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CONTENTS.



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## Physiology and Athletics.

PROF. HILL'S address on "The Physiological Basis of Athletic Records," an abridgment of which appears elsewhere in this issue, affords another instance of the value of laboratory work and its application to practical problems. The investigations of the functions of the isolated frog's muscle which were almost notorious for their supposed uselessness, have laid the foundation of the later work on muscular exercises. Prof. Hill does not claim that physiology can teach us how to win races, or, what is more important to certain sections of the public, "how to spot winners." The physiologist can aid, however, in the selection of men and women who are likely to become successful in the field of athletics.

The measurement of the gaseous exchanges of the body have been used for some time as a means of investigating certain functions of the body. In the hands of workers such as Haldane, Douglas and Krogh, among others, these methods have yielded results which have led to an understanding of the functions of the circulatory and respiratory systems. Benedict and Cathcart, by direct and indirect calorimetry, showed how the metabolism of the body and the physiological cost of work might be studied. Prof. Hill, by measuring (*a*) the maximum oxygen intake (income) and (*b*) the maximum oxygen debt, has extended the scope of these investigations. The measurements afford a means of investigating not only the metabolic changes during exercise, but also of studying the recovery process in the tissues after exercise is over.

It is clear that the measurement of the oxygen used will enable us to estimate the physiological cost of work, but movement to be physiologically efficient must be carried out in a skilful manner. The athlete who is able to go into debt heavily for oxygen is not necessarily the most skilful. The degree of skill which is shown will depend on factors such as posture, coordination of muscles, and the integrative action of the nervous system. Even the most simple movements of the body will on analysis be found to be exceedingly complex, many factors being harmonised to bring about the unity of motion. The work of Marey and the Webers demonstrated, many years ago, that the mere act of walking involved not only movements of flexion and extension of the lower limbs, but also accompanying movements of the shoulders, arms, head and hips. At each step, oscillations of the hips, shoulders and head occur. The leg that is moving forward is accompanied by a forward movement of the hips and a backward movement of the shoulders, that is, a slight twist of the trunk around a vertical axis. This torsion may be so exaggerated as to become very apparent, but it is manifest to a slight extent even in normal walking, especially in women with a large pelvis. The torsion of the trunk and active oscillations of the upper limbs which balance the body increase on rapid walking. These accessory movements, unless reduced to a minimum, will lessen the efficiency of the movement and increase the physiological cost.

The muscular system which controls voluntary movement may be divided into three parts: (1) the prime movers, (2) the antagonists, and (3) the synergic group of muscles. Flexion of a limb is brought about by the contraction of one set of muscles, the flexors, and relaxation of the opposing set or extensor muscles, the two groups working in harmony. This dual action is essential and is found in every voluntary movement. To allow the third group, the synergic muscles, to function in a co-ordinated manner with the prime movers and antagonists, the limb or body must adopt the correct position. The action of the muscles, as pointed out by Magnus, depends on the posture. Bedale and Cathcart have recently investigated the physiological cost of work, by indirect calorimetry, in different types of weight-carrying, and their results show that the cost of work varies with the same load according to the posture adopted.

The body controls the movements of muscles and the posture of the part by the action of the nervous system. The regulating mechanism involved has been termed by Sherrington "the proprioceptive system," and includes nerve fibres from the muscles, tendons and joints, the internal part of the ear, and the external muscles of the eye connected through the various regions of the brain. In maintaining balance and posture each organ plays a definite part, regulating position, judgment of distance and the co-ordination of movement. The interaction and co-ordinated mechanism of these systems can be demonstrated by any skilled act, as, for example, movements of the expert skater in cutting a figure on the ice. It is impossible at the present time to express these various factors in measurable terms, but the investigations of the oxygen consumption correlated with the speed of movement gives a basis for discussion. It must be clear that a first-class athlete who is capable of breaking records does possess a high degree of skill in his movements. A man who is capable of establishing a large oxygen debt may become a record-breaker if he can be taught how to use his limbs to the best advantage. The elimination of unnecessary movements is receiving attention in the fields of athletics and industry. Slow motion photography and motion study are means by which the movements may be studied and faults corrected.

There still remains a factor of which we have little knowledge, namely, the determination to win. How often is form upset on the racing track through a man losing his will to win at the psychological moment. This faculty, vague and indefinite as it may be, undoubtedly plays an important part in athletic life.

The comparisons drawn between men and women will be hotly contested, and Prof. Hill is a brave man to express the female performer as a fraction of a man. Certain anatomical differences in structure of men and women are known and probably militate against the female athlete. The flat female pelvis allows greater torsion of the trunk on exercise, and accessory movements of this nature will interfere with speed of action. Again, it is not clear that women up to the present have given as much time and attention to sport as men, and improvement is likely to be made by training and physical culture. Prof. Hill has arranged to carry out further work on this subject, and the results will be awaited with interest.

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## Fossil Insects of the Carboniferous Period.

*A Monograph of the Fossil Insects of the British Coal Measures.* By Dr. Herbert Bolton. Part 1. Pp. 80 + 4 plates. Part 2. Pp. viii + 81-156 + plates 5-10. (London: Palæontographical Society, 1921–1922.)

PALÆONTOLOGISTS are now aware that, at the epoch when the coal beds of the Carboniferous Period were deposited, the arthropods were the first of all living creatures to gain the conquest of the air—these insects bore sway in that silent domain which as yet the birds did not dispute with them. This most ancient world of insects has been revealed by the progress of study as of so special a character that it cannot be brought within the narrow limits of the zoological classifications of the present day.

British palæontologists possessed the honourable record, with regard to fossil insects, of having first discovered, early in the last century (1833), an impression of an insect in these carboniferous strata (*Lithosialis brongniarti* Mantell, 1854). They have now added to their list of successes a record which is still more glorious because it is due, not to chance, but to the sustained effort of one of their number—to-day the insect fauna of the British Coal Measures must be regarded as the best known of all those brought to light from all the Carboniferous basins of the world, thanks to the scrupulous and patient work which Dr. Herbert Bolton, director of the Bristol Museum, has carried out during close on twenty years.

The following figures will speak for themselves: in 1908, when Dr. Bolton began his investigations, only thirteen species of fossil insects were known in the Coal Measures of Great Britain; Dr. Bolton's researches have increased their number at the present day to almost sixty different species, contained in the five principal groups of these insects.

Dr. Bolton has lately collected together the result of his studies in the remarkable monograph before us. This work does the greatest honour to British science. It is accompanied by a perfect set of figures consisting first of an actual reproduction, somewhat enlarged, of each specimen, due to the photographic skill of Mr. W. J. Tutcher, and giving a good idea of the exact nature of the impression, and secondly, of an outline drawing in which the author indicates the manner in which he has read the structure; thus the actual record is well separated from the interpretation. This is accompanied by a very precise description in the text. Dr. Bolton's monograph is thus of very great documentary value, and a model to all palæontologists for their descriptions. We can well imagine what an amount of effort and of patient criticism the author must have needed in order to present this memoir to the world of science. The difficulties must have been very great: it must be remembered that very small portions of the body of these creatures have been found, often only a tiny fragment, and these have been subjected to great pressure changes. When to this is added that in structure and relationship they differ widely from living forms, we cannot repress legitimate wonder that it has been possible, as with a magic wand, to bring to life, from a few fragments of stone bearing obscure impressions, so varied a swarm of unknown insects.

The greater part of this winged company revealed to us by Dr. Bolton's memoir is placed in the order Palæodictyoptera—he groups together the most curious of these insects, because they are the simplest, probably the oldest, and because they have no equivalents in Nature to-day, not having survived the Palæozoic era. Dr. Bolton describes nineteen species of them. These creatures appear to have flown, in large numbers and great variety, above the coal-swamps of Great Britain. They are provided with three pairs of wings possessing a very simple nervation, and with three pairs of legs, one pair of wings and legs to each thoracic segment. The legs are all alike; the first pair of wings (on the pronotum) is very much reduced, the hinder pairs only being functional; no specialisation of the organs of the mouth. The development is direct, without metamorphoses. In short, it appears as if these ancient Palæodictyoptera had almost exactly realised the *protentomon* formerly dreamed of by entomologists as the ancestral synthetic type of the Hexapods. Their size is variable and may reach a span of wing of about 30 cm. (*Hypermegethes northumbriæ*, Bolton) and even 70 cm. (*Archæoptilus ingens*, Scudder).

Besides these insects, also flying over the swamps and equally good sailers, were rarer forms which appeared later, more highly specialised and more similar to the insects of to-day: the dragon-flies. *Boltonites radstockiensis*, Bolton, found in the Upper Coal Measures of Somersetshire, is one of these curious Protodonata of large size (span of wing 40 cm.).

Following upon the Palæodictyoptera, the author describes a remarkable series of insects which Dr. A. Handlirsch, the Viennese entomologist, has placed in the two orders Protorthoptera and Protoblattoidea. As the names indicate, these insects are "generalised" types, very near to the living Orthoptera. Dr. Bolton describes eight species of Protorthoptera from the British Coal Measures.

Finally, an important section of these fossil insects (nearly twenty species) is formed by the cockroaches which, in the Coal Measure forests, under vegetable debris, lived in such large numbers and with so many varieties that Dr. Handlirsch has proposed to form a special order (Blattoidea) intended to contain them. S. H. Scudder was right in calling the Carboniferous Period "the era of cockroaches." Dr. Bolton has recognised that the English types had the closest relationship with those which we have described in the Coal Measure basin in the north of France. These innumerable cockroaches, the most minute details of whose organisation are known, are, except for a few primitive characteristics, constructed exactly after the same type as their rarer descendants of to-day. The latter, since the Carboniferous Period, have shown themselves proof against all evolution. They are *permanent* organic types, even more suggestive than the Lingula, often quoted on this account, for this is a case of animals which are very sensitive to change of surroundings, and very easily linked up with them.

Thus palæontology rehabilitates the cockroaches. They are far from meriting our scorn, for they are of aristocratic descent and the most conservative of all creatures. Is it in memory of the "Paradise Lost" of the Coal Measure forest where they reigned supreme, that they have become with most people the emblem, the *bête noire*, of their melancholy?

No insect in all the Coal Measure fauna is found undergoing complete metamorphoses, passing through the stages of caterpillar and of chrysalis before reaching the adult winged form. Dr. Bolton figures the larvæ of the Palæodictyoptera and of the cockroaches found in the English basins, which differ from the adult forms only by the lesser development of the wings, not in shape. The metamorphic insects (Holometabola) did not appear until the beginning of the Mesozoic Period, at the same time that the seasonable alternations of heat and cold were produced. Doubtless there is a relationship of cause and effect. At any rate, the definition of a butterfly made by a French poet does not, according to the witty remark of Prof. Ch. Barrois, apply to these Coal Measure insects which lived before the seasons and the flowers existed: "Naître avec le printemps, mourir avec les roses." These insects, made known to us by Dr. Bolton, were born and died before the world had known the first spring-time and the first rose.

The greater number of the coal basins of Great Britain, and almost all the levels of the Coal Measures, but principally the Upper (Middle and Upper Coal Measures), have yielded fossil insects. From the point of view of their stratigraphical distribution, Dr. Bolton has established facts similar to those which have been recognised in France, namely: (1) In the Lower Coal Measures the Palæodictyoptera predominate, and cockroaches are rare; (2) in the Middle Coal Measures simple Blattoidea are found such as the Aphthoroblattina, and Protoblattoidea such as Coselia; (3) finally, at the base of the Upper Coal Measures flourish the genera of Blattoids, Archymylacris, Phylomylacris, Soomylacris, etc...., as in France, in the Bruay beds. Thus the Coal Measure insects, which have evolved rapidly, are excellent fossils characteristic of the successive horizons.

In his introduction, Dr. Bolton touches upon a certain number of theoretical questions, such as that of the origin (aquatic or terrestrial ?) of insects, the origin of their wings (which appear merely as an exaggeration of the pleural expansions which all Palæozoic arthropods bear on their segments). But he does not linger over them, because he rightly prefers to produce a work of actual observation, and he examines in detail the interesting question of the faunal association of the Coal Measure insects only because he has found in the beds a whole series of instructive facts. The frequent association of fossil insects with the Myriapoda and the Arachnidæ in the ironstones reminds him of the colonies of spiders, millepedes, and cockroaches living under the bark of trees which he has observed in the bush country of Australia. Even under a tropical sun the nightly dew preserves during the day, in the low parts of the jungle, conditions of humidity favourable to the life of arthropods, which Dr. Bolton compares with those which must have prevailed at the Coal Measure Period.

Such are a few of the reflections suggested by the reading of this memoir. When one reflects that, among the seventy specimens of insects dug up from the coal basins of Great Britain, there are almost sixty different species, one is struck by the great diversity of this vanished world. Almost every impression which is discovered reveals an unknown organic type, so that the number of forms which we do not yet know must be immense. Therefore Dr. Bolton encourages us to seek for them: "The fossil insects already found in the British Coal Measures form probably but a small fraction of those which remain to be discovered, when attention is more fully directed to them" (p. 3).

In thus concluding a work of such great value, the fruit of so much conscientious labour, Dr. Bolton could not more modestly or more wisely apply the precept, "The man who has finished has only just begun." We hope for the sake of palæontological science that Dr. Bolton's wish may be realised by himself.

P. PRUVOST.

## Modern Meteorology.

(1) *Dynamische Meteorologie.* Von Prof. Felix M. Exner. Zweite, stark erweiterte Auflage. Pp. viii + 421. (Wien: Julius Springer, 1925.) 24 gold marks.

(2) *Les méthodes de prévision du temps.* Par J. Rouch. (Nouvelle Collection scientifique.) Pp. 280. (Paris: Félix Alcan, 1924.) 10 francs.

(3) *Wellen im Luftmeer: neuere Untersuchungen über Gesetzmässigkeiten im Gange und in der Verteilung des Luftdruckes.* Von L. Weickmann. Erste Mitteilung: Symmetriepunkte des Luftdruckganges der Luftdruck als zusammengesetzte Schwingung. Pp. 46 + 6 Tafeln. (Leipzig: S. Hirzel, 1924.) n.p.

(1) PROF. FELIX M. EXNER is known to be the author of some sixty original papers, joint author of a standard work on "Meteorologische Optik," joint editor of the *Meteorologische Zeitschrift,* and Director of the Austrian Zentral Anstalt für Meteorologie und Geodynamik. His "Dynamische Meteorologie" is regarded as important by meteorologists, and will probably also interest those who teach dynamics, because it is largely written in their style; the "soluble" problems of atmospheric dynamics being set out in neat mathematical language.

The early chapters expound fundamentals concerning the distribution of gravity, the thermodynamics of moist air, the dynamics of a fluid on a rotating sphere, and the statics of an atmospheric column. So far the topics are common to many books. Much of what follows is original; indeed, we know of no other book that overlaps to any considerable extent.

The best way of classifying the enormous heap of meteorological facts and theories is a puzzling problem of which Exner's solution is to head chapters thus: iv. Vertical Temperature Distribution in Equilibrium, v. Kinematics, vi. General Dynamics of Air Currents,

vii. Energy of Air Currents, viii. Steady Motion in the Atmosphere, ix. General Circulation of the Atmosphere, x. Dynamics of Cyclonal Motion, xi. Non-periodic Changes at one Place, xii. Non-periodic Changes on the Map, xiii. Periodic Changes in the Atmosphere. Many ordinary topics run on from chapter to chapter, for example, the modern work on cyclones will be found in Chapters xi. and xii. as much as in x.

Some of Exner's prettiest results are obtained on the hypothesis that the air moves adiabatically, without friction, at a speed which, in view of the earth's rotation, just balances the pressure gradient. Meanwhile every column is supposed to be in vertical equilibrium. He thus (§ 76) derives the remarkable equation

$$\frac{\partial P}{\partial z}\cdot\frac{\partial^2 P}{\partial z\partial t}=\frac{g}{l}\left[\frac{\partial P}{\partial y}\cdot\frac{\partial^2 P}{\partial x\partial z}-\frac{\partial P}{\partial x}\cdot\frac{\partial^2 P}{\partial y\partial z}\right],$$

in which $x$, $y$, $z$, $t$ are the co-ordinates, $z$ pointing vertically, $g$ is the acceleration of gravity, $l$ is 2 (earth's angular speed) × (sine of latitude), and $P$ is the 0·288th power of the pressure. From this he deduces (on p. 299) a rule that may be stated thus: "If the isobars turn with increasing height in the direction of the sun's apparent daily motion, then, in the region of their turning, the potential temperature is rising; and vice versa." Next this rule is applied (on p. 350) to explain why it is that a shallow unsymmetrical cyclone usually travels eastwards. Again (p. 381) the same ideas enabled Prof. Exner to forecast that a particular cyclone would move in the direction of the upper wind, westwards.

Those who follow Clerk Maxwell's tradition will regret to see left-handed axes on pp. 196 to 197. There appears to be a mistake in the kinematic conditions at an interface between hot and cold air on p. 313. The treatment of turbulence on p. 125 still contains the idea that lumps of air, like molecules, have a "mean free path," although nothing of the sort has been observed in the atmosphere, and G. I. Taylor has provided a theory of "Diffusion by Continuous Movements."

Considerable attention is given (in Chap. xi. and elsewhere) to the ideas about sliding surfaces, which, after coming down from Helmholtz via Margules, Exner, and Ficker, have recently been brought into relation with rain, and with forecasting by V. Bjerknes and his associates.

Another important allied topic is the conversion of heat-energy into mechanical energy in the atmosphere. English readers will welcome the extensive account of the researches of Margules and of Sandström. The point of the present reviewer's work, on the supply of energy to eddies, is unfortunately quite missed on p. 186. With regard to the energy of cyclones, Exner writes (in the preface):

"The question of the energy of winds in our latitudes was treated in the first edition entirely in the sense of Margules' work. Since then I have come more and more to comprehend, particularly through the influence of Alfred Wegener, that the aforesaid energy comes originally from the unequal supply of heat to the lower and higher latitudes of the earth, that is to say, from large circulating currents, a change whereby Margules' calculations of course do not lose the least part of their value. But in the new edition it will be found that the rôle of the exchange of air between the tropics and the polar latitudes is made more prominent and that cyclones and anticyclones appear as conditions of this exchange. This conception cannot be brought into complete harmony with Bjerknes' view of the stable polar front and the wave theory of cyclones. . . ."

