rising curve, the second a straight rapid rise, and the third a straight and much more rapid descent.

Further experiments were carried out on the effect of speed of rotation. In an alternating field the speed of reversal has been shown to be without sensible effect on the hysteresis, and theory points to this result as a natural deduction. From an extremely slow speed up to seventy revolutions per second no definite change was found in the value of the hysteresis. At the same time several small modifications were noted, produced by rapid variations in the speed of rotation or magnetising force. The effect lasted through many revolutions, but ultimately the same steady condition was arrived at. At and near the maximum value the hysteresis was very variable. The effects were much more marked in soft iron than in hard steel, as would be anticipated from the theory of their constitution.

June 11.—"The Relation between the Refraction of the Elements and their Chemical Equivalents." By Dr. J. H. Gladstone, F.R.S.

This paper is intended to give a preliminary account of some recent investigations into the specific refraction of the elements. The first part contains the atomic weights, with the specific and atomic refractions of fifty-five of the elements.

The specific refraction cannot claim a constancy equal to that of the atomic weight. Several of the elements exhibit two or more values, besides many smaller variations scarcely, if at all, beyond the limits of experimental error, which depend upon differences of physical condition or chemical combination.

The second part deals with a law previously suggested by the author, namely, that the "specific refractive energy of a metal is inversely as the square root of its combining proportion." The product of these two quantities as determined from their compounds is found to be for 5 univalent metals about 1·3, for 10 bivalent metals about 0·99, for 7 trivalents about 1·01, for 6 quadrivalents about 1·06, and for one quinquivalent 0·98.

The observations show: First, that the metals which have the same valency, have the same, or nearly the same, constant of refraction for equivalent weights. Secondly, that the constants of the bivalent, trivalent, quadrivalent, and apparently quinquivalent groups are practically the same, ranging about 1·01. Thirdly, that when a metal combines in a proportion that indicates a lower valency than that ordinarily assigned to it, its constant is somewhat elevated.

The relation involved is not between the optical property and the atomic weight, but between it and the electro-chemical equivalent.

It is proposed to give this product the descriptive name, "Refractive constant of equivalent weights." It may be represented by—

$$SE^{\frac{1}{2}} = \text{constant, or by } S^2E = \text{constant},$$

where S is the specific refraction, and E the chemical equivalent of the metal.

The Lorenz expression for S may be equally used if preferred.

This is suggested as a first approximation to a law, which holds good, however, only for the metallic elements, and that when they are electro-positive radicals.

"The Effects of a strong Magnetic Field upon Electric Discharges in Vacuo." By A. A. C. Swinton.

This paper deals with some effects of a strong magnetic field upon electric discharges in vacuo.

A pear-shaped Crookes' tube was suspended with the kathode terminal uppermost above the pole of a very powerful electromagnet.

When the magnet was not excited the walls of the tube showed everywhere green fluorescence, which was especially strong over the rounded end of the tube opposite the kathode. When the magnet was magnetised, the whole appearance of the discharge was found to alter immediately to what is shown in the illustration (Fig. 1). Excepting for a little near the kathode and