Mr. W. H. Dines showed that the correlation between pressure and temperature was about 0·9 at 9 km., and decreased gradually as the earth was approached. Prof. Exner exhibits (Fig. 95) and explains this decrease of correlation as due to a shift of phase between waves of pressure and of temperature. We seem to approach again to a wave theory of cyclones.

There are numerous interesting and original features which we have not room to mention. The book is a sort of museum full of standard types, obtained by imagining in turn various different restrictions in order to make the differential equations integrable. These types resemble events sometimes to be found among the multifarious behaviour of the actual atmosphere, and they greatly aid us to understand what happens. They do not provide a continuous account of its day-to-day progress. No integral formulæ could. It is to be hoped that some publisher may be persuaded to issue an English translation of this excellent book. It does not attempt to summarise the researches by many authors published recently in England.

(2) In comparison with Exner's great work, this of Rouch is a simple popular book treating historically in clear French, without mathematics, the various forms under which the problem of weather forecasting has been proposed, from the earliest times to the present decade. The outlook is practical. There are diagrams showing Bjerknes' rain-areas, Gold's fifteen types of isobars, and Schereschewsky and Wehrle's cloud-system. The author estimates that, of the forecasts made nowadays by any method for one day ahead, not more than seven out of ten are justified by the event, and he considers that the fraction of success has not increased much during the last fifty years, owing to the inherent difficulties of the problem.

(3) In this astonishing paper, L. Weichmann, Director of the Leipzig Geophysical Institute, asserts that it has been proved from the barograms of stations in middle latitudes of Europe, Asia, and North America, that there are certain dates such that the preceding

part of the barogram is the mirror image of the succeeding part, the mirror being placed parallel to the pressure axis. Such reflections occur at

July 4, 1922, in North America; Jan. 1, 1914, in Russia.
Nov. 6, 1923, in Hamburg; Jan. 15, 1924, in Hamburg.

The correspondence of the "incident" and "reflected" portions of the barogram is said to extend over months in time, and over areas on the map as big as continents.

A number of barograms and weather maps are printed in support of this contention; and the degree of correspondence is tested by correlating the corresponding pressures. After a slight judicious stretching of parts of the time-axis when the air was cold, the correlation attains the value 0·7. It is pointed out that a reflection will occur if all the Fourier component waves into which the barogram can be analysed attain their extremes at the same instant. Harmonic analyses have been made of pieces of the barogram including 180, 90, or 72 days. This was done after the stretching referred to above. It is shown that five or more component waves attain their extreme values at times which agree within ± 1 day.

The author does not give an estimate of the probability of this being a chance occurrence. We may get an estimate thus. Suppose many waves of period $T_1$ days, with phases at random. The chance of an extreme (*i.e.* maximum or minimum) lying within ± 1 day of a given instant is $4 \div T_1$. If there are four other periods, $T_2$, $T_3$, $T_4$, $T_5$, with phases independently at random, the chance that these extremes should all lie within the chosen 2-day interval is $4^5 \div T_1 T_2 T_3 T_4 T_5$. That is to say, such an event would occur by chance on the average once in $2T_1 T_2 T_3 T_4 T_5 \div 4^5$ days. On this reckoning the coincidence shown in Weichmann's Fig. 18 would occur by chance once in six years on the average, if the time-axis were not judiciously stretched, and presumably more often when, as now, judgment comes into play.

L. F. RICHARDSON.

## Stellar Spectra and the Physics of Gases at High Temperatures.

*Stellar Atmospheres: a Contribution to the Observational Study of High Temperature in the Reversing Layers of Stars.* By Cecilia H. Payne. (Harvard Observatory Monographs, No. 1.) Pp. ix+215. (Cambridge, Mass.: Harvard Observatory; Cambridge: W. Heffer and Sons, Ltd., 1925.) 2.50 dollars.

IT is announced by the Director of the Harvard College Observatory that, in addition to its Annals, Circulars, and Bulletins, the Observatory will from time to time publish Monographs dealing with subjects in which the Observatory is doing a large amount of original investigation. Unlike the Annals, etc., the Monographs will not be distributed gratis to observatories and others, but special funds are available to enable them to be published at less than cost price. The first volume of the series is Dr. Cecilia Payne's "Stellar Atmospheres."

Astronomers will welcome not only the announcement itself but also the choice of the first subject, and their expectations will be fully justified by a study of Miss Payne's book. "Stellar Atmospheres" should immediately take its place as an indispensable handbook for the stellar spectroscopist who wishes to have easy access to the series classifications of the spectra he is interested in on one hand, and to the latest deductions concerning the temperatures and pressures in stellar atmospheres on the other. Miss Payne has brought to her task an enthusiasm and a thoroughness which, with the wealth of observations contributed by herself, make her book at the same time an attractive story and a work of reference. It may be mentioned that there are more than five hundred references to the original literature, of which more than half are to the sources of spectral classifications and determinations of critical potentials.

Part I. is a concise study of the physics of the atom as regards the origin of line spectra and of the physics of stellar atmospheres in so far as this is known independently of the methods initiated by Saha. An account is given of the colour temperatures of the stars, and of the various lines of evidence which indicate the order of magnitude of the pressure in the reversing layers of stars, following Russell and Stewart. A qualitative account of the probable structure of a stellar atmosphere is followed by a useful synopsis of the elements that occur in stellar spectra and the series classifications of the relevant lines.

The core of the book is formed by Part II., which is concerned with the physical interpretation of the observed features of stellar spectra. Six years ago, practically no explanation existed of why some lines appear in stellar spectra and not others, why some lines always decrease in intensity through the stellar sequence and others appear, reach a maximum, and fade away again. It is to Saha that we owe the key which has unlocked these mysteries. Saha showed that elementary thermodynamics, considered in connexion with Bohr's theory of the origin of spectra, demands that atoms pass through successive stages of ionisation as the temperature increases, and that they must necessarily produce just that sequence of absorption spectra which is observed in the stars. At the hands of Saha and others, this simple physical idea has received quantitative treatment which allows a wealth of detailed deductions to be made concerning pressures and temperatures in stellar atmospheres from the observed intensity changes in stellar spectra.

Miss Payne has devoted her own labours to this object. She has tabulated her own measures of line-intensities for the different spectral classes. She has then deduced the scale of stellar temperature, refining the standard procedure by a method which takes account of the differing levels at which lines originate.

An observed maximum of a line in the stellar sequence determines a certain relation between the temperature and pressure at the level in the atmosphere at which the line originates when at its maximum intensity. If the temperature be taken to be known from the colour scale, an observed maximum fixes the pressure. Theoretically the pressure is a complicated function of the relevant atomic and stellar quantities. Among other things, it might be conjectured to be inversely proportional to the maximum concentration of the atoms in the appropriate excited state—the stronger the concentration, the less deep we can see into the star in the frequency concerned and the lower the pressure. Miss Payne tests this conjecture and finds it to be reasonably well satisfied. She therefore uses the empirical relation to construct the temperature scale for the hotter stars, for which trustworthy colour-temperatures are wanting.

The fact that the product of partial electron pressure and relative concentration of excited atoms at maximum is approximately constant is of considerable significance. It will be one of the prime objects of theoretical astrophysics in the immediate future to remove the empirical character from this " constant " and to calculate it in terms of the ordinary atomic and stellar quantities. The "constant" will, of course, be found to be a function of surface gravity and atomic absorption coefficient, and the possibility will arise of measuring either " $g$ " for the stars or the absorption coefficient for the atoms from observations of maxima.

Perhaps the most stimulating portion of Miss Payne's book is Part III., which deals with special problems. She lays special stress on the circumstance that the lines of $Sr^+$ are in many respects anomalous—for example, on the high-temperature side of the maximum they would be expected to be weaker in giants than in dwarfs, on the usual theory, whilst the reverse is observed. The reviewer would suggest that in this case the dominant factor is not the concentration of suitable atoms. In the steady state, the residual intensity in the principal doublets of $Ca^+$ and $Sr^+$ cannot exceed the values just capable of supporting the corresponding atoms against gravity. Surface gravity being weaker in giants than in dwarfs, the residual intensity must be weaker in giants than in dwarfs. Thus the lines must cut deeper into the continuous spectrum of the giant than of the dwarf, and they may in consequence appear stronger in spectrograms.

It is perhaps to be regretted that Miss Payne has not adopted a linear classification of the O-type stars—for example, the one suggested by H. H. Plaskett. This leads to apparent anomalies in some of the tables—for example, a temperature of 35,000° is allotted to type O from the maximum of the $He^+$ lines, a temperature of 25,000° to the same type from the $Si^{+++}$ lines. Reference to the tables of measures of actual O-type stars removes the apparent inconsistency, but the suggestion might be made that in a future edition a division of the absorption-line O-stars into sub-classes, even a provisional one, would be a help to the reader. This would be more consistent with the plan of the book, which is primarily concerned with the temperature classification of stars on the basis of absorption lines.

The treatment of the physical basis of the dissociation formula, first used in this connexion by Saha, seems to the reviewer unsatisfactory. The author appears to consider that Saha's own justification for the formula was merely analogy with physical chemistry, in particular the physical chemistry of dilute solutions, and that it was thus based on the law of mass action; that the acquisition of a charge at dissociation is the only feature that " chemical " and " thermal " dissociation have in common; and that thermal ionisation is a process different from ionisation by collision, for example. But thermal ionisation is not a process—it is an equilibrium state. The mechanism by which the final state is arrived at consists in part of photo-electric absorption, in part of ionisation by collision, and so on. Each of these processes in the long run will set up of itself exactly the same final equilibrium state. This final state is one which can be predicted by pure thermodynamics, save for a constant of integration, and the general dissociation formula was in fact given by Willard Gibbs in 1875 and applied by him to the " thermal " dissociation of gases such as $N_2O_4$. It is, of course, possible to make some progress towards the deduction of the dissociation formula by using the law of mass action, but then any equilibrium-state formula can be deduced via reaction velocities. The final state is, however, known independently of any assumption about reaction velocities or of the mechanisms of decomposition and recombination. The only doubt in the original application of the dissociation formula to high-temperature ionisation was the value of the above-mentioned constant of integration —the " chemical constant " of the electron. Statistical mechanics adds nothing whatever to the validity of the dissociation formula. But it succeeds in going a little further—it actually evaluates the constant.

The spectroscopic notation used is that recently suggested by Russell and Saunders, and it proves very convenient for the purpose. There is, however, some inconsistency in applying it to the Balmer series. Thus in one place the series is described as ($2P - mD$), whilst elsewhere the line $H\beta$ is described as ($1S - 2P$). Surely the Balmer series should be described as the superposition of ($2P - mD$) and ($2S - mP$).

Space does not permit an account of the many other interesting subjects studied in the monograph, but reference should be made to the astrophysical determination of ionisation potentials, and also to the chapter on the relative abundance of the elements in stellar atmospheres, which consists entirely of Miss Payne's own work on the subject. E. A. M.

## Evolution and Popular Thought.

(1) *The Earth Speaks to Bryan.* By Prof. Henry Fairfield Osborn. Pp. vii+91. (New York and London: Charles Scribner's Sons, 1925.) 1 dollar.

(2) *Concerning Evolution.* By Prof. J. Arthur Thomson. Pp. x+245. (New Haven: Yale University Press; London: Oxford University Press, 1925.) 11*s*. 6*d*. net.

(3) *Evolution in the Light of Modern Knowledge.* A Collective Work. Pp. xv+528+4 plates. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1925.) 21*s*. net.

(1) THE present widespread interest in evolution, largely due to recent events in the United States, manifests itself in the number of books addressed to the general reader which deal with evolutionary topics. "The Earth Speaks to Bryan" comprises five articles written for American newspapers and reviews apropos of the Tennessee anti-evolution trial. There is little doubt that, as Osborn believes, the trial has been a good thing for America. It has brought the chronic disease to a head and made the common people think about the whole issue. But in one respect it has had results which, to some at least, are not so desirable. So bibliolatrous is the general temper of many American States, and so anxious have some American men of science been to show that the teaching of evolution is not, as Mr. Bryan amazingly put it, essentially atheistic and immoral, that they have gone to the opposite extreme and tried to reconcile evolution and the Bible in every particular, and to gloss over the real differences which are inevitable between the supernaturalism of a revealed religion and the naturalism of modern science. Osborn seems to be in this category. He confuses religion with theism and apparently with Christianity, and belief in the soul as a psychological tenet with a belief in "the reality of moral and spiritual values." He goes so far as to say that the "proof," which he asserts has been furnished by palæontology, of the non-fortuitous nature of variation (as to which proof most biologists would be in disagreement with him) brings us back to find Paley's argument for the existence of God "just as strong as ever it was" in pre-Darwinian days. He, of course, asserts that "God used evolution as his plan," as if this were self-evident; and actually states that the Bible is an "infallible (*sic*) source of spiritual and moral knowledge."

The merit of the book is its easy and vigorous style.

(2) Prof. Thomson has an equally easy style, but it sometimes has rather a fluffy effect. Perhaps he is too open-minded, and tries to do justice, a little too liberally, to everybody's views all round: and perhaps he writes too many popular books to preserve his native terseness. Otherwise his volume is an admirable summing-up, not too technical but not too popular, not ultra-modern and yet not old-fashioned, of his view of evolutionary biology. He also tries a fall with the old problem of religion and science, and comes to the characteristic conclusion that each is right in its own sphere. But when he says, "there is no possible way in which Science could disprove God," he has not concerned himself to point out that though this is in one sense a truism, yet science can disprove, and has disproved, many gods, and many assertions as to the attributes of God. As usual, Prof. Thomson is especially interesting in regard to animal behaviour.

(3) The third volume is by far the most ambitious. It contains contributions from thirteen scholars on different aspects of evolution, from cosmogony to anthropology, from physics and chemistry to philosophy and religion. Canon Wilson, in one of his broad-minded and reverent articles, traces the influence of the evolutionary theory on his mind from the time of the appearance of the "Origin of Species" (when he was already the science master at Rugby School!), through a period of doubt, to a new form of belief. It is interesting to hear that his mature belief took its source in reflections on the human spirit. This is religious naturalism, though the form of his belief be very different from that of many others who would start building their religion upon naturalistic foundations.

We are glad to see an article by another G.O.M., Prof. Lloyd Morgan—a sane and mellow article on general biology and the relations between mind and matter, with an interesting brief summary of the writer's views on emergence in evolution. Dr. Pembrey's article on physiology is interesting in itself, and also as showing how the influence of the theory of evolution upon this branch, at one time much less than that upon morphology, is to-day very strong, just at the time when many zoologists are hypercritical on evolutionary matters. His discussion of the inheritance of acquired characters is vitiated by a certain vagueness consequent upon his taking no account of modern genetic work. Prof. McDougall has a rather sketchy article on mental evolution, and Prof. Taylor writes a long and not always easy essay on philosophy and evolution. At one point he makes the slip (p. 448) of omitting all the "orthogenetic" side of evolution, which has been emphasised in different ways by men so different as Huxley and Eimer, Osborn and Morgan. Prof. Soddy sums up evolution in physics and chemistry, but with very little reference to theories of cosmogony. Because *now* the only changes we can detect in the elements are degradative, that is no reason why in wholly different conditions, for instance of temperature, progressive and truly evolutionary changes in inorganic matter may not have occurred. Prof. Elliot Smith has a provocative article on anthropology. At one time he uses biological analogies in support of his theory of the spread of culture, while later he stigmatises such procedure as dangerous and misleading. It is rather amusing to find him laying down as obvious that similarity implies common descent, while in the same volume Prof. Bower in his article on botany is cautiously coming round from this to the idea of a parallel development in a whole group like ferns! We would also remind Prof. Elliot Smith, first, that Wheeler has made it clear that the social habit of ants, bees, and wasps has been acquired independently for each, and probably more than once in some of the three groups, and secondly, that the work of the Morgan school is showing that parallel mutations may occur independently in different species (*e.g.* of Drosophila, etc.). It behoves anthropologists, whose material is vaguer than that of the systematist, to walk rather more warily than they (or some of them) are at present in the habit of doing.

Prof. Bower's article is rather more technical than most, and will be of more interest to biologists than to the general public. Prof. MacBride enters his usual plea for Lamarckism. It might be wise to lay less stress on Tornier's work as "proving" the inheritance of acquired characters and the origin of mutations, considering that it was never taken beyond $F_1$! The "indirect proofs of the inheritability of the effects of habit" are not proofs at all; and the remarks about mutation are very one-sided. At the close Prof. MacBride commits himself to the definite statement that the typical larva of molluscs and annelids represents an ancestral form, whereas it is at least equally probable that it is a special adaptation to dispersal, and there is, in the absence of fossils, no means of deciding which view is right!

The excellent articles by Drs. Jeans and Jeffreys on cosmogony and the evolution of the earth as a planet will be read with special interest, because of the great advances which have recently been made in these fields.

The book is in many details interesting. However, it can scarcely be said to fill the gap mentioned in the preface—the want of any recent authoritative statement on the subject of evolution by British naturalists. Too many of the writers have axes to grind in the shape of pet theories, and there is not enough of a central scheme running through the book, so that the articles are heterogeneous in nature. But it contains plenty of good reading, both for layman and man of science.

## University Calendars.

*The Calendar of the London School of Economics and Political Science (University of London) for the Thirty-First Session, 1925–26.* (London: London School of Economics and Political Science, Houghton Street, Aldwych, W.C.2, 1925.) 3*s.* 6*d.*

THE aim of a university is to supply information to its students, to train their intelligence, and to render them capable of doing and making things in the best way. This doing and making being the ultimate aim of a university education, it is not unreasonable to inquire into the success of a university when it is itself engaged in doing or making. A university does not often give the chance of this test, but every university does every year produce one book, its university calendar.

The members of a university do not inquire whether their own calendar is a satisfactory production. It may be that even the least patient of us can ascertain the contents of one ill-arranged book; it may be that a university has a few experts who make the information available for the rest; it may be that the handing down of the facts by oral tradition makes the study of the calendar unnecessary.

It is the man who has to study university calendars in bulk who is really in a position to see their merits and defects. Such a man, when he has to ascertain some point about a university, turns to the index of the calendar. In many cases the word sought does not appear in the index; in other cases it is there and gives reference to a number of pages none of which contain the information desired. The man then tries the index for all other possible keywords, but frequently with no better success. The investigator next turns to the table of contents. He tries first to ascertain the general arrangement in order to see in which division his point is likely to be found. There is usually no orderly arrangement. The principle of the calendar is often that of the dust-heap. When anything has to be added to the calendar it is simply dumped on the top of the stuff already there. The investigator is thus compelled to read through the table of contents until he finds a likely item. The descriptions in the table are, however, so colourless and so inappropriate that he has to study quite a number of likely and unlikely items before he finally runs to earth the information he is pursuing.

There is probably no man in the United Kingdom who has more occasion to study university calendars than the present writer and three of his colleagues; and the foregoing description gives their experience down almost to the present day. The calendars of universities and colleges have hitherto shown such a dead level of badness that it has not been possible to pick out one as being either worse or less bad than the rest.

That time of dead uniformity is past. There is now one calendar that has evidently had some of the attention that an author is accustomed to bestow on his book. It has an index that functions; related portions are brought together; the table of contents gives evidence of an orderly arrangement; and the titles used for the various portions are reasonably descriptive of the contents of the portions. In the average calendar the title-page is lost among a mass of advertisements or other misplaced matter, and the beginning of the text is similarly concealed and has not the smallest fraction of a page left blank to show it up; so little do æsthetic matters appeal to the ordinary university. The calendar of the London School of Economics for the current year has a title-page at the place where one naturally looks for it, and by the use of appropriate type for the titles of divisions and subdivisions it shows up the orderly arrangement of the text. It has, in fact, some of the attractive traits which we expect to find in all proper books.

This calendar does not yet show much appreciation of æsthetic values. It would be improved by a more generous allowance of blank paper at the head of a page on which a chapter begins. The use, also, of appropriate blanks between sections of a chapter would have æsthetic value, and at the same time add to the clearness of the general plan of the calendar. The first step in reform has, however, been a long one, and we may hope that further steps will be taken, and that æsthetics will presently come into their own.

Some people uphold economics as a better training for most walks in life than the older studies. On that we express no opinion beyond inquiring whether it is a mere coincidence that this school of economics, which is not half a century old, should have been able to make of this calendar a pleasing book with its information readily accessible, while the universities that have had centuries of experience in the production of calendars still give us the kind of abortion described above. However that may be, the wise university will study the calendar of the London School of Economics and see if it cannot do something on the same lines.

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## Financing Agriculture in North America.

*Farm Credits in the United States and Canada.* By James B. Morman. (The Rural Science Series.) Pp. xvi+406. (New York: The Macmillan Co., 1924.) 15*s*. net.

UNTIL the establishment, under Federal auspices in 1916, of the land banks and joint-stock land banks, the farmer in the United States obtained loans mainly from commercial sources and life insurance companies. The book under notice is a careful review in simple language of the gravely important consequences of the changes in the methods of obtaining credit facilities which these banks have introduced. The success of the land bank system, with its fixed maximum rate of interest, its appreciable reduction in the initial charges to the mortgagee, and its scheme for gradual repayment of the sum advanced, is evidenced by the value of mortgages taken out. In six years they have amounted to 90 per cent. of those accumulated in the life insurance companies in all their existence, which in some cases is more than fifty years.

This "success" is, in the author's opinion, a mixed blessing. Advances are much more easy to obtain, and although a farmer may obtain temporary relief from immediate embarrassments, he has nevertheless taken on an additional burden. It is not so much the interest as the debt itself that is the real trouble. Whether the debt be repaid in annual instalments or as a lump sum, the burden is intensified with lapse of time because of capital depreciation, a factor seldom considered by the farmer when negotiating the mortgage. Most forms of capital equipment are worn out or reduced to a nominal value in ten years, and unless depreciation has been allowed for, the farmer may find the temporary alleviation of his difficulties has, in the long run, intensified them. Even with the more equitable terms of the land banks, in which the provision for gradual repayment of mortgage is perhaps the most important, the proportion of failures to meet obligation is increasing.

The heavy load of debt is undeniable, and the author considers that for many years to come, United States agriculture, as a whole, will have to carry the heaviest financial burden of any industry, and this in spite of the fact that more than 50 per cent. of owner-farmers are free from debt. It is satisfactory to record that Canadian systems of credit—especially short-time credit—receive favourable comment.

The most significant statement in the book is that mortgage credit agencies, however beneficial their intentions, are not to be compared in their usefulness and service to farmers with the agricultural colleges and experiment stations throughout the country. These institutions are helping the farmer to increase his income in various practical ways, and if they cannot rescue him from the dilemma in which he finds himself as the result of easier mortgage credit terms and conditions, he will find no relief anywhere. In view of the author's position of economist on the Federal Farm Loan Board, this considered statement of the limits of direct financial aid to agriculture must carry great weight.

Although the book does not discuss British conditions, it contains the material for useful analogies, as well as much of direct interest to agricultural economists on the eastern side of the Atlantic.

B. A. K.

## Our Bookshelf.

*Abridged Scientific Publications from the Research Laboratories of the Eastman Kodak Company.* Vol. 8, 1924. Pp. 155 + vi. (Rochester, N.Y.: Eastman Kodak Co.; London: Kodak, Ltd., 1925.) n.p.

THE Research Laboratories of the Eastman Kodak Company have been in full working order for about twelve years, during which time investigations have been carried on by the staff, not only on matters directly concerning the practice of photography and the manufacture of the materials and apparatus required for it, but also on various chemical and physical matters that appear at first sight to be rather remote from this subject. Time will doubtless justify this wide view of what is desirable. The results are published in numerous scientific journals as may be suitable in each case, but the papers, slightly abridged, are all brought together in the series of volumes of which this is the most recent.

This volume contains full and often lengthy abstracts of the 28 papers published last year. Many of these have already been referred to in our columns, and others are of interest only to the manufacturers and users of films for "motion pictures." Mr. F. E. Ross has dealt with the mensurational characteristics of photographic film, because film is now used for so many scientific purposes where the sensitive surface must be flexible. It appears that, generally speaking, films may show no greater distortion than glass plates, and that the different kinds of film vary somewhat. The relationship between time and intensity of illumination in photographic exposure is investigated in considerable detail and under considerably improved experimental conditions as compared with earlier work on this subject, by Messrs. L. A. Jones and E. Huse. Messrs. A. B. Corey and H. Le B. Gray, in seeking to prepare a standard cellulose, find that by treating the product obtained as described in a previous communication with 1 per cent. acetic acid solution for two hours and subsequent washing, the ash is reduced to a very low quanity without apparent injury to the material. The reduction is stated to be "from 0·12 to 0·4 per cent." This misprint and a figure upside down at p. 16 show that more revision is desirable.

(1) *A Laboratory Manual of the Anatomy of the Rat.* By Prof. Harrison R. Hunt. Pp. viii + 123. (New York: The Macmillan Co., 1924.) 6*s.* net.

(2) *Laboratory Manual of the Foetal Pig.* By Prof. W. J. Baumgartner. Pp. xii + 57. (New York: The Macmillan Co., 1924.) 4*s.* 6*d.* net.

THESE manuals have both been written as guides to mammalian types which have been found suitable for laboratory purposes in the two universities at which the respective authors are engaged in teaching zoology. The use of the fœtal pig as a type for dissection must of necessity be limited to universities and schools situated in towns, such as Chicago and Kansas, where packing plants are available as sources of supply, but the use of the rat has wider possibilities, and, for that reason, Prof. Hunt's manual will be specially welcome in Great Britain. Prof. Baumgartner's manual is modelled on Marshall and Hurst's "Practical Zoology," that is to say, clear directions for dissection are picked out in italics throughout. Prof. Hunt, on the other hand, has chosen to give a more or less connected account of the various systems and organs of the rat in which instructions for dissection are given in their appropriate places, but only incidentally. The former style has so many advantages in a book designed for the use of students that one almost regrets that Prof. Hunt did not adopt it for his book, particularly as it is almost sure to have a wider field of service.

A serious defect in both books is the absence of illustrations. This is deliberate on the part of Prof. Hunt, who believes that it is better for the student to get his visual impressions from the animal itself. While appreciating this point of view, it cannot be doubted that clearly reproduced figures are a wonderful aid to dissection and are worth many pages of the most carefully written text. The authors may, perhaps, reconsider the question should further editions be called for. The addition of figures would enhance the usefulness of these two excellent manuals enormously.

*The Psychology of Emotion, Morbid and Normal.* By Dr. John T. MacCurdy. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xvi + 589. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1925.) 25*s.* net.

THE author expresses a hope that his readers may be drawn not only from psychiatrists and psychologists but also from laymen interested in psychological problems. If this hope be fulfilled, the ranks of the former will be recruited from the latter. A person who has read and understood this book and studied the work of the authorities referred to in it can scarcely be styled a layman thereafter. Should he find his interest flag, the short but excellent chapter on treatment may be relied on to revive it.

As may be surmised from these observations, the book is a comprehensive one. To fortify his thesis the author gives stimulating reviews and criticisms of the work of C. Lange and William James, of McDougall, Freud, Janet, and Morton Prince, in so far as they have concerned themselves with emotions. He includes full studies of states of anxiety, mania, stupor, depression, and perplexity, illustrated by detailed notes of some seventy cases. The thesis in question is, that emotion, both as regards its expression and its feeling-tone (or affect), is the product of mental processes occurring co-consciously, co-conscious being the term applied to unconscious mental processes in a state of activity.

The methods and reasoning by which this conclusion is arrived at cannot be compressed into a short notice, but accompanying Dr. MacCurdy along his psychological and psychiatrical highways and byways is an interesting journey. On page 571 he states that "a particular grouping of words will excite a stylist pleasantly or unpleasantly." Some of the "Americanisms" in "The Psychology of Emotions" may produce the latter effect on the English stylist, but they do not detract from the value of the work as a whole.

*The History of the English Novel. The Age of Romance: from the Beginnings to the Renaissance.* By Dr. Ernest A. Baker. Pp. 336. (London: H. F. and G. Witherby, 1924.) 16*s.* net.

Dr. Baker takes a broader view of the origins of the English novel than is customary. He links it up not only with prose fiction of the Middle Ages, but brings it into relation with much of the material with which the student of the folk-lore and cultural history of Great Britain has to deal in the form of popular tales, legends and romances. His book, therefore, appeals to a wider public than that which is interested only in literary history. He passes beyond early prose fiction in Great Britain, touching upon its complement in France and Brittany, and goes back to early Greece, the connexion being traced through Euhemerus, the paraphrasts of Homer, and the later Greek and Latin writers of romance. To those who hold the view that the study of the folk-tale in Europe is largely a matter of literary history, Dr. Baker's investigation of sources and, perhaps in particular, of Anglo-Saxon fiction, will prove suggestive. In dealing with the Arthurian cycle, he covers ground which has been made familiar by the work of Miss Jessie Weston, Dr. Oskar Sumner, and, above all, the late Sir John Rhys; but his later chapters, dealing with other or later romances and with popular tales and *fabliaux* such as appear in the "Gesta Romanorum" and other collections, form a useful guide in a maze much of which, though not untrodden, is as yet inadequately explored. Dr. Baker's work shows wide reading and sound scholarship.

*The Fats.* By Prof. J. B. Leathes and Prof. H. S. Raper. (Monographs on Biochemistry.) Second edition. Pp. vii+242. (London: Longmans, Green and Co., 1925.) 12*s.* 6*d.* net.

The appearance of the second edition of this monograph, after a lapse of fifteen years, will be welcomed by all those interested in the subject. The author of the first edition, Prof. J. B. Leathes, has collaborated with Prof. H. S. Raper in the re-editing and re-writing of the present volume. The first three chapters are devoted to the chemical and physical properties of the fats, with methods for their extraction and estimation. The remaining seven, a lengthy expansion of only a short section in the first edition, deal with their physiology and give an up-to-date and reasoned account of the parts played by them in both plant and animal tissues. The stages in their digestion, synthesis, and utilisation are fully described as far as present knowledge permits; the transport of fat in the blood is considered in detail, and a reasoned criticism of Bloor's deductions from his experimental results put forward. The last chapter deals with the rôle played by fats, apart from their function as a source of energy, in the life of the cell; they form an integral part of the structure of protoplasm, and modern work already suggests possible ways in which their molecules may be arranged therein. The work is completed by a bibliography and index.

*Organic Medicaments and their Preparation.* By Ernest Fourneau. Authorised Translation by W. A. Silvester. Pp. x+262. (London: J. and A. Churchill, 1925). 15*s.* net.

It throws an interesting light on the working of the British educational system that although French is taught in practically every school above the elementary rank in England, it should still be thought necessary to issue English translations of French books. The French edition of M. Fourneau's book has already been reviewed in Nature (July 15, 1922, p. 50), and the opinion there expressed that it "should find a place wherever organic chemistry is taught to advanced students" is heartily endorsed by the present writer.

Mr. Silvester has done his work well and the terseness, clarity, and precision of the original have not suffered in his handling of the text. He has taken the opportunity to add a short but well-selected bibliography, which will be useful to those unfamiliar with the subject, and notes are appended here and there throughout the text directing attention to recent developments. The French edition was issued in 1921, and it says much for M. Fourneau's skill in the selection of material that the translator has been able to bring the English edition up-to-date with so few additions of his own.

T. A. H.

*Wales: an Economic Geography.* By L. B. Cundall and T. Landman. Pp. x+364. (London: George Routledge and Sons, Ltd., 1925.) 6*s.*

The authors have taken pains to collect and arrange their material for this geography of Wales, the first of its kind to be published. They have interpreted their subject liberally and succeeded in producing a full and accurate volume, which has the further advantage of being interesting and readable. Several of the chapters, such as those on coal and non-ferrous metals, take a wide survey of the whole subject, and might well be read by those to whom the details of Welsh geography are of minor importance. A further advantage of the book is that the historical side of industrial activity is kept well in view, so that a very clear picture is gained of the evolution of Welsh industries and towns. Statistical matter is freely used, and there are even appendices giving the trade terms used in the coal and other industries. The index is full, but might be revised in a later edition.

## Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### The Conditions of Chemical Change.

PATIENCE has its limits and modesty may be overdone. I am moved to these reflections by a three-page note in the Journal of the Chemical Society to hand to-day. I am carried back forty years, to a meeting at the society, in March 1885, when a shy Oxford graduate, a worker in Mr. H. B. Dixon's laboratory, told us practically that charcoal and phosphorus could not be burnt in dry oxygen. Actually, he told us less, as he did not then go nor has he since gone beyond his facts. That, however, was the inference to be drawn from his work, taken in conjunction with that of Cowper, Dixon, Wanklyn and others, on the effect of drought in checking chemical interactions. I there and then stated what I will now venture to term the *theory* of chemical action, chary as I am always of using the word, if there be the least reason to rest more faith in honest doubt than in a creed. In a sentence, that theory is, that chemical action, of whatever kind, is essentially electrolytic: consequently, change takes place only when the potentially interacting substances constitute an electrolytic circuit: such circuit appears always to be one of three components, of which one, necessarily, is an electrolyte. I was, therefore, able to say that hydrogen and oxygen would not and could not interact; further, that even when "wetted" they would not interact, as water was not an electrolyte: only when the water was made "conducting," by the presence of a dissolved "salt," would change be possible.

Several years later, by further exact experiments, Baker demonstrated the truth of these propositions. He developed an uncanny ability in "drying" things, and proved, in numerous cases, that the conditions I had laid down were essential to the occurrence of change. Others have verified some of his observations. About three years ago, however, Coehn and Tramm questioned his work and stated that hydrogen and oxygen not only interacted, under the influence of the light from a quartz-mercury lamp, but at the same rate whether the mixture were dry or moist.

Talking the matter over with Baker, I said: "Yes, as interaction takes place in a liquid film, at the surface of the containing vessel, ultra-violet light, at a low temperature, may well have a greater effect than heating, in bringing about change. Persevere in cleaning and drying the vessel and its contents and action will be stayed."

Baker now reports, that in a quartz tube which had been dried during twelve weeks no measurable action was observed during an exposure of thirteen hours to a quartz-mercury lamp at a distance of 2 cm., although action took place in tubes less thoroughly "prepared."

Baker and I have wandered all but alone these forty years in an arid wilderness, athirst for recognition and sympathy. I feel that we must now compel this, and that we have the right to challenge all and sundry, chemists and physicists alike, to consider the grounds of their belief, if they have one. When the history of our time comes to be written, nothing will appear more striking than the strange psychology of the "scientific" worker so-called: particularly the way in which he was captured by the wild Arrhenic speculation, more especially by Ostwald's dogmatic rulings. After all, he has but shown that he is human and dominated by the herd-instinct. Many may be called into "science," but few are chosen—to think for themselves and behave as reasoning beings. Still—

> One must receive their nature in its length
> And breadth, expect the weakness with the strength!
> *Sordello.*

The issue I raise is of consequence at a time when so much importance is attached to the determination of ionisation potentials in gases and so much argument is based upon the values deduced—but no attention whatever paid to the conditions prevailing in the vessels used. Neglectful as is the chemist, the physicist is far worse: seemingly he has no conception of chemical cleanliness, and the chemist, in consequence, often takes leave to doubt not a few of his deductions. It was not always so—it was not so when chemistry was taught together with physics. Of late years, we seem to have sought how not to teach the various branches of science effectively—by teaching them singly and encouraging a crass specialisation, which is leading us to neglect and fail in solving the problems of real importance.