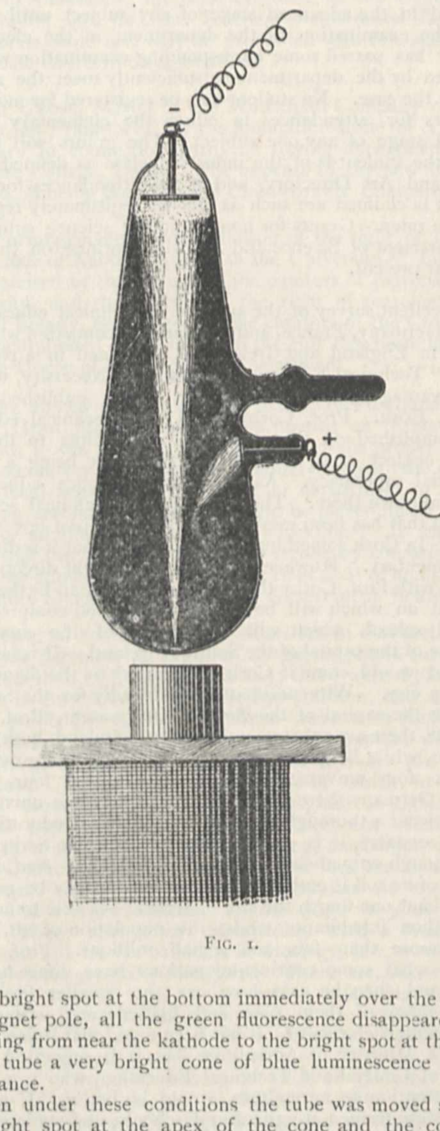

FIG. 1.

a very bright spot at the bottom immediately over the centre of the magnet pole, all the green fluorescence disappeared, while extending from near the kathode to the bright spot at the bottom of the tube a very bright cone of blue luminescence made its appearance.

When under these conditions the tube was moved sideways, the bright spot at the apex of the cone and the cone itself moved, the spot and apex always maintaining a position exactly over the centre of the magnet pole.

At the same time, while the magnet was excited, the internal resistance of the tube as measured by an alternative spark gap was found to be very greatly diminished.

On demagnetising the magnet the appearance of the discharge and the resistance of the tube immediately reverted to what they had been previously. The effect was quite independent of the polarity of magnet pole, and when the position of the tube was reversed, so that the kathode was next the magnet, the excitation of the magnet reduced the resistance of the tube as formerly, the green fluorescence at the same time disappearing; but the blue luminescence, instead of being concentrated into a cone, was diffused throughout the whole interior of the tube.

[Since the above paper was written, further experiments have revealed the following additional facts.

With a tube of the form shown, exhausted to an extent that gave X-rays plentifully under ordinary conditions, and supported over an electro-magnet as shown in Fig. 1, the X-rays disappeared as soon as the magnet was excited, but reappeared the moment the magnet was demagnetised.

With another tube of similar form but furnished with an inclined platinum plate forming the anode placed near the bottom of the tube, similar results were obtained. This tube being kept on the pump was further exhausted to a degree that allowed the electric discharge to pass with difficulty when the magnet was not excited, and under these conditions gave X-rays of a character that penetrated the bones of the hand almost as easily as the flesh with but little contrast. With this exhaustion the excitation of the magnet not only caused the kathode rays to focus on the platinum, thus giving sharper shadows, but at the same time had precisely the same effect as lowering the vacuum in so far as the moment the magnet was excited the X-rays became more plentiful, and became of such a character as to penetrate the flesh with much greater ease than the bone, so that the contrast between bone and flesh was exceedingly marked. A photograph of the hand taken with one minute's exposure with the tube in this condition, and with the magnet excited, though considerably over-exposed, proved to be a very good one. Further investigations are in progress, but the application of a strong magnetic field in the manner described, gives promise of having considerable practical utility, not only in so far as it facilitates the accurate focusing of the rays proceeding from a flat kathode upon any desired point of the platinum anode, but also and more especially because by employing a high exhaustion and by varying the intensity of the magnetic field, it is possible at will to arrive with ease at the exact conditions requisite to produce a maximum of X-rays of exactly the penetrative character that may be best for any given purpose, a result which hitherto has been difficult of attainment.—A. A. C. S., July 7.]

June 18.—"A Magnetic Detector of Electrical Waves, and some of its applications." By E. Rutherford, 1851 Exhibition Science Scholar, New Zealand University, Trinity College, Cambridge.

The effect of Leyden jar discharges on the magnetisation of steel needles is investigated, and it is shown that the partial demagnetisation of strongly magnetised steel needles offers a simple and convenient means for detecting and comparing currents of great rapidity of alternation.

The partial demagnetisation of a collection of fine steel wires, insulated from each other, and over which is wound a small solenoid in series with the receiving wires, was found to be a sensitive means of detecting electrical waves at long distances from the vibrator. A small but quite marked effect was obtained at a distance of half a mile from the vibrator.

A fine steel wire detector was found to be of the same order of sensitiveness as a bolometer for investigating waves along wires.