HENRY E. ARMSTRONG.

October 1.

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### Haploidy in the Male Sawfly (Tenthredinidae) and some Considerations arising therefrom.

IN 1907 Doncaster published certain statements on the gametogenesis of the common gooseberry sawfly, *Nematus ribesii* Scop. ("Gametogenesis and Fertilisation in *Nematus ribesii*," *Quart. Journ. Micro. Sci.*, vol. 51 n.s., 1907), but later, in 1909, he published a correction (*ibid.* 1909. "Gametogenesis of the Sawfly *Nematus ribesii*. A Correction." NATURE, Dec. 2, 1909, p. 127). Unfortunately, he never resumed the investigation, and the problem was so left that its solution demanded work *ab initio*. Since then, nothing further has been done to elucidate the question, but work done by me on the spermatogenesis of the sawfly *Pteronidea melanaspis* Htg., together with certain breeding experiments with *Pteronidea* (*Nematus*) *ribesii*, permits certain pronouncements which throw considerable light on the subject.

Doncaster's material and mine belong to the same genus,[1] and the two species behave alike sexually in that the females, by parthenogenesis, produce males only (arrhenotoky), whilst, after insemination, they produce both sexes. These reproductive habits are likewise common to a great many sawflies, and indeed, except possibly for one species only, we may lay it down as a principle that for all bisexual sawflies in which the sex-ratio is normal (about 100 : 100), parthenogenesis results in the production of males only.[2] Any conclusion concerning *P. melanaspis*, therefore, will apply most probably to all such arrhenotokous species.

The cytological results for *P. melanaspis* are:

1. The spermatogonial chromosome number is 8 (Fig. 1);
2. The spermatocyte chromosome number is also 8 (Fig. 3);
3. There are two maturation divisions in spermatogenesis, but no reduction in chromosome number (Figs. 4 and 5);

[1] *Nematus ribesii* now is called *Pteronidea ribesii* according to Enslin's classification.

[2] The experience of sawfly workers, notably Miss E. F. Chawner, shows that the list of arrhenotokous species will be greatly increased by further work, and indicates also that all bisexual sawflies are facultatively male-producing by parthenogenesis. Occasionally a female is produced, but this occurrence raises questions which cannot be discussed here.

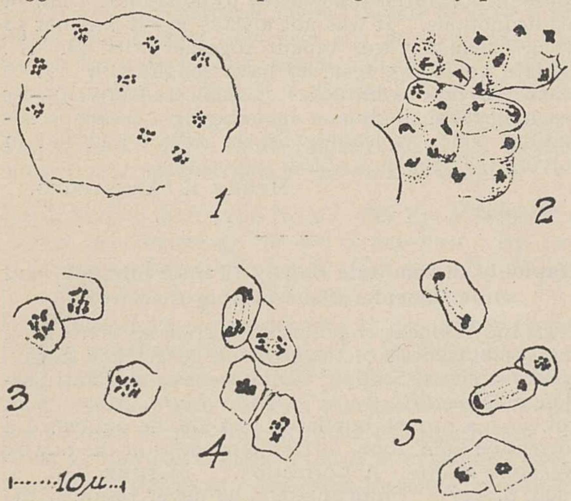
4. No abnormal methods of cell division, such as described in the spermatogenesis of the hive bee and hornet by Meves and others, have been discovered ;

5. The above hold good for males obtained from parthenogenetic females and from wild larvæ collected in the field.

The technique employed, fixation by Carnoy or Bouin, with the usual succeeding operations and staining by iron-hæmatoxylin, has given excellent results, so that the cell appearances are perfectly plain.

These findings lead to the following inferences. As the spermatogonial chromosome number of the male is 8, the somatic number is likewise 8. It follows that 8 is the haploid number, and that the male sawfly produced by parthenogenesis, in arrhenotokous species, is haploid in constitution.

Immediately, the further important question suggests itself : if the parthenogenetically produced sawflies of bisexual species are both haploid and male, are the males from inseminated females of such species likewise haploid and really of parthenogenetic origin also ? That is, do bisexual species of sawflies follow a plan similar to that of the hive bee in which the queen, by controlling the fertilisation of the egg, produces diploid, fertilised, female-producing eggs, as well as haploid, unfertilised, male-producing eggs ; or, if this be not the case, do they conform to the general rule among bisexual insects (except lepidoptera) that inseminated females give diploid and homogametic females and diploid and heterogametic males ? That the former is the case is the main point of this letter.




OUTLINE DRAWINGS ILLUSTRATING HAPLOIDY IN THE SAWFLY *PTERONIDEA MELANASPIS.*

All figures drawn to same scale, using a Leitz microscope with a 10 periplanatic ocular and a $\frac{1}{10}a$ oil immersion objective and a Reichert drawing apparatus. Cytoplasmic appearances and cell outlines largely lost owing to the material being fixed with Carnoy's fluid.

FIG. 1. Group of spermatogonial plates with chromosomes up to 8 in number.
FIG. 2. Spermatogonial mitosis.
FIG. 3. Chromosome plates of spermatocytes of the first order : two show 8 chromosomes and one shows 7.
FIG. 4. Equational division in spermatocytes of the first order.
FIG. 5. Plate of 8 chromosomes and phases in the division of spermatocytes of the second order.

Note, the differences in the sizes of the chromosomes and plates of the first and second spermatocytes.

These questions could be solved at once and directly if we knew the chromosome constitutions of such female sawflies and of the males produced by them after insemination. Unfortunately, the material from collected wild males does not provide complete information on such, but, nevertheless, an answer can still be obtained indirectly in another way, as will be seen presently, from certain breeding experiments.

The argument is as follows, and it is based on the assumption that the female sawfly is diploid and homogametic and therefore produces only one kind of germ cell—the haploid sort. This assumption is perfectly justifiable in the light of present knowledge, but its truth will be tested for the purpose of this discussion.

For example, let us suppose that the chromosome number of all parthenogenetically produced male sawflies of a given species is $n+x$, $x$ representing the sex chromosome condition. The female, therefore, would have a diploid constitution of $2n+2x$, and would produce eggs of only one kind having the haploid chromosome number of $n+x$. Unfertilised eggs, by parthenogenesis, would of course give haploid offspring, which would be males, while the fertilised eggs would have the diploid number of $2n+2x$ restored and so yield females.

Let us now test the possibility that males produced by inseminated females have a chromosome constitution different from males produced by parthenogenesis, *i.e.* that there are two different kinds of males, haploids and diploids. Such diploid males, produced by the union of male and female gametes, according to present convention, would be designated $2n+x+y$ ($y$ representing that sex chromosome possession of which determines maleness). A male would therefore produce gametes of two kinds constituted $n+x$ and $n+y$. The union of a male $n+y$ gamete with a female $n+x$ gamete would give an organism of complement $2n+x+y$, that is, a male : the union of a male $n+x$ gamete with a female $n+x$ gamete would always give an organism of $2n+2x$ complement, that is, a female. But, and here is the important point, my experiments (unpublished) with *Pteronidea* (*Nematus*) *ribesii* controvert the latter consideration, because parthenogenetically produced males, $n+x$ in constitution, mated with females, induce the production of both sexes.

Clearly, then, as the gametes from parthenogenetically produced males are all alike, the diversity in the results of pairing depends upon the female ; further, this diversity can only be explained in three ways, either (1) the female controls egg fertilisation, or (2) the female is digametic, or (3) the parthenogenetically produced eggs of $n+x$ constitution are different from the $n+x$ eggs of the fertilised females. The second hypothesis is untenable for the critical reason that its consequence would be the production of two kinds of males by parthenogenesis, and we know from the above cytological results that this is not the case. Again, all female insects, except lepidoptera, are homogametic. The third hypothesis may also be dismissed, for all our knowledge to-day, and it is very considerable, on animal cytology proves that identity of chromosome constitution in eggs results in the identity of their end products, provided, of course, that the conditions of development are normal and alike.

We are left to conclude, therefore, that the inseminated female sawfly of bisexual species controls the fertilisation of its eggs, the unfertilised eggs yielding males and the fertilised eggs females.

Additional support to this thesis is obtainable from other sources, as, for example, the fact that other hymenoptera such as bees, wasps, the parasitic wasp Hadrobracon (Whiting) and the cynipids (Doncaster), behave in this way. Further, in the very species which has been cytologically examined, *P. melanaspis*, the very fact that the wild male larvæ have the same chromosome constitution as the pedigree parthenogenetic males is very significant, for, even if these wild larvæ were offspring of an unfertilised wild female, it is an indication that they are utilised in Nature as, certainly, similar larvæ of *ribesii* are utilisable because they have been successfully paired with females in the laboratory and offspring of both sexes have resulted.

There can be no reasonable doubt, therefore, that all sawfly males are of one kind in that they originate from unfertilised haploid eggs which may be laid by virgin females or by inseminated females.

This finding affords a clue to other problems of sawfly parthenogenesis and its evolution, but these will not be explored at this juncture, their discussion being deferred for the paper, now in preparation, which is to deal, in detail, with the matter of this letter together with other features of sawfly spermatogenesis.

It remains to make grateful acknowledgements to the British Association for a grant in aid, and to the following, all of Armstrong College: The Research Endowment Fund Committee for the provision of a Leitz Binocular Microscope, Prof. A. Meek for the facilities of his zoological laboratories, including the services of the steward, Mr. D. C. Geddes, and Dr. J. W. Heslop Harrison, who checked my cytological conclusions.

A. D. PEACOCK.

Armstrong College (University of Durham),
Newcastle-on-Tyne, September 20.

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## On the Advancement of Science by Published Papers.

UNDOUBTEDLY science is kept alive by teaching; and without good teaching, there can be but little discovery. Edison, for instance, when young, possessed and studied Faraday's masterly researches on electricity.

The present writer has been engaged in scientific research for eighteen years or so. He does not pretend, however, to have observed all the following rules, of the importance of which he became cognisant by degrees. The foundation of the co-operative fabric of science and scientific discovery has been built up by the work of the early "missionaries of science," when research entailed more or less of a martyrdom. It is hoped that we can pass on to posterity this edifice of science, undecayed and even embellished, now that research is a privilege and a giver of prestige. If we do not, the position of science and scientific work may deteriorate without limit.

(1) The truth, and nothing but the truth, but never the whole truth *for publication*. One must omit trivialities. Our scientific magazines are now sometimes more or less packed with never-to-be-utilised details, most of which perhaps would have better rested in the notebook. The penalty for non-observation of this rule is the, probably now imminent, cessation of publication, except in the form of abstracts.

(2) It is perhaps unethical for a research worker, as for a medical man, to advertise. Plethoric papers, pictures not absolutely necessary, repetitions in different magazines, references mainly to one's own work, and unneeded elaboration or enlargement of figures, seem to partake of the nature of advertising. The penalty for infraction is the introduction of competitive business methods into science as an ideal; instead of the co-operative aims, which have produced such good results in the past.

(3) Mere facts, however new, are often (though not always) of perceptible scientific value only when their discoverer, or some one else, has demonstrated their relations to other facts, or to a theory or hypothesis of value. If they have no such demonstrable relations, they are probably "trifling though true." The penalty is again the ending of magazine publication *in extenso*.

(4) The repetitions and confirmations of a discovery on similar or related material are of sufficient scientific interest to warrant full publication only to a certain degree of repetition. Whether this is ten or a hundred times, the point is at length reached when only the accounts of exceptions to the rule are worth full publication. The penalty is again the flooding of magazines, and the future reduction to abstract publication.

(5) The publication of a working hypothesis by one who has discovered a sufficient amount of relevant fact is welcome, and indeed almost necessary. (A working hypothesis is one that is immediately to be tested.) But a mass of untested hypotheses is readily producible; and may be aimless, except to fill space. A flood of hypotheses, which cannot be immediately tested, may be a brake on the progress of a science. Since it is easier, for many of us, to spin hypotheses than to make discoveries, the penalty for the appreciation and prestige of this form of mental exercise is the partial, or even complete, cessation of experiment.

(6) It is probably unethical to claim credit or priority for an untested hypothesis (mostly for writers in the distant past), to the prejudice of those who have borne the full burden of testing it. A writer who has published, among a number of unworkable hypotheses, one which has subsequently been used as a successful working hypothesis, does not apparently deserve to be cited. Perhaps one should not attach priority to *any* untested hypothesis, but only to true working hypotheses.

(7) It is generally recognised that, in a serious scientific paper, citations of a genuinely relevant previous work should be complete, so far as they are not known to all readers. Even excessive and pedantic citation is a fault on the right side. But surely much space might be saved by referring to standard numbered annual lists of scientific papers. The penalty for lack of citation is, of course, to leave it doubtful as to how much the writer has himself discovered. It leads also to the isolation of workers or countries. But excessive citations again overload the magazines.

(8) A form of scientific co-operation consists in the sending of separate copies of papers, in not readily accessible magazines, to other interested workers. This has now extended to all magazines, even those accessible to everybody. Stanley Hall regards it as a means of working up a personal following or constituency; in other words, it is now an advertising method. Perhaps as much as anything else, it injures the circulation of the scientific magazines.

These and other similar rules are, of course, well known to, and observed by, many experienced workers.

JOHN BELLING.

Huntington, N.Y.

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## The Band Spectra associated with Carbon.

IN an interesting letter to NATURE (August 8, p. 207), Prof. Birge has directed attention to a band system which I described as a "New Band System" in Proc. Roy. Soc., A, vol. 108, p. 349 (1925). More recently (NATURE, Sept. 5, p. 360) M. Baldet has written with reference to this system, pointing out that three of the six bands I recorded were measured and described by him in *C.R.*, vol. 178, p. 1525 (1925). I should like to take the opportunity of saying that at the time of writing my paper I was not aware of this work of M. Baldet, and to him must be given the credit for the first recorded measurements of the system. At the same time, the discovery of this spectrum was first recorded by Prof. Merton and myself in Proc. Roy. Soc., A, vol. 103, p. 389 (1923), as follows: "It should be remarked that in addition to the Comet-Tail bands which are degraded to the red, there are a number of very much fainter bands which are degraded to the violet, but are somewhat similar in appearance." Under the conditions of production in helium mixtures, this spectrum is isolated along with the comet-tail bands and negative carbon bands from all other band spectra which might conceivably have rendered the identification from this brief description uncertain.

In view of Prof. Birge's letter in NATURE of August 1, p. 170, which represents first steps towards the theoretical correlation of the numerous band spectra of carbon, it may not be inappropriate to record a few observations of a purely experimental character with the evidence they afford as to the origin of some of these spectra. During the last couple of years, while working with the inert gases, I have gained a detailed acquaintance with almost all the band spectra of carbon. The various conditions under which it has been found possible to isolate some spectra and eliminate others have inevitably led me to form impressions of their molecular origin.

Without wishing to open the old controversy as to the origin of the Swan bands, the following facts appear significant. The Swan bands can be isolated with exceptional brilliance in 20-50 mm. of any of the inert gases. Of helium, neon, and argon, the last named is perhaps the best in this respect. When a tube is fitted with carbon electrodes, side bulbs containing caustic potash and phosphorus pentoxide, and a palladium regulator, and filled in this way with argon, it usually shows only the Swan bands and the triplet system (*vide* Proc. Roy. Soc., A, vol. 103, p. 390). Prolonged passage of a discharge with the regulator heated so as to remove the hydrogen eliminates the triplet system and leaves the Swan bands, while further running of the tube ultimately removes the latter and there remains only the continuous spectrum of high pressure argon and perhaps the strongest lines of "red" argon. If hydrogen be now admitted through the regulator, the reversed processes can be produced, namely, first the production of the Swan bands with great brilliance, and with much hydrogen, the production of the triplet system. Tentatively, one might suggest a CH or $(CH)_2$ molecule for the former, and a molecule of greater hydrogen content, possibly $CH_4$, for the latter.

I am at present engaged in a fine structure analysis of these spectra which will probably yield more definite information of the nature of the radiating molecule. The CH band, $\lambda 4315$, and associated heads can be completely isolated from all other carbon spectra under suitable conditions. In the presence of 20 to 30 mm. of argon or neon containing a little water vapour and a minute trace of a carbon impurity, the system can be produced strongly. What relationship these bands bear to the Swan and triplet systems it is at present premature to say. The fourth positive group is quite possibly of a C-H origin and appears strongly in argon under the conditions of isolation of the triplet system and the Swan bands. It was apparently not observed by M. Baldet in his thermionic bulb when filled with pure carbon-monoxide.

As regards C-O spectra, the recent work of Birge and of Blackburn appears conclusive in assigning the comet-tail bands, the associated bands previously discussed, and the negative carbon bands to a singly charged CO ion. I incline to think from experimental work that the Ångström bands, the third positive bands, and possibly the new band spectrum observed by Cameron (in course of publication) will be found to arise from a neutral CO molecule. As regards the high pressure CO bands discovered by Fowler, both their complexity of structure and conditions of isolation (which differ so profoundly from those of the comet-tail bands) point to a more complex molecule as the emitter.

R. C. JOHNSON.
Physics Department,
Queen's University, Belfast,
September 9.

### The Theory of Hearing.

IN reference to Mr. R. L. Wegel's letter to NATURE of September 12, p. 393, under this heading, I think it must be admitted that he and his co-workers at the Bell Telephone Laboratories have contributed a wealth of new facts bearing on the theory of hearing. It will probably be some time before these facts are fully interpreted and correlated, so that their significance in regard to the theory can be rightly appreciated.

Mr. Wegel has elaborated in detail his conception of the deformations of the basilar membrane in response to pure tones of various pitch and intensity. From careful measurements of "masking" of one tone by another, when both tones are sounded together, he estimates the spread of resonant response. The results arrived at are so surprising that the question arises whether the observed facts afford a sufficient basis for the elaborate deductions drawn from them, or whether a simpler solution cannot be found. His primary assumption is that the masking of one tone by another of greater intensity is to be explained by the submergence of the apex of the displacement produced by the masked tone in the basilar membrane by the rising slope of that due to the masking tone (*Physical Review*, February 1924, and Fig. 9, Reprint B. 58. 1).

Mr. Wegel draws the conclusion that the response to a pure tone extends the whole length of the basilar membrane, with a maximum point or apex at a level corresponding to the pitch of the tone. If we take it that the maximum displacement of a stretched string when vibrating freely does not exceed 1/100th of the length of the string, it would follow that for a tone of say 800 d.v. per sec. (length of basilar fibre $=0 \cdot 35$ mm.) the displacement of the basilar membrane along its length would have an average slope of about 1 in 5000 on one side of the apex, and 1 in 4000 on the other.

It seems almost incredible that the internal ear could instantaneously detect, and interpret as a single clearly defined pitch, a maximum point of stimulation so slightly accentuated as compared with the displacement of the rest of the membrane. But, one may ask, do Mr. Wegel's curves (Fig. 9, *loc. cit.*) actually represent the deformation to be expected, even granting the spread of resonance which he presupposes? Such a curve should be composite, and should represent the algebraical sum of the components. We should not expect the secondary tone to be entirely masked. It would give rise to a lesser secondary peak. If it caused a displacement of the basilar membrane at all, this should be appreciable, at least as an alteration of the quality of the masking tone. The ear is remarkably sensitive to alterations in the quality of sounds, either musical or unmusical. Its beats with the masking tone, though too rapid to be perceived as beats, would have the effect of doubling its intensity. As it is not perceptible, the inference is that it produces no deformation of the basilar membrane. It is suppressed, not submerged.

The phenomena of "masking" are undoubtedly puzzling, but the outstanding fact that a low tone masks one of higher pitch to a greater extent than a higher-pitched tone masks a lower one, suggests that the explanation is to be sought in the hydrodynamics of the cochlea. It may be that the larger and slower oscillations of the cochlear fluids associated with vibrations of the basilar membrane in the apical region damp out heterorhythmic vibrations on the proximal side of the membrane over which they pass, and so suppress the higher-pitched tones. It would not follow that the harmonics, which are intermittently homorhythmic, would also be suppressed.

Mr. Wegel finds that subjective harmonics are developed in the case of pure tones of medium intensity. These subjective harmonics apparently do not affect the character of the tone heard. This would suggest that their intensity is not great relatively to that of the fundamental. The ear readily distinguishes between a pure thin tone and a rich full tone in which a number of harmonics are present. If all the " pure " tones we hear contain a whole series of overtones, what distinguishes them from the " rich " tones? That such an extensive " pattern deformation " as is represented in Fig. 1 (NATURE, September 12, p. 393) is generated by each tone which acts on the cochlea is difficult to reconcile with the extraordinary power the ear has of analysing compound musical tones, and even more with its power of instantaneously analysing, and recognising the source of, characteristic noises. This would necessitate an integration of nerve impulses within the auditory tract of almost inconceivable complexity.

G. WILKINSON.

Glossop Road, Sheffield.

## Physics and Metaphysics.

IT is no doubt a splendid simplification to express the ninety or more chemical elements in terms of two entities, and of only two, namely, electrons and protons, but those who face squarely the problems of physics find it a large leap to follow Mr. Bertrand Russell in " What I Believe," when he states (p. 10): " Physical Science is thus approaching the stage when it will be complete, and therefore uninteresting. Given the laws governing the motions of electrons and protons, the rest is merely geography. . . ."

Those familiar with the life and writings of the late Lord Rayleigh will have come to a directly opposite conclusion, namely, this, that the region to be discovered expands continually with discovery.

The assignment to the world of a wound-up system, like a watch, consisting of protons and electrons, ignores in the first place the problem of radiation, about which we have at present two theories utterly incompatible with one another in the minds of even the finest living intellects.

The further question whether life can be interpreted, for it cannot possibly be explained, by the laws of physics alone is a wide and doubtful issue, on which the best informed are the least emphatic. It is unlikely that any great progress will be accomplished in terms of physics as known or imagined to-day.

Sufficient warning may be found in Kelvin's estimate of the age of the earth, where the logic and mathematics were faultless, so that the conclusions appeared inevitable, until a wholly new branch of physics arose, and radioactivity enabled us to realise that the initial concepts of the problem were founded on insufficient data.

Later in Mr. Russell's book (p. 22) we arrive, however, at the refreshing statements that " the philosophy of nature is one thing and the philosophy of value is another"; and again, " It is we who create value"; and yet again, " In this realm we are kings."

Values cannot be appraised in foot-pounds or calories, nor be cribbed and confined to electrons and protons. Shakespeare and Newton were sustained by food calories as other men are. The foot-pounds or ergs of work expended on " Hamlet " or the " Principia " are comparable in magnitude with those used in the efforts of an ordinary writer or worker. But how can we estimate or express the profound differences in the resulting values! These values are not material, nor can they be reduced to electrons, radiation or æther as understood or imagined by most physicists of to-day.

Another scientific heresy, not imputed to Mr. Russell, but common enough to-day, is the avowal that electrons and protons were " created " in the past, that certain " laws " were imposed upon them, and that the universe has since then been a going concern, running itself from these initial impulses alone. The idea that something created at one instant *must* continue to exist at another instant or for a period of time may be eliminated as a crude conception. The continuation of existence is as difficult to explain as is the initial existence itself.

The only solution that may be offered (and yet it is obviously no solution to us) is that time is the great illusion. We are permitted to see the moving picture film of existence unroll, but the record is, was, and will be always there. Most marvellous of all, we are allowed to take part in the production ourselves, or at least to enjoy the illusion of an active participation therein.

Statements of this kind, passing from the region of physics to metaphysics, are naturally open to more condign criticism than those to which this letter ventures to direct attention.

A. S. EVE.

McGill University,
Montreal,
September 12.

## The Worth of Knowledge.

THE comments on the functions of the British Association, in the article in NATURE of September 12 on " The Worth of Knowledge," raise a consideration that should command the attention of the scientific world, whether interested in the Association or not.

We are justly proud of our science and our scientists. We can point to the departments of science, in our universities and schools, as flourishing institutions, and yet doubt whether they are fulfilling their function to the widest and best extent. Our teachers of chemistry, physics, botany, geology, and all the other branches of science, are men whose names command a world-wide respect. Further, we can agree that the time has passed when any man could include in his survey of life a complete and detailed knowledge of science as a whole. The chemist is to be congratulated if he knows all there is to be known of the chemistry of one small group of substances, and similar conditions hold for other fields of science.

Yet, with equal truth, it may be claimed that science is more than a set of separate departments of natural knowledge; and the claim that the future of humanity rests on a scientific basis can scarcely be denied. This truth and claim are to-day fairly well recognised by a wide public, which is doing its best to get as close acquaintance with scientific work as its non-technical education will permit. As Bateson wrote before the War, " I think it needs little observation of the newer civilisations to foresee that they will apply every scrap of scientific knowledge which can help, or seem to help them in their struggle, and I am good enough Selectionist to know that in that day the fate of the recalcitrant communities is sealed." True in those days, it is urgent and equally true now.

If we have a living faith in the claim, then it is a duty to preach the gospel of science far and wide. I would like to suggest that the time is ripe for the giving of life to that old subject summed up under the term Natural Science. I would like to see a department of natural science as a whole in every university and school in the land, and the growth of the idea that no man—classic, historian, linguist, or chemist—could claim to be educated who had not passed through its curriculum. I am aware that in name such departments do exist, but they cover only a number of specialist courses. The natural science for which I plead should be organised to give wide-flung views of the aims, ideals, and methods of science. They would train the individual to think and act in a scientific manner. The professorial staff should be men who, in the words of your article, could "address a public or any other audience in a manner which will command attention or stimulate interest." The research they would undertake would be the investigation of how best use, not necessarily in the material sense, could be made of scientific advances among the masses of the community.

The matter is urgent, for one has only to read the headlines of a daily paper, watch the hoarding of the kinemas, or the reading matter bought by the general public, to realise that the affairs of the world are receiving "quiet, calm deliberation" very much along Gilbert and Sullivan lines. W. F. F. SHEARCROFT.

126 Huntly Grove,
Peterborough.

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### The Arc Spectrum of Phosphorus.

KIESS (Jour. Opt. Soc. Am., July 1925) has recently shown that the arc spectrum of nitrogen consists of doublets and quartets, one very particular feature being that the lines lie either in the extreme ultra-violet or in the infra-red. There are some lines in the visible range, but they are excited only under very special circumstances.

The spectrum of the next homologue, viz. phosphorus, has been investigated by Miss Saltmarsh in Prof. A. Fowler's laboratory (*Phil. Mag.* xlvii. 874, 1924). Miss Saltmarsh has shown that the arc spectrum of phosphorus consists of doublets, and has also pointed out certain constant frequency differences.

It appears from an inspection of Miss Saltmarsh's data that the following pairs of lines having the constant frequency difference 25·0 form a sharp series of the type $2\pi_{1 \text{ or } 2} - m\sigma$, where $2\pi_1 = 53614{\cdot}8$ and $2\pi_2 = 53639{\cdot}8$ approximately.

| λ (I.A.), Intensity. | ν. | Δν. | m. | mσ. | Difference between Calculated and Observed Values of mσ. |
|---|---|---|---|---|---|
| 2536·38 (10)<br>2534·75 (8) | 39426·3<br>39451·6 | 25·4 | 2 | 14188·2 | +2·8 |
| 2154·77 (7)<br>2153·63 (6) | 46408·7<br>46433·2 | 24·5 | 3 | 7206·6 | +5·3 |
| 2034·02 (7)<br>2032·98 (6) | 49163·7<br>49188·9 | 25·2 | 4 | 4450·9 | +8·0 |

The more refrangible components of the pairs are fairly well represented by the formula

$$\nu = 53639{\cdot}8 - \frac{R}{\left(m + 1{\cdot}13909 - \dfrac{0{\cdot}718054}{m}\right)^2}$$

where $m = 2, 3, 4$ consecutively. Closer agreement with the observed values of $\nu$ and those calculated from the formula is obtained by taking $2\pi_2 = 53645{\cdot}0$.

The difference between the terms $2\sigma$ and $3\sigma = 6982$, and this difference repeats itself in the combination of two pairs of lines having the frequency difference of 14·9 as follows:

| | | | | |
|---|---|---|---|---|
| | (8)<br>2136·79 | | (6)<br>1859·36 | |
| $x_1 - 2\sigma$ | 46799·2 | 6982·8 | 53782·0 | $x_1 - 3\sigma$ |
| | 15·0 | | 14·7 | |
| | (6)<br>2136·10 | | (8)<br>1858·85 | |
| $x_2 - 2\sigma$ | 46814·2 | 6982·5 | 53796·7 | $x_2 - 3\sigma$ |

whence $x_1 = 60987{\cdot}4$ and $x_2 = 61002{\cdot}4$.

Miss Saltmarsh has pointed out frequency differences of 7281 and 298, and it is seen here that 7281 is the sum of 6983 and 298, the differences being within the limits of experimental error.

N. K. SUR.

Physics Department,
University of Allahabad,
August 15.

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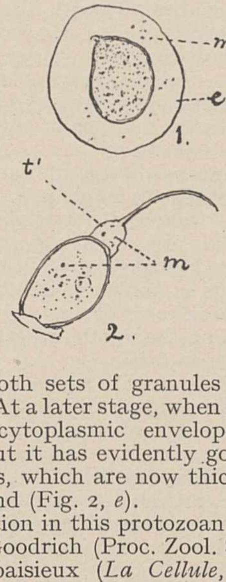
### Formation of the Spore Tails in *Haplosporidium chitonis.*

IN *Haplosporidium chitonis* the method of formation of the spore tails, which grow to a great length after the completion of the spore coat, has always been rather difficult to understand; it seemed unlikely that the material for these tails could be provided from the interior of the spore, owing to the thickness of the spore wall, at least toward the end of their growth. On a recent *intra vitam* examination of some of these spores in Janus green, I discovered that, in the younger stages, each is surrounded by a very distinct thick cytoplasmic envelope (Fig. 1, *e*). The appearance at this stage gives the impression that the spore is being formed inside a cell, but the absence of nucleus outside the spore shows, of course, that this is not the case.

Certain granules can be seen in the envelope, and these appear to be similar to granules inside the spore, which I believe to be mitochondrial in nature (Figs. 1




and 2, *m*). Both sets of granules stain slightly in Janus green. At a later stage, when the spore tails are forming, the cytoplasmic envelope, as such, has disappeared, but it has evidently gone to the formation of the tails, which are now thick and bulging at the proximal end (Fig. 2, *e*).

Spore formation in this protozoan has been studied by Dr. Pixell Goodrich (Proc. Zool. Soc. Lond., 1915) and Prof. Debaisieux (*La Cellule*, t. xxx., 1920), and by myself in a paper still in press, but the cytoplasmic investments of the young spores have not been previously described. The cytoplasm of this form is very delicate, and very susceptible to adverse fixation; this must account for the disappearance of the cytoplasmic envelope in the fixed material from which most of the previous work has been done, as it would have been impossible, otherwise, to overlook such conspicuous structures. S. D. KING.

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Trinity College,
University of Dublin.

### Dispersal of Butterflies and other Insects.

THE letter of Mr. Robert Adkin in the issue of NATURE of September 26, on the vertical upward flight of moths from the Downs near Walmer, supplies one of the desiderata required to confirm the view indicated in Mr. Felt's article in NATURE of September 5 that the upper air-currents may play an important part in the distribution of flying insects. I have myself long expected that the dispersal of insects would ultimately attract the attention of the meteorologist, and Dr. Simpson's British Association address, which immediately precedes Mr. Felt's article, reads apposit ely beside Mr. Felt's appeal for the aid of convectional currents arising from heated surfaces in assisting insects to gain the upper air-strata. But in this connexion we must not forget that mountaineers have long exercised their brains over the problem of insects on high mountain tops. Whymper in particular, in his work on the equatorial Andes, dealt with this subject, and he quotes Humboldt and Bonpland as showing that insects are transported into the upper regions of the atmosphere (16,000 to 19,000 feet), and adds that the transportation of insects by ascending air-currents has occasionally been observed in operation. One such set of observations is noted by Mr. Felt when he writes, "Collectors on some of the high mountains, such as Mount Washington, have taken insects which are distinctly southern or south-western in habitat, probably carried there by the upper air-currents and dropped upon these cooler mountain tops."

After reading about the recent developments of our knowledge of the upper air-strata, I am inclined more and more to regard the trans-oceanic distribution of insects as carried out mainly in the upper air. My difficulty would be in assuming that insects are hardy enough to withstand the strain of upper-air conditions. When I was camped out on the top of Mauna Loa (13,600 feet) in Hawaii in 1897, this aspect of the question was brought home to me in a striking fashion. The lava rock and beds of cinders outside my tent were strewn with butterfly wings cast off by butterflies which had been brought by the trade-wind current up the mountain slopes from the forests below. The air was intensely dry and extremely electrical, producing distressing physiological effects, which, together with the freezing up of everything liquid in my tent, made life for a man scarcely bearable. To these conditions all the butterflies succumbed that reached the top of Mauna Loa.[1] There their wings lay around me in their hundreds. Mr. Felt should in this experience of mine find the greatest difficulty in accepting the 2000-mile air-trip postulated for Californian insects in reaching the Hawaiian Islands, and perhaps the meteorologist would decline taking on his shoulders the responsibility of Insect Distribution in the upper air.

Mr. Felt suggests the possibility of there being sometimes a condensation of insect life at particular levels, due to atmospheric disturbances, and that their instinctive efforts to save themselves may result in the great invasions of insects noticed in different localities. This seems likely enough. Perhaps some air-man on the wing at high altitudes has flown through a bank of insects in the clouds, held there by unfavourable conditions in the air-strata above and below.

H. B. GUPPY.

32 Daglands Road,
Fowey, Cornwall,
September 27.

[1] My observations on Mauna Loa were given in my book on "Plant Dispersal in the Pacific" (1906), and were alluded to in NATURE towards the close of 1897 (vol. 57, p. 20).

### Locomotion of the Sunfish.

THE mode of swimming of the sunfish (Mola), which I have had many opportunities of observing at close quarters, is unusual, perhaps unique, but easy to comprehend as compared with that of other fishes. The long dorsal and ventral fins are stiffened on their anterior and flexible on their posterior edges, like the wings of insects. The action of great masses of muscle at their bases causes them to strike the water laterally, first to the right and then to the left, the two fins striking simultaneously towards the same side like wings, but in a horizontal instead of a vertical direction (Fig. 1, B). Owing to the differences

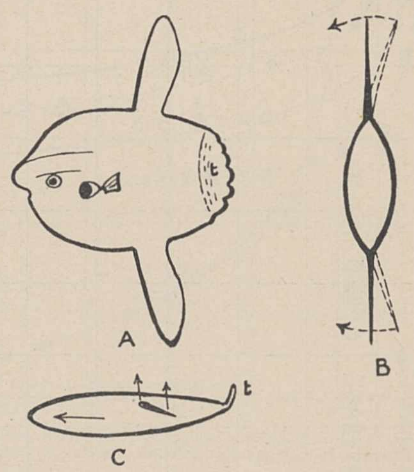


FIG. 1.—A, side view of Mola; B, transverse section in region of fins; C, diagram of Mola seen from above with fins striking to the right.

of flexibility over the surfaces of the fins, their planes are twisted in the act of striking so as to give a forward thrust (Fig. 1, C). Of course, since they strike sideways, there is also a lateral thrust, but this is correlated with the flattened shape of the body, which, acting like the keel of a sailing boat, resists lateral displacement.

The body of the fish is rigid except for the "tail" (*t* in figures), which acts exactly like the rudder of a ship. Fig. 1, C, shows it hard a'port; I have seen it held over like this as the fish turned in a large circle to the right. Since the backwash from the fins does not strike the rudder, one would expect the sunfish to resemble a paddle steamer (as opposed to a screw steamer) in not being able to turn before getting a fair amount of headway on. It is perhaps to provide an auxiliary steering apparatus that the respiratory arrangements are modified so that a very powerful jet of water can be squirted backwards from under either gill cover at will.