This detector has the property of distinguishing between the first and second half oscillations of a Leyden jar discharge, and may be readily used for determining the damping of oscillations. The absorption of energy of spark gaps of different lengths is investigated.

The resistances of iron wires for high frequency discharges are quantitatively determined. The permeability of the different specimens is deduced, and it is shown that the calculated value of the permeability varies greatly with the diameter of the wire and the intensity of the discharge.

A method of experimentally determining the period of oscillation of a discharge is based on the division of a rapidly alternating current in a multiple circuit, one arm of which is composed of a standard inductance, and the other of a variable electrolytic resistance.

PARIS.

Academy of Sciences, June 29.—M. A. Cornu in the chair.—Some properties of the secondary roots of prime numbers, by M. de Jonquières.—Formulæ for the coefficient of internal friction in gradually varied flow of liquids, by M. J. Boussinesq.—Remarks by M. Appell on presentation of his work on "The principles of the theory of elliptic functions and their applications."—M. Albert Goudny announced the death of Sir Joseph Prestwich, correspondent of the Academy in the Section of Mineralogy.—M. Bakhuyzen was elected a correspondent for the Section of Astronomy.—Report on a memoir of M. Bazin, entitled "New experiments on the distribution of velocities in pipes."—Control of the results obtained by the dynamometric pedal of the bicycle, by M. Bouny. Experiments in which the work done was measured at the same time on the brake and by the dynamometric pedal, showed that about 95 per cent. of the work exerted on the pedals was shown by the brake, the remaining 5 per cent. being absorbed by the friction of the axes of the pedals, the chain, and the axis joining the cranks.—Actinometric experiments made on Mont Blanc with a view to determine the solar constant, by M. J. Vallot. Simultaneous observations were made at Chamounix and at the summit of Mont Blanc. Two types of instrument were used, the absolute actinometer of M. Violle, and the mercury actinometer of M. Crova. Extremely concordant results were obtained, giving as a mean value 1·70 for the solar constant.—On rays when $\lambda = 0$, by M. C. Maltézos.—On the spectrum of phosphorus in fused salts and in certain metallurgical products, by M. A. de Gramont. Fused phosphates submitted to the action of a condensed spark, give a fine spectrum of the lines of phosphorus of greater clearness and intensity than the spectrum given by a Plücker tube containing phosphorus. The same method showed easily the presence of phosphorus in alloys, as little as 2 per cent. being readily recognised by the characteristic triplet in the red.—On the blue nitrodisulphonic acid and some of its salts, by M. Paul Sabatier.—Action of iodine upon stannous chloride, by M. V. Thomas. Mixed addition products, similar to those obtained with bromine, were not found, the reaction taking a different direction according to the equation

$$3SnCl_2 + 7I_2 = 3SnI_4 + 2ICl_3.$$

Thermal researches on the uranium compounds, by M. J. Aloy. The heats of solution and formation of some of the commoner uranyl salts.—New method for the preparation of aromatic aldehydes, by M. L. Bouveault. The hydrocarbons are converted into glyoxylic acids by means of ethoxalyl chloride in presence of aluminium chloride, and these heated with aniline give nearly quantitative yields of phenylimides, the condensation to the phenylimido-acid and elimination of CO_2 from the latter proceeding simultaneously. A good yield of the corresponding aldehyde is obtained on hydrolysing the phenylimide by boiling with dilute sulphuric acid. The aldehyde group has in this way been introduced into toluenes m-xylene, cymene, anisol, di-methyl ether of resorcinol, and of di-methyl-hydroquinol.—Researches on the chlorination of gallic acid. Formation of dichlorogallic acid and of trichloropyrogallol, by M. A. Biétrix.—Crystallographic properties of benzylidene, methylsalicidene, ethylsalicidene, and anisol camphors, by M. J. Minguin.—On isaric acid, a new unsaturated fatty acid, by M. A. Hébert.—Digestive apparatus of *Brachytrypes membranaceous*, by M. Bordas. This has many points of resemblance with the *Gryllotalpa*, but differs from this species by the atrophy of the œsophagus, the reduction of the intestinal appendices, and especially by the great length and numerous circumvolutions of the intestine proper.—On a coloration of hepatic origin in the oyster, by M. J. Chatin.—Petrographical study of the meteoric stone that fell at Madrid, February 10, 1896, by M. Gredilla y Gauna. In the metallic portion schreibersite, ivoilite, and chromite were recognisable, whilst the stony portion contained the minerals peridote, enstatite, augite, plagioclase-oligoclase felspar, and olivine.—The grotto of Spelugues, by M. E. Rivière. This cave was discovered during the construction of a railway near Monte-Carlo, and contained human bones, apparently from nine individuals. Other bones represented the remains of animals resembling fox, hare, and sheep. The conclusion is drawn that the race of men represented by these remains lived in the Neolithic period, and are quite distinct from the race whose remains have been found in the cave of Mentone.—On an electric variation determined in the acoustic nerve when excited by sound, by MM. H. Beauregard and E. Dupuy.—Action of diverse substances upon the movements of the stomach, and the ennervation of that organ, by M. F. Battelli. Of all the substances examined, muscarine, pilocarpine, and physostigmine exercised the most energetic effect upon the movements of the stomach. Less energetic are nicotine and other alkaloids, alcohol, and peptone; whilst purgatives, strychnine, and pepsine were without action.—On specific heats, by M. J. Taupin.