G. C. C. DAMANT.

Thursford, Cambridge Road,
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September 16.

# The Physiological Basis of Athletic Records.[1]

By Prof. A. V. HILL, F.R.S.

FATIGUE AS THE DETERMINING FACTOR.

AN important and interesting problem for any young athlete is presented by the question: "How fast can I run some given distance?" The maximum speed at which a given distance can be covered is known to vary largely with the distance. What are the factors determining the variation of speed with distance? How far, knowing a man's best times at two distances, can one interpolate between them for an intermediate distance, or extrapolate for a distance greater or less?

Obviously the answer to such questions depends upon the factor which in general terms we designate fatigue. Fatigue, however, is a very indefinite and inexact expression; it is necessary to define it quantitatively before we can employ it in a quantitative discussion such as this. There are many varieties of fatigue, but of these only a few concern us now. There is that which results in a short time from extremely violent effort: this type is fairly well understood; there is the fatigue, which may be called exhaustion, which overcomes the body when an effort of more moderate intensity is continued for a long time. Both of these may be defined as muscular. Then there is the kind which we may describe as due to wear-and-tear of the body as a whole, to blisters, soreness, stiffness, nervous exhaustion, metabolic changes and disturbances, sleeplessness, and similar factors, which may affect an individual long before his muscular system has given out. Of these three forms of fatigue the first one only is as yet susceptible of exact measurement and description. The second type may quite possibly come within the range of experiment at no distant date. The third type is still so indefinite and complex that one cannot hope at present to define it accurately and to measure it. Undoubtedly, however, all these types of what we call "fatigue" influence—indeed, determine—the results which are to be presented.

In Fig. 1 all the important world's records are presented, average speed against time, for men and women running and for men and women swimming. The crosses representing men rowing in an eight-oar boat will be discussed later. It is obvious in all four cases that we are dealing with the same phenomena, a very high speed maintainable for short times, a speed rapidly decreasing as the time is increased and attaining practically a constant value after about 12 minutes. There are no trustworthy records, in the case of swimming, for times of less than about 50 seconds, so that the curves cannot be continued back so far as those for running. There can, however, be no doubt that the curves for running and swimming are essentially similar to one another and must depend upon the same factors. The phenomena shown in Fig 1 are susceptible of a fairly exact discussion.

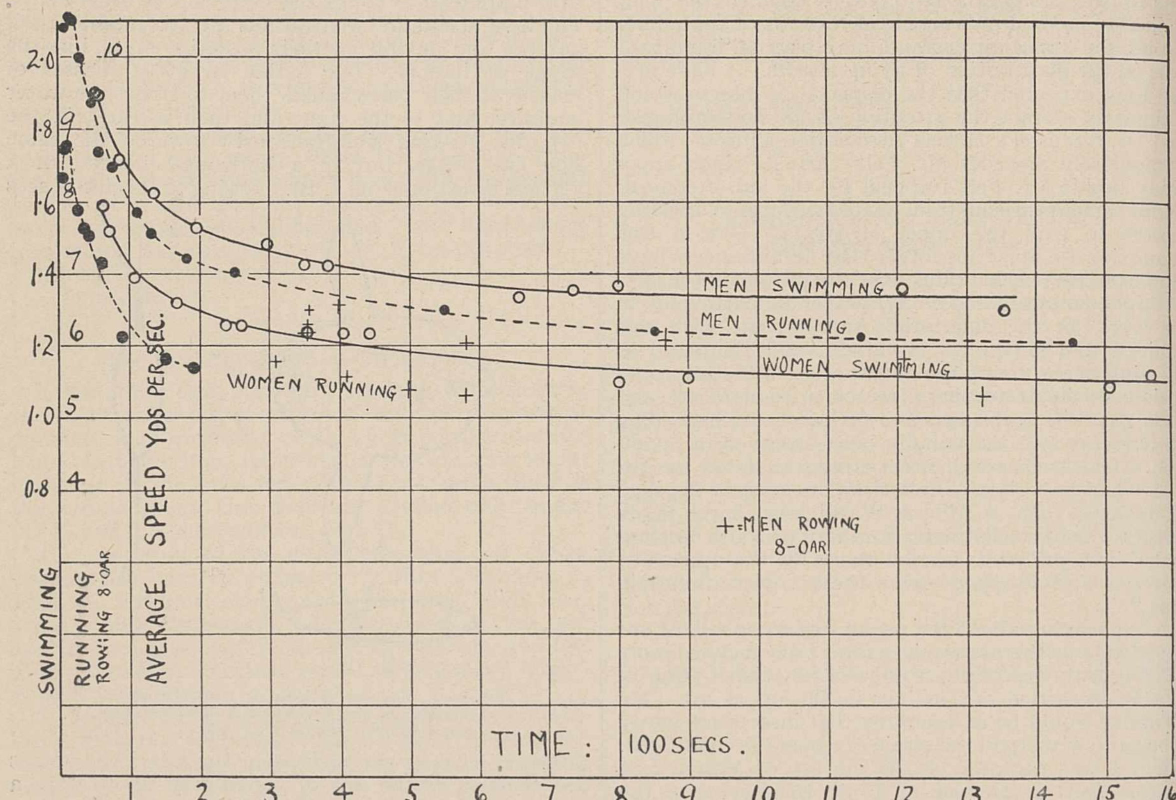


FIG. 1.—World's records for men and women swimming and running: average speed in yards per second against time in seconds. *Note.*—The scale for swimming is five times as great as for running. The observations for men rowing an eight-oar boat are on the same scale as running and are referred to later in the text.

[1] From the presidential address delivered at Southampton on August 31 before Section I (Physiology) of the British Association.

## OXYGEN INTAKE, OXYGEN REQUIREMENT, AND OXYGEN DEBT.

In recent papers my colleagues and I have tried to emphasise the importance of a clear distinction between the oxygen intake and the oxygen requirement of any given type and speed of muscular effort. When exercise commences, the oxygen intake rises from a low value characteristic of rest to a high value characteristic of the effort undertaken. This rise occupies a period of about 2 minutes; it is nearly complete in 90 seconds. The oxygen used by the body is a measure of the amount of energy expended: one litre of oxygen consumed means about five calories of energy liberated, enough to warm 5 litres of water 1° C.—expressed in mechanical energy, enough to raise about 1 ton 7 feet into the air.

It has been established, however, that the oxygen need not necessarily be used during the exertion itself. The muscles have a mechanism, depending upon the formation of lactic acid in them, by which a large amount of the oxidation may be put off to a time after the exercise has ended. The recovery process, so called, requires this delayed oxidation: it is just as important to the muscle as recharging to an electrical accumulator. The degree, however, to which the body is able to "run into debt" for oxygen, to carry on not on present but on future supplies, is limited. When an "oxygen debt" of about 15 litres has been incurred the body becomes incapable of further effort: it is completely fatigued. In anything but the shortest races our record-breaking athlete should finish with something near a maximum oxygen debt, otherwise he has not employed all his available power, he has not done himself full justice. The maximum effort, therefore, which he can exert over a given interval depends upon the amount of energy available for him, upon (*a*) his maximum oxygen intake (that is, his income), and (*b*) his maximum oxygen debt (that is, the degree to which he is able to overdraw his account). These maxima are fairly well established for the case of athletic men of average size—about 4 litres per minute for the one, about 15 litres or rather more for the other.

It is possible for a man to make an effort far in excess of any contemporary supply of oxygen. This effort will require oxygen afterwards, and the total oxygen needed per minute to maintain the exercise can be measured. It is what we call the "oxygen requirement" characteristic of the effort involved. Now experiments have shown (see Fig. 2) that the oxygen requirement varies very largely with the speed: it increases far more rapidly than the speed, more like the second, third, or even some higher power of the speed, so that high speeds and intense efforts are very wasteful. These facts enable us approximately to deduce the general form of Fig. 1. . . .

It is obvious, however, that we must not pursue the argument too far. A man cannot exhaust himself completely in a 100 or a 200 yards race: a quarter-mile, in the case of a first-class sprinter, is enough, or almost enough, to produce complete inability to make any immediate further effort. We have found an oxygen debt of 10 litres even after a quarter-mile in 55 seconds, and one of 15 litres after 300 yards at top speed. It is obvious, therefore, that we cannot pursue our argument below times of about 30 to 40 seconds, and that the maximum speed for very short distances is limited by quite other factors than the amount of energy available. Neither can the argument be applied to very long races, where other types of exhaustion set in.

## COMPARISON OF MEN AND WOMEN; SWIMMING AND RUNNING.

There are certain characteristics of these curves which are of interest. In the first place, those for men and

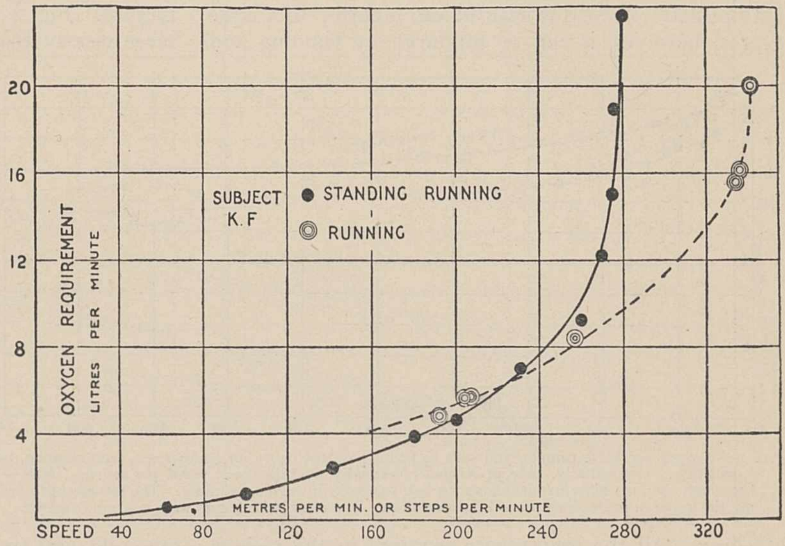


FIG. 2.—Observations of oxygen requirement of K.F. running and standing-running at various speeds. Horizontally, speed: running, metres per minute; standing-running, steps per minute. Vertically, oxygen requirement per minute, litres.

women are almost precisely similar. For a given time of swimming the maximum speed for a woman appears, throughout the curves, to be almost exactly 84 to 85 per cent. of that for a man. If we assume what is roughly true, that the energy expenditure rises approximately as the square of the speed, we may conclude that a woman swimming is able to exert, per kilogram of body weight, about 72 per cent. of the power expended by a man. Women are well adapted to swimming: their skill in swimming is presumably just as great as that of men; the difference in the maximum speed for any given time can be a matter only of the amount of power available.

In running, the same type of comparison may be made, and it is found that a woman running is able to liberate in a given time only about 62 per cent. of the energy expendible by a man of the same weight. It is probable that this ratio as determined by swimming and by running respectively is really the same in either case, and that the apparent difference depends upon an inexactness in the simple laws assumed. It would seem fair to take the mean of these two values, 67 per cent., as the ratio of the amount of energy expendible by a woman in a given time as compared with that by a man of the same weight. It would be of great interest—and quite simple—to test this deduction by direct experiment on women athletes.

### The Characteristic Oxygen-requirement-speed Curve and Skill.

The curves given in Fig. 2 define the economy with which movements are carried out. By such means can be shown the amount of energy required, in terms of oxygen used, in order, say, to run or swim for a minute at any given speed. The curves will vary largely from one individual to another. It is obvious, however, that such a curve must exist for any person performing any kind of continuous muscular exercise. In it we have a characteristic of that given individual for that particular form of work.

Some people are much more skilled than others. To a large degree, of course, the skill and grace associated with athletic prowess is natural and inborn; to a large degree, however, it can be produced by training and breeding. All the movements required in the violent forms of muscular exertion here discussed are rapid ones, far too rapid to be directly and continuously subject to the conscious intelligence: they are largely, indeed mainly, reflex, set going by the will, but maintained by the interplay of proprioceptive nervous system and motor apparatus.

The forms of the characteristic curves of Fig. 2 depend upon the skill of the subject in ordering his movements, just as the "miles per gallon" of the motor-car depends upon the skill of those who designed and adjusted its timing gear and its magneto. Given incorrect adjustment due to lack of skill, given imperfect timing of the several parts of the mechanism, given unnecessary movement and vibration, the whole system will be inefficient. Fundamentally the teaching of athletics for anything but the shortest distances consists in training the performer to lower the level of his characteristic curve, to carry out the same movements at a given speed for a smaller expenditure of energy.

### Bicycling and Horse-running.

Not all forms of muscular exertion are so violent, involve so great an expenditure of energy, when carried out at the highest speed, as running and swimming. In Fig. 3 are two examples of this fact, horse-running and bicycling. It is obvious at once that neither of these two curves falls anything like so rapidly as does that of a running man; fatigue does not so soon set in; the amount of energy expended at the highest speed must be much less than in a running man. This conclusion, indeed, is obvious to any one who has tried to ride a bicycle fast. It is impossible to exhaust oneself rapidly on a bicycle. The curve for horse-running is almost parallel to that for bicycling; presumably, therefore, the movements of a horse are so arranged that the extreme violence of effort possible in a human "sprinter" is unattainable.

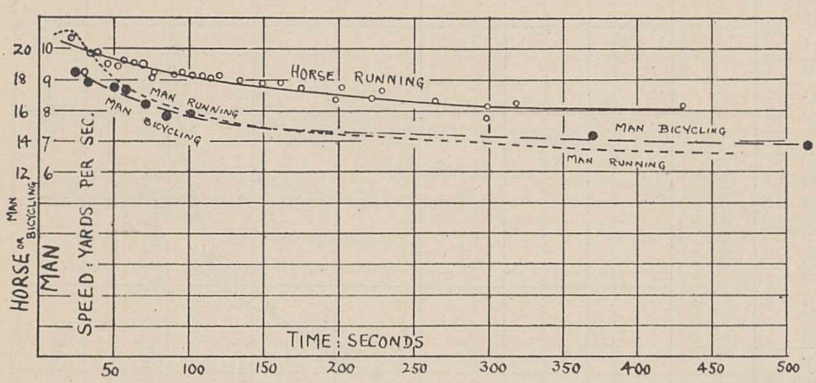


FIG. 3.—Records for horse running and man bicycling; dotted curve for comparison, man running, taken from Fig. 1. Horizontally, time in seconds; vertically, average speed yards per second. *Note.*—The horse and the man bicycling are shown on half the scale of the man running. The records for bicycling are the unpaced professional records against time. The records for horses were made in America.

### Short and Long Races.

Let us pass now to a consideration of the last diagram, Fig. 4. Average speed in a race is plotted against the logarithm of the time occupied in it, the logarithm being employed for the purpose of including all records from 75 yards to 100 miles in the same picture. Fig. 4 presents the data of athletics perhaps more clearly than any other. The initial rise of the curve for men running, which is due to starting inertia, is very obvious. The rapid fall beyond 220 yards is clearly seen. It is obvious that the 100 and the 220 yards ($\frac{1}{8}$ mile) records are better than those lying in their neighbourhood, that the quarter-mile record is extremely good, the 500 yards record very bad, by comparison with its neighbours. This diagram should enable any enterprising and scientific athlete to select the records most easy to break: let him try those for 120 yards, for 500 yards, for three-quarter-mile, for three miles, but not for 220 yards, quarter-mile, one mile, and six miles.

In Fig. 1 we saw that the speed fell to what seemed to be practically a constant level towards the right of the diagram: this fall represents the initial factor in fatigue. On the logarithmic scale, however, where the longer times are compressed together, the curve continues to fall throughout its length. This later fall is due to factors quite different from those discussed above. Consideration merely of oxygen intake and oxygen debt will not suffice to explain the continued fall of the curve. Actually the curve beyond 10 miles seems to some degree doubtful. Apparently the same extent of effort has not been lavished on the longer records: the greatest athletes have confined themselves to distances not greater than 10 miles. The most probable continuation of the running curve would seem to be somewhere between the lines B and C.

The continued fall in the curve, as the effort is prolonged, is probably due either to the exhaustion of the material of the muscle, or to the incidental disturbances which may make a man stop before his muscular system has reached its limit. A man of average size running in a race must expend about 300 gm. of glycogen per hour; perhaps a half of this may be replaced by its equivalent of fat. After a very few hours, therefore, the whole glycogen supply of his body will be exhausted. The body, however, does not readily use fat alone as a source of energy: disturbances may arise in the metabolism; it will be necessary to feed a man with carbohydrate as the effort continues. Such feeding will be followed by digestion; disturbances of digestion may occur—other reactions may ensue.

The women's curve, so far as it goes, is very similar to the men's. An enterprising woman athlete who wants to break a record should avoid the 300 metres; she would be well advised to try the 500 metres. It would be very interesting to have an intermediate point between 100 and 220 yards.

### Rowing.

There are only a few records available, and those lying between rather narrow limits, for the case of rowing. Taking the case of an eight-oar boat, the most reliable of the data have been plotted in Fig. 1 on the same scale as the running, on five times the scale of the swimming. The observed points, shown by crosses, are somewhat scattered. So far as they go, a mean curve through them would lie practically along the curve for women swimming, but, of course, on five times the scale. The interesting part of the curve to the left

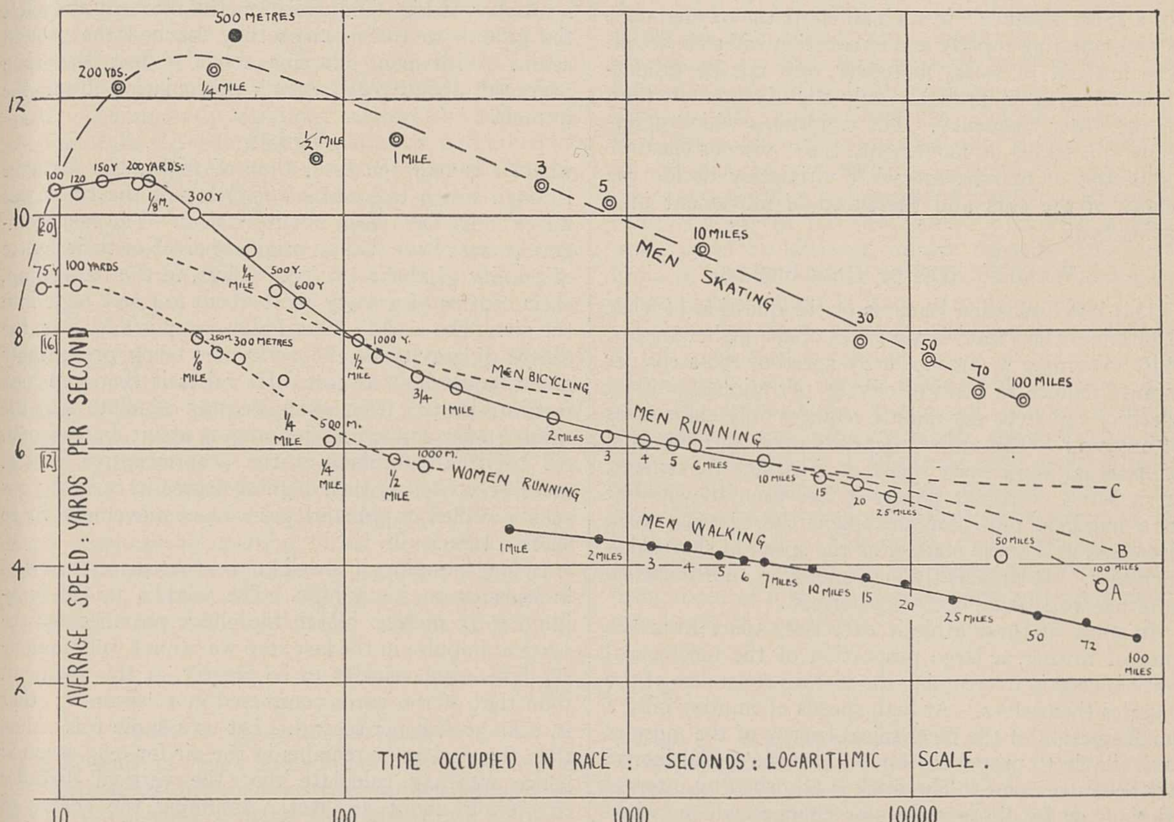


FIG. 4.—Records for men skating, bicycling, running and walking, and for women running. Horizontally, logarithm of time occupied in race; vertically, average speed in yards per second. The same scale is used throughout, except for bicycling, where half the scale is employed, as shown in square brackets. The curve for men running appears to be somewhat doubtful beyond 10 or 15 miles, and three alternative curves are shown by broken lines.

### Bicycling and Walking.

As before, the curve for men bicycling, which is drawn on twice the scale vertically of the running curves, is far less steep than they are. The conclusion from this was emphasised above. The walking curve is interesting—it is approximately straight. Physiologically speaking, there is not much interest in the shortest walking races, since here walking is artificial and extremely laborious; running at a considerably higher speed is much more easy. For longer distances, however, say from 10 miles onwards, we have probably in walking the most trustworthy data available for long-continued muscular effort. If we wish to study the exhaustion produced by exercise of long duration, walking-men may well provide the best subjects for our experiments.

is lacking: it is obviously impossible to make observations on an eight-oar boat for periods of 20 seconds; starting inertia is too great and no result of any value could be obtained.

In rowing the movements are slow: in an eight-oar boat, from 30 to 40 strokes per minute. According to observations by Lupton and myself, the maximum efficiency of human muscular movement is obtained at speeds of about one maximal movement per second. In rowing, experience and tradition alike suggest that such a speed is about the optimum. In an eight-oar boat the recovery takes almost as long as the stroke, both occupying about one second. It is of interest how practical experience has gradually evolved a speed of movement which is almost exactly what a physiologist might have predicted as the most efficient. At a stroke of about 32 per minute the mechanical efficiency is apparently near its maximum.

An enormous amount of work has to be done in propelling a boat at speeds like 10 to 12 miles per hour. According to Henderson, each member of the crew of an eight-oar boat must exert about 0·6 of a horse-power. Clearly, if this enormous amount of external work is to be done, it must be accomplished by working under efficient conditions: those conditions necessitate a stroke of a particular frequency; only when the race is very short is it permissible, in order to obtain a greater output, to work less efficiently by adopting a more rapid stroke. The stroke may rise to 40 per minute for a short distance: in such an effort the oxygen debt is accumulating rapidly and exhaustion will soon set in. The amount of work, moreover, will not be proportionately greater, probably only slightly greater, than at the lower frequency. The conditions which determine the speed of movement, the "viscous-elastic" properties of muscle, are what ultimately decide the length of the oars and the speed of movement in a racing-boat.

### Wastefulness of High Speeds.

This last discussion leads us to the question of what determines the great wastefulness of the higher speeds. Why, returning to Fig. 2, does a speed of 280 steps per minute require 24 litres of oxygen per minute, while a speed of 240 steps per minute requires only eight litres of oxygen? The answer depends upon the variation of external work with speed of muscular movement. In a series of recent papers it has been shown that in a maximal muscular movement the external work decreases in a linear manner as the speed of shortening increases. At sufficiently high speeds of shortening no external work at all can be performed.

In most of these athletic exercises, apart from the case of rowing, a large proportion of the mechanical work is used in overcoming the viscous resistance of the muscles themselves. At high speeds of running only a small fraction of the mechanical energy of the muscles is available to propel the body, once the initial inertia has been overcome. The work is absorbed by internal friction, or by those molecular changes which, when the muscle is shortening rapidly, cause its tension to fall off. When working against an external resistance, as in rowing, there is an optimum speed. If an effort is to be long continued it must be made at a speed not far from the optimum. When, however, the whole of the resistance to movement is internal, as in running, there is no optimum speed: the expense of the movement increases continually as the speed goes up; the faster we move, the greater relatively the price: our footsteps are dogged by the viscous-elastic properties of muscle, which prevent us from moving too fast, which save us from breaking ourselves while we are attempting to break a record.

### Jumping.

One final point may be worthy of mention—this time connected with high-jumping and long-jumping. Recently I made a series of observations, with a stop-watch reading to 0·02 second, of the times occupied by a number of high-jumpers from the moment they left the ground to the moment they reached the ground again. With men jumping about 5 feet the time averaged about 0·80 second. Calculating from the formula

$$S = \tfrac{1}{2}gt^2,$$

where $t$ is half the total time of flight, the distance through which the centre of gravity of the body was raised must have been about 2·5 feet. The men competing must have had an original height of their centre of gravity of about 2·9 feet. Thus, in the high-jump, their centres of gravity went about 5·4 feet high into the air. The world's record high-jump is 6·61 feet, the centre of gravity of the performer being presumably about 3 feet high at rest. He raises it therefore 3·61 feet into the air, from which we may calculate that the whole time occupied in the jump is about 0·96 second. All the characteristics of the proprioceptive system must be evoked in their highest degree in carrying out such a skilled, rapid, and yet violent movement in so short a time.

In long-jumping, it is well known that success consists in learning to jump high. The world's record long-jump is 25·48 feet. With the check provided by the vertical impulse in the last step we cannot well imagine the horizontal velocity to be greater, at this moment, than that of 100 yards completed in 10 seconds; that is, than 30 feet per second. Let us assume this value, then the performer remains in the air for 0·85 second: hence we may calculate that the vertical distance covered is about 2·9 feet. Assuming the centre of gravity of the subject to have been originally 3 feet high, this means that it must have reached a height 5·9 feet in the air, enough, in a high-jump, to enable its owner to clear 5·9 feet. It is interesting to find that the simple laws of mechanics emphasise so strongly the precepts of the athletic trainer.

## A High-frequency Induction Furnace for making Alloys.

A PAPER on a high-frequency induction furnace for making alloys was presented by Mr. D. F. Campbell at the autumn meeting of the Iron and Steel Institute held in Birmingham on September 10. The early work in this field was carried out at Princetown University by Dr. Northrup, whose investigations of the physical laws governing induction from high-frequency equipment led to the evolution of the first metal-melting furnaces. As Mr. Campbell points out, low-frequency induction furnaces have been known for forty years, and twenty years ago it seemed possible that they would, to a large extent, replace the crucible process for high-grade steel making. This possibility, however, has for a variety of reasons not been fulfilled. Inductive heating has, however, found wide application in the non-ferrous trade in furnaces having a vertical slot worked on normal commercial frequencies. These furnaces have the disadvantage of requiring an iron core, in consequence of which the molten metal is contained in small channels surrounding the iron core as well as in the main bath of the furnace. This involves much wear and tear of the refractory material.

In the case of high-frequency heating the conditions are quite otherwise. The container is a cylindrical vessel holding the maximum of metal with a minimum of radiating surface and refractory material exposed to corrosive action. The heat is generated in the charge to be melted and consequently there is no loss in the passage through refractory containers as in crucible furnaces. The high-frequency furnace has an immensely steep heat-gradient between the molten metal and the outside of the furnace. The furnace described by Mr. Campbell consists merely of a container or crucible placed inside a flat cylindrical coil. The intermediate space, about one inch in diameter, is filled with zircon or other insulating material contained in a silica or mica sleeve. The crucible need not be more than half an inch thick. As the heat is generated within the metal, the temperature of the crucible is very much lower than that of the metal itself. Consequently, reactions between the metal and crucible walls are reduced to a minimum, and crucibles of material quite inadmissible in other high temperature processes stand up well in the furnace.

According to the author, an ordinary clay crucible, such as is used for gold assays, will make from 10 to 30 heats of nickel-iron alloys containing less than 0·02 per cent. of carbon. A high-frequency furnace mixes the metal very thoroughly. The surface of the molten metal is pronouncedly convex, owing to the violent upward current at the centre of the liquid mass. This is a great advantage for the manufacturer of alloys made from metals which do not mix readily. The frequencies used may be termed "high" or "medium" and have varied from 20,000 to 400 periods per second, the lower figures being applicable to the larger furnaces for melting nickel silver and similar alloys. Furnaces of a capacity of 600 lb. are now working on certain nickel alloys. In cases where it is essential that the alloys should contain a minimum of carbon, it looks as though they will have a great field of application. The author states that the capital cost of equipment is high, but that some cheapening ought to be obtained in the future.

At present the principal application of this method of heating is in the preparation of alloys which are used for the manufacture of continuously loaded cables. Indeed, the discovery of the two principal alloys now used, namely, permalloy and mumetal, was made possible by the use of a high-frequency furnace. These alloys are composed principally of nickel and iron with small percentages of other metals, and the lowest possible amount of carbon. By the use of this alloy the speed of signalling by long-distance submarine cables has been raised from a maximum of 300 letters per minute for that type of cable to 1800 for a continuously loaded cable. This performance was obtained between the Azores and the United States. An installation recently completed near Birmingham has by far the largest melting capacity of any high-frequency metallurgical works yet erected. The equipment consists of forty-two small converter units of from 35 to 40 kilo-volt ampere capacity fitted with furnaces capable of melting 20 lb. of nickel-iron alloys of the highest purity in from 40 to 45 minutes.

Great advantages are also being found for furnaces of this type used in research, owing to the speed with which small heats can be made either *in vacuo* or in air. The author states that in one instance where an investigation was being made into the properties of a series of alloys with a relatively high melting-point, twenty 2-lb. heats were made in eight hours. For some time past the Metallurgical Department of the National Physical Laboratory has included in its equipment a furnace of this type, and great use is being made of it in the preparation of an exceptionally pure series of iron alloys.

## Obituary.

### PROF. H. H. HILDEBRANDSSON.

THE death of Hugo Hildebrand Hildebrandsson at Upsala on July 29 of this year, at the advanced age of eighty-seven years, marks the passing of a meteorologist of exceptional character. He was secretary of the International Meteorological Committee in succession to R. H. Scott from 1900 until 1907, when he himself retired from the direction of the Institute of the University of Upsala, at which he was the first professor of meteorology, to be succeeded by his son-in-law, F. Åkerblom, the present professor. His name is known throughout the meteorological world for his activity in connexion with the study of clouds in all parts of the world, which culminated in the "International Cloud Year" 1896–97, and found further expression in the "International Cloud Atlas" published mainly under his guidance in 1896, with a new edition in 1910.

Hildebrandsson was scarcely less well known for his researches on "centres of action of the atmosphere" in the Transactions of the Royal Swedish Academy, and still further for his collaboration with Teisserenc de Bort, not only in the investigation of the upper air, but also in the publication through Gauthier-Villars of "Les Bases de la météorologie dynamique: Historique—État de nos connaissances," a truly magnificent work left unfinished by the untimely death of Teisserenc de Bort. For the text of that work Hildebrandsson was mainly responsible, though it expressed the joint ambition of both to have full regard to the unity of the atmospheric circulation and treat meteorology as a world study. With that ambition, in 1907, the two friends became the bureau of an International Commission for a *réseau mondial*. Teisserenc de Bort wished it to be telegraphic, but the expense at that time being prohibitive, Hildebrandsson pressed the claims of a climatological *réseau*. The Commission still exists, with Dr. Simpson as president, and in the development of wireless telegraphy Teisserenc de Bort's ambition will be realised.

It was in his attitude towards world meteorology and a *réseau mondial* that Hildebrandsson displayed his special characteristic. Most meteorologists are content to write commentaries on some point or subject of physical or geographical importance in the structure or circulation of the atmosphere; Hildebrandsson wanted to make out the connected story of the atmospheric circulation before embarking upon a commentary. He recognised that writing commentaries runs great risk of marking time so long as the author has only nebulous ideas about the text upon which he comments, and that the elaboration of the text for meteorology is an inductive enterprise of the most embarrassing character. At the same time, he knew that there is no short cut: no ingenuity can produce a substitute for the inductive co-ordination of the real facts of the circulation. Hence the Meteorological Institute at Upsala, an academic establishment with no responsibility for any *réseau* of stations, became a centre of illumination and learning for the Scandinavian countries, and typical of a college for the meteorology of the globe, a nucleus round which effective knowledge of meteorology may crystallise with a rapidity as surprising and as beautiful as the laboratory experiment which furnishes the analogy.

Like some other meteorologists, Hildebrandsson began as a physicist and he remained a physicist to the end; but it is clear from the records of his work that he recognised the true basis of the science of meteorology to be neither physics nor geography alone, but a combination of the two. NAPIER SHAW.

MR. THOMAS STEEL.

BY the death of Mr. Thomas Steel in Sydney on August 17 last, Australia has lost an enthusiastic and observant naturalist. His publications include descriptions of Australian land planarians and notes on their habits. Mr. Steel was born in Glasgow in 1858, and after training as a chemist entered the service of a sugar refinery in Greenock. In 1882 he was appointed chemist to the Colonial Sugar Refining Company of Sydney. Much of his spare time was devoted to the study of the fauna of New South Wales and of Victoria, and he accumulated a large collection of excellently preserved specimens, especially of land planarians and Peripatus, many of which he gave to the Australian Museum and others to his zoological friends in Great Britain. Mr. Steel was a prominent member of the Linnean Society of New South Wales, and was president in the years 1905–7.

PROF. S. J. JOHNSTON.

PROF. S. J. JOHNSTON has not long survived his former chief, Prof. W. A. Haswell. Johnston joined the staff of the Department of Zoology in the University of Sydney in 1906, and soon became known as a stimulating lecturer and demonstrator in the practical classes. His memoir on the Trematodes of Australian frogs gained for him the doctor's degree in 1912. On the retirement of Prof. Haswell in 1918, Johnston was appointed to succeed him, but his health soon failed and he resigned at the beginning of 1922. He died on July 16.

WE regret to announce the following deaths:

Prof. H. Bekker, secretary of the Natural History Society (Rerum Naturae Investigatorum Societas), at the University of Tartu (Dorpat) in Estonia.

Dewan Bahadur Lewis Dominic Swamikannu Pillai, president of the Madras Legislative Council, and author of "An Indian Ephemeris, A.D. 700 to A.D. 1799," and other works on Indian calendar systems and chronology, at sixty years of age.

Capt. H. Riall Sankey, past-president of the Institution of Mechanical Engineers, an authority upon steam and gas engine problems, and consulting engineer of the Marconi Wireless Telegraph Co., Ltd., on October 3, in his seventy-second year.

Sir William Schlich, F.R.S., formerly professor of forestry, University of Oxford, and inspector-general of forests, Government of India, on September 27, at eighty-five years of age.

## Current Topics and Events.

CONGRATULATIONS are due to Prof. W. Carmichael M'Intosh, F.R.S., emeritus professor of natural history in the University of St. Andrews, who celebrates his eighty-seventh birthday this week, having been born on October 10, 1838. Time has dealt kindly with this veteran of science, as all must have noticed who, in London, this summer, came in contact with his engaging and breezy personality. A pioneer of research in fishery problems, he was the first to found a marine biological station in Great Britain. Elected a fellow of the Royal Society in 1877, Prof. M'Intosh received a Royal medal in 1899, at the hands of Lord Lister, then president, in recognition of his labours as a zoologist. Earlier (1869) the Royal Society of Edinburgh awarded him its Neill prize for his paper "On the Structure of the British Nemerteans, and on some New British Annelids." President of the Section of Biology of the British Association, Aberdeen meeting, 1885, he discoursed at some length on the phosphorescence of marine animals. Last year Prof. M'Intosh received the Linnean medal allotted especially to mark the Linnean Society's admiration for the single-hearted devotion and unremitting industry with which he had engaged in the study of the animal inhabitants of the sea. Opportunity was taken to congratulate him on the completion of his great "Monograph of the British Marine Annelids," published by the Ray Society. We understand that Prof. M'Intosh has been a fellow of the Linnean Society for sixty-two years, whilst being second in seniority amongst the whole body of fellows, in point of election.