PHILADELPHIA.

Academy of Natural Sciences, June 9.—Papers under the following titles were presented for publication :—"Contributions to a knowledge of the Hymenoptera of Brazil," by Wm. J. Fox; "The Correct Position of the Aperture of Planorbis," by Frank C. Baker; "The Mesenteries of the Lacerti ia," by E. D. Cope; "Revision of the Slugs of North America—Ariolimax and Aphallarion," by Henry A. Pilsbry and E. G. Vanatta.—Dr. Harrison Allen made a communication on forms considered specific, but which were merely instances of arrested development. He referred in illustration to certain species of *Vespertilio*, claiming that *Lucifugus* is merely an arrested form of *Gryphus*, the species *Albescens* also being based on similar characters. He had applied the term pædomorphism to the condition which had been worked out, he believed, only among the bats, and by himself. He held that the specific names of such forms were not valid, and should be dropped. Dr. George H. Horn stated that many such instances of arrested development were found among insects. He referred to the dimorphic males of *Eupsalis minuta*, a rhyncophorous beetle on which a French writer had founded three species. The egg-depositing habits of the female, and the assistance rendered when necessary by the male, were commented on.

June 8 (Botanical Section).—A paper was read from Mr. Thomas Meehan on *Erigeron strigosus*. A tendency of the ray florets to become discoidal, together with an acceleration from the lingulate to the discoid condition, was noted. The hermaphrodite state of the flower is not established until the tubular condition becomes permanent.—Dr. Ida A. Keller recorded the fact that if a cold alcoholic solution of chlorophyl be treated with benzol, the chlorophyl will be extracted and float as a green film on the surface of the liquid.

NEW OUTH WALES.

Linnean Society, May 27.—Mr. Henry Deane, President, in the chair.—Observations on Peripatus, by Thomas Steel. In this paper was embodied an extended series of observations on the habits and characteristics, food supply and life-history, with remarks on the individual range of colours, and relative proportions of the sexes, based on the examination of numerous living specimens of various ages kept under continuous observation for more than a year.—Descriptions of new Australian Fungi, (No. 1), by D. McAlpine.—Description of a new species of *Astralium* from New Britain, by C. Hedley and Dr. Arthur Willey. *A. moniliferum* (n. sp.), allied to the Japanese *A. triumphans*; dredged in 30 to 40 fathoms on a shelly bottom.—On a rare variation in the shell of *Pterocera lambis* (Linn.), by Dr. Arthur Willey. A series of sixty-seven specimens of this common tropical species from New Britain and the Eastern Archipelago of New Guinea has been examined. Numerous instances of substantive variation were met with, the more striking of which relate to the curvature of the digitations, their length, the intervals between them, and the extent to which the apical whorls of the shell are involved in, concealed by, or fused with the posterior digitation. There is also much variation as to the stage of growth at which the deposition of callus on the outer lip of the shell takes place.

AMSTERDAM.

Royal Academy of Sciences, May 30.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Hubrecht gave a description of the embryonic vesicle of *Tarsius spectrum*, and pointed out its close resemblance to that of man and monkeys. From this and from the placentation the author concluded that the order of Primates should henceforth embrace only the Hominidæ, the Siniæ, Tarsius, and the fossil Anaptomorphus. He was, moreover, disinclined to admit the possibility of deriving the placental arrangements, and the peculiarities of the clastocyst of the Primates from what is presented by the *Lemures*. The Primates should be derived from certain unknown insectivorous mammals of the Mesozoic period, of which the recent Erinaceus and Gymnura might perhaps prove to be the least distant relatives.—Prof. Pekelharing described a new method of preparing pepsin.—Prof. Schoute read a paper on the area of parabolæ of higher order, and, on behalf of Prof. Holleman, a communication to the effect that already some months ago he obtained the isophenylnitromethane recently described by Hantzsch and Schulze, and that his results were identical with those arrived at by these chemists. Mr. Holleman has also studied the reaction between benzoylchloride and the sodium compound of phenylnitromethane, and in doing so obtained dibenzohydroxamic acid.—Prof. Franchimont described isomers of neutral nitramines. They were obtained by Mr. van Erp both from the potassium compounds and the silver compounds of the acid nitramines; in the first case as a secondary product, in the second case as the principal product. Their boiling points and their specific gravity are lower than those of the nitramines; moreover, they are strongly affected by sulphuric acid, with the formation of gases, which is not the case with nitramines. By decomposition with alkali solutions, butylmethylnitramine yielded butylamine, while the isomer produced butyl alcohol; so that it seems as if in the first case butyl is united with nitrogen, in the second with oxygen. By the action of methylnitramine potassium upon allylbromide, Dr. H. Umbgrove obtained, besides allylmethylnitramine, also an isomer with a lower boiling-point, and acting violently upon sulphuric acid. A similar isomer seems also to be produced, in addition to ordinary dimethylnitramine, when methylnitramine is heated by itself, while nitrous oxide escapes. When heated with β-naphthol nitrogen escapes, and β-naphtholmethyl ether is formed, besides colouring matters.—Prof. Kamerlingh Onnes presented a communication concerning the measurement of low temperatures, and (on behalf of Mr. E. van Everdingen, jun.) (1) remarks on the method of observing Hall's effect; (2) measurements on the dissymmetry of Hall's effect in bismuth, and on the average Hall-effect in bismuth and antimony, carried out in the Leyden physical laboratory.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Skertchly's Physical Geography, revised edition (Murby).—Practical Radiography: H. S. Ward ("Photogram," Ltd.).—Beginner's Guide to Photography, 6th edition (Perken).—The Universal Law of the Affinities of Atoms: J H. Loader (Chapman).

PAMPHLETS.—Absolute Oder relative Bewegung?: Dr. B. and I. Friedlaender (Berlin, Simion).—The Position of Argon and Helium among the Elements: Prof. W. Ramsay (Frowde).

SERIALS.—Lloyd's Natural History. Butterflies: W. F. Kirby, Part 2 (Lloyd).—Scribner's Magazine, July (Low).—Humanitarian, July (Hutchinson).—Journal of the Royal Agricultural Society of England, Vol. vii. Part 2, No. 26 (Murray).—A Monograph of the Land and Fresh-water Mollusca of the British Isles: J. W. Taylor, Part 3 (Leeds, Taylor)—Bulletin de la Société de Géographie, 4e Trimestre, 1895 (Paris).—Astrophysical Journal, April and June (Chicago).—Fortnightly Review, July (Chapman).—Sitzungsberichte der Physikalisch-Medicinischen Societät in Erlangen, 27 Heft. 95 (Erlangen).—Proceedings of the Society for Psychical Research, June (K. Paul).—Westminster Review, July (Warne).—Geographical Journal, July (Stanford).—Annals of Scottish Natural History, July (Edinburgh, Douglas).—Mind, July (Williams).

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