NEITHER students nor staffs have much enthusiasm for the speech-making incidental to the formal occasions of academic bodies; but few of us, happily, are really immune from the infection of ideas, and the flood of formal oratory serves a variety of purposes, mostly good. The London Medical Schools have just experienced such a flood on the opening of their winter session. Prof. Buckmaster, at St. George's, referred to his own student days half a century ago, when the microscope was not of much service to medicine and practically no students possessed one. Some specialists may be found who declare that the days of the microscope are now over: probably a partial and propagandist view. But ten years are enough to cover the latest revolution in medical outlook, for the rise of physiology to its present dominating position is scarcely older. Sir Charles Sherrington, speaking at the London (Royal Free Hospital School) of Medicine for Women, said the average annual earning of the medical practitioner in England to-day had been put down at between 500*l.* and 600*l.* The estimate is surprisingly low, and, if trustworthy, should be a salutary reminder that extravagantly paid specialists must constitute but a small group within the profession of medicine. It was not, to his mind, a discouraging average in the era before us, "which must, perforce, be one of national economy and fortitude." Bread alone would not account for the enthusiasm shown in the choice of medicine as a calling. Sir Arthur Keith, addressing the King's College Hospital students, besides suggesting "a curious warfare between the stomach and the brain" (Carlyle, Darwin, Huxley and Spencer constantly complained of their stomachs), repeated a statement which he has made before, much to the pleasure of the lay press, that we do not use all our brains—that "there is no fear of using the matured brain to its fullest capacity." Sir Arthur, always a lively and suggestive speaker, has not, so far as we know, wholly elucidated this thesis. Why should we have inherited for a quarter of a million years, possibly for much longer, an organ of such intricacy if in all the generations of this considerable period we have never used it? Does Sir Arthur Keith mean quite what the newspapers—or even brother anatomists—understand him to mean?

WE have received notice to the effect that the Government of Bombay has been pleased to direct that the Bombay Bacteriological Laboratory at Parel should in future be designated "The Haffkine Institute." The suggestion of change of name appears to have come in the first instance from Lt.-Col. F. P. Mackie, who received the support of Major-Gen. Hooton. The president of the Bombay Medical Council, and the Municipal Commissioner for the city of Bombay, saw no objection to the alteration. The laboratory was first started by Mr. Haffkine in 1896 for the preparation of his plague prophylactic and was then housed in Byculla. Later (1899) it was moved to the present site and was called the Plague Research Laboratory and afterwards was named "The Bombay Bacteriological Laboratory." Since 1896, more than 25 million doses of plague vaccine have been issued from this institute, and it is considered just that Haffkine's name should be attached to the Laboratory on the analogy of the Lister or Pasteur Institutes. There must, however, be many who would not assign to W. M. Haffkine a place beside Lister and Pasteur. Waldemar Mordecai Wolff Haffkine comes of a Jewish family and was born in Odessa in 1860. He was educated in Odessa as a geologist, and after a short time with Schiff the physiologist in Geneva, migrated to Metchnikoff's department in the Pasteur Institute in Paris. Here he held a subordinate post and developed his ideas on cholera protection by inoculation. Through the influence of Lord Dufferin, especially, he went to India in 1893 and inoculated a large number of people against cholera and at a later period against plague. He was a man of uncanny enthusiasm and was regarded by many as a prophet of a new regime. Thirty years' persistence of plague in India have not entirely established his fame as a great reformer.

IN the October issue of the *Forum* Dr. E. E. Free discusses what he regards as "one of the most surprising failures of modern chemistry"—the failure to create life. For Dr. Free the problem is really that of the origin of protoplasm, and he tries to reconstruct the environment in which its abiogenetic synthesis may have become possible. It is refreshing to find an American rejecting the Planetesimal Hypothesis in favour of the more recent views of Jeans. Few of the British school, however, will agree that after the earth had solidified, the sun's heat was still sufficient to maintain the surface at a temperature of 1400° F. At a later stage during the cooling of the primeval atmosphere Dr. Free supposes that prussic acid and carbon monoxide were formed, followed by water; and he thinks it reasonable to assume that in the resulting ocean a natural synthesis of glycocoll and other amino-acids occurred. These had millions of years to be built up into more complex compounds, and at last the remarkable reaction was achieved whereby something akin to protoplasm came into being and started off the course of evolution that has culminated in man. The earliest known relics of life seem to represent bacteria, and on the other hand, glycocoll has already been prepared in the laboratory. The suggestion is that the gap is narrowing, and that chemists may soon succeed in synthesising "protoplasm." But it may well be doubted whether the chemist who first makes "protoplasm" will, as Dr. Free appears to hope, have also created life. A piece of protoplasm cut from an *amœba* soon dies if it does not contain the nucleus, and it is surely unreasonable to anticipate that the chemist's "protoplasm" would fare so much better that it could reverse the process and come to life where no life had been before.

DR. ALEŠ HRDLIČKA, whose lecture at the Royal Anthropological Institute on his recent visit for purposes of archæological investigation to India, Java, Australia, and South Africa appears in another column, is universally recognised as one of the foremost of American anthropologists. For many years he has been Curator of Physical Anthropology in the United States National Museum at Washington. His first contribution to anthropological literature was made in 1895, when he published a report on an investigation of the characters of the inmates of an institution for juvenile delinquents, in which he was able to show that the theories of Lombroso on signs of degeneracy to be observed in the physical characters of the criminal had no basis of fact. Dr. Hrdlička is perhaps best known for his work on the question of the antiquity of man in America. He has studied carefully all the osteological remains from that continent to which high antiquity has been attributed, and has visited the sites on which they were found. As a result of these investigations he was forced to the conclusion that neither in North nor in South America was there any evidence which supported anything but a relatively recent date for the peopling of the continent. It has been an inestimable gain to archæological studies that the first trained observer to visit the Broken Hill Cave and investigate the conditions of the discovery should be so stern a critic of evidence as Dr. Hrdlička.

IN a recent article (NATURE, August 22, pp. 265-267) on modern developments in British optical instruments, reference was made to the acknowledged superiority of British photographic lenses over those of foreign manufacture. It is satisfactory to learn from the makers of such lenses that the importation of optical glass for the manufacture of photographic lenses of the best type is now almost negligible. Before the War, the optical glass supplied by the one British manufacturer engaged on its production excelled that from abroad, kind for kind, both in transparency and homogeneity—the two essential properties; but only twenty-six types were available. These did not afford sufficient variety to meet the needs of the lens makers, who were thus dependent upon Germany, and to a less extent upon France, for their supplies of special glasses. The production of new types of glass was systematically developed in Britain during the War; and two additional firms took up its manufacture. There are thus three home sources of supply. The oldest of these firms now lists eighty optical glasses, and the quality of its products has been maintained. British photographic lens makers are now reaping the benefit of the enterprise shown by the glass manufacturers. The experience gained by the latter, combined with the research facilities now available, should assist them in supplying the optician with such new types of glass as may be called for as the result of developments taking place in optical science.

WE note with pleasure that work has been recommenced on the Exhibition Road frontage of the new buildings of the Science Museum, South Kensington. These buildings, planned some thirteen years ago, were supposed to have been completed in 1915, but while the skeleton ferro-concrete structure was being erected the War broke out, and the galleries were made later habitable for war-time offices by filling in the walls with temporary brickwork. This brickwork is now being demolished. It is thought the galleries will be completed in about two years and then the Museum will be in possession of suitable entrances, a feature it has always lacked. For years visitors have had to proceed by the rather disreputable passage at the side which suggests to one the entrance to a slum rather than a great national museum. We still think the Office of Works might make it less forbidding though it has to do duty for only two years longer.

ON September 30, in the Usher Hall, Edinburgh, before an audience of nearly three thousand people, Capt. Roald Amundsen was presented with the Livingstone Gold Medal of the Royal Scottish Geographical Society in recognition of his polar achievements. The Rt. Hon. Lord Salvesen, president of the Society, in presenting the medal said that it was offered as a token of the admiration that Edinburgh people had for the gallantry, courage and endurance which Capt. Amundsen had displayed in the various arduous undertakings which he had initiated. The Livingstone Gold Medal was endowed to the Royal Scottish Geographical Society in 1901 by Mrs. A. L. Bruce in memory of her father, Dr. David Livingstone, to be awarded for distinguished services to geographical exploration or research. This special honour has been conferred on fifteen previous occasions, the recipients being Sir Harry H. Johnston, Dr. Sven Hedin, Commdr. R. E. Peary, Capt. R. F. Scott, Sir Archibald Geikie, Sir George D. Taubman Goldie, Viscount Milner, Lord Avebury, Sir Ernest Shackleton, Sir John Murray, Capt. Evans, Lord Kitchener, Mr. Douglas W. Freshfield, Col. Frederick M. Bailey and Dr. Marion I. Newbigin.

As a sequel to the work of the Australian National Research Council in securing the foundation of a chair of anthropology in the University of Sydney, the Rockefeller Foundation is sending a delegation to Australia in November to visit the various universities and study at first hand their work and plans for research in anthropology and in all those sciences which may be grouped under the heading of "human biology." The delegation will consist of Mr. Edwin R. Embree, director of the Division of Studies of the Foundation, and Dr. Clark Wissler, head of the Department of Anthropology of the American Museum of Natural History.

IN the budget presented to the Commonwealth Parliament on August 14, provision is made for the appropriation of the sum of 100,000*l*. for the purposes of the Commonwealth Institute of Science and Industry. This represents a very large increase in the annual income of this Institute, which will shortly be completely reorganised and put in a position to attack national scientific problems in a manner hitherto beyond its resources. Proposals for a new constitution have been prepared at the request of the Commonwealth Government by a conference representative of the chief industrial concerns and scientific organisations of Australia, but it is not yet known to what extent they will be accepted by the Cabinet and submitted to Parliament.

THE Russian Academy of Sciences has received information of the discovery of an ore containing a valuable radioactive uranic mineral. The ore was found by Labuntsov on the western coast of the White Sea in the course of investigations on some mica and feldspar quarries on behalf of the Mineralogical Museum. It is expected that further deposits of this ore will be revealed in those regions. Deposits of this nature were unknown in Russia before. Hitherto this ore was found chiefly in the Congo. Samples of the new mineral were on view at the Mineralogical Museum during the recent bicentenary celebration of the Academy of Sciences.

THE third International Limnological Congress was held at Moscow in the "Home of Science" on August

25-30. The opening of the Congress was preceded by a visit to Leningrad, where a public reception in honour of the foreign delegates was given by the Russian Geographical Society. The delegates then visited the Hydrological Institute, the Zoological Museum of the Academy of Sciences, the Botanic Gardens, and the Scientific Research Institute at Peterhof. At the close of the session the delegates left for Saratov to inspect the oldest biological station, whence they travelled down the Volga to the Caspian Sea, inspecting the Volga and Caspian fisheries.

A NOTE from Carl Meissner, now Curator of the Botanic Gardens at the University of Kowno, Lithuania, but formerly Curator of the Botanic Gardens, Leningrad, which appears in the *Gardeners' Chronicle* for August 8 last, throws a vivid light upon the difficulties under which plants have been reared at the Botanic Gardens, Leningrad, during and since the War. With improvised incubators or other heating arrangements, however, Meissner still succeeded in raising *Victoria regia* and sends an interesting photograph to the *Gardeners' Chronicle* which shows one of the floating leaves of this enormous aquatic plant supporting the weight of a full-grown woman (72 kilograms). The appearance of the leaf margin shows that this unusual weight is causing considerable distortion of the leaf, but it is a striking example of the great buoyancy and strength of this floating lamina.

THE Georgian Academy of Sciences (Tiflis) had recently organised an expedition to study the architectural monuments scattered in different parts of the country. The main objects of interest were found at Uplisziche, Samzevrisi and Svimosti. Uplisziche is a cave city hewn out in the rocky banks of the river Kura, near Gori. It is one of the most ancient architectural monuments in Georgia, part of the caves being traceable to the epoch of the Roman Empire, the majority, however, belonging to the Middle Ages. Samzevrisi and Zromi are represented by monuments of ecclesiastical architecture of the pre-Arabic period, while at Svimosti there is a basilica belonging to the eleventh century.

WE learn with regret that the Comptroller of the British Patent Office has been prevented by indisposition from attending the international conference on industrial property, which is being held at the Hague. His absence will mean a serious loss to the British delegation, for Mr. Temple Franks has earned a high reputation as an exponent of British patent law. At the last moment, however, Mr. H. A. Gill, president of the Chartered Institute of Patent Agents, was appointed to take his place, so that the delegation will not lack an experienced technical expert. The appointment of Mr. Gill was a wise step, particularly in view of the fact that, for some unexplained reason, no representative of the technical staff of the Patent Office is accompanying the delegation.

A SPECIAL exhibition of palæolithic implements recently discovered by Dr. O. Hauser in excavations in Saxony has been arranged in the Naturkundliches Heimat-Museum, Leipzig, and will remain on view until the end of November.

A PUBLIC inaugural lecture on "Science and Culture" will be delivered on Friday, November 6, at 5.30 P.M., at King's College, London, by Prof. Julian S. Huxley, who was recently appointed to the chair of zoology in the college, in succession to the late Prof. A. Dendy.

THE Chemical Engineering Group of the Society of Chemical Industry performs two useful functions, one of which is educational and the other commercial. Many of the papers read before it contain useful information which is not otherwise easily obtainable in a compact form; other papers serve mainly to direct attention to special types of plant which are, or may be, on the market. Volumes 5 and 6 of the Group's Proceedings, covering the years 1923 and 1924, have recently been issued under one cover; they contain thirteen contributions together with reports of the supplementary discussions. As types of the purely educational paper may be mentioned those by Mr. B. Heastie on heat-transmission and on water-purification; genuine research work is represented by a valuable paper on silica gel as an adsorbent, by Prof. E. C. Williams, of University College, London; and descriptions of manufacturing plant and processes are embodied in papers on the manufacture of wood-extract, water-softening, the extraction of oil from seeds, nuts, and kernels, centrifugal dryers and separators, the Premier and other disintegrating mills. Prof. J. W. Hinchley contributes an interesting paper on the large-scale manufacture of potash fertiliser, alum, etc., from Italian leucite, and Prof. F. G. Donnan gives some useful control formulæ for leaching and evaporating, with special reference to the Chilean nitrate industry. Several of the papers were communicated to joint meetings of the Group and other societies, and in many instances the discussions were informative.

A BIBLIOGRAPHY of meteorological literature prepared by the Royal Meteorological Society, with the collaboration of the Meteorological Office, has recently been issued by the Royal Meteorological Society. At first the bibliography formed part of the Society's Quarterly Journal, but since 1920 it has been published in six-monthly parts. References are added to the several papers to indicate where they are located. The divisions deal with general meteorology, methods of observation and computation, instruments, physics of the atmosphere, investigations of the upper atmosphere, the several elements of meteorology such as temperature and rainfall, climatology, and terrestrial magnetism. The publication is of value to meteorologists in different parts of the world. The price to non-fellows is 2*s*. 6*d*.

THE British Museum (Natural History) has recently issued Series 7 and 8 of postcards in colour illustrating flowering plants native to Britain. Each series of five cards (price 1*s*.) contains a brief discussion of the elements of the British flora, together with a list of the plants in the series, each with brief descriptions. The general account concludes as follows, after referring to some of the rarer elements in the British flora: "Rare plants should not be picked except for special reasons; they should be investigated and left to seed. Wild-flower competitions in which children are told that they must actually pick a flower before they add it to their list are much to be deprecated."

WE have received from the firm of Eisenschnidt, 60 Dorotheenstrasse, Berlin, a complete catalogue of German official maps, including the maps published by the various States and the geological maps. There is added a catalogue of Austrian maps. Full indexes of most of the issues are given with the catalogue.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: A poultry instructor at the Norfolk Agricultural Station, Norwich—The Director of the Station, 11 Bridewell Alley, Norwich (October 17). Junior assistants at the National Physical Laboratory in the electricity and aeronautics departments—The Director, National Physical Laboratory, Teddington (October 24). Two research fellows in the department of Glass Technology of the University of Sheffield—The Registrar (October 24). An assistant for soil survey work in the Harper Adams Agricultural College, Newport, Salop—The Principal (October 26). A professor of surgery in the University of Lucknow—The Registrar (October 31). A senior lecturer in botany and agronomy, and a lecturer in geography (especially in human and commercial geography), in the Transvaal University College—The Registrar, Transvaal University College, Pretoria (November 12). A professor of physics in the University College, Colombo, Ceylon—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (November 20). An assistant lecturer in agriculture at the Harper Adams Agricultural College, Newport, Salop—The Principal. A senior hydraulic engineer by the Government of the Gold Coast—The Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/13968). A computer for the Gold Coast Survey Department—The Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/13965). Teachers for evening classes at the Northampton Polytechnic Institute in the subjects of mathematics, electricity, mechanics and heat, light and lens workshop—The Principal. A fellowship in chemistry at Trinity College, Dublin—The Registrar.

## Our Astronomical Column.

MEASUREMENT OF PLANETARY RADIATION.—W. W. Coblentz and C. O. Lampland describe their researches in this field in Lowell Observatory Bulletin, No. 85. Various screens (fluorite, quartz, water, glass) were used to isolate different regions of the spectrum; bismuth and platinum-rhodium wires were chiefly used in the thermo-couples; tellurium wire is found to be still more sensitive, but its action is slower.

The percentage of radiation that is planetary (*i.e.* due to warming of the planet's surface or atmosphere) is 3 from Jupiter, 9 from Venus, 15 from Saturn, 30 from Mars, 80 from the moon. It thus increases with diminution of atmospheric density. It cannot be inferred, where the atmosphere is dense, that the surface of the planet is as cold as these figures would indicate. It is, for example, quite improbable that the surface of Venus (on the sunlit side) is near freezing-point; the measures really refer to a high layer in its atmosphere. The case of Mars is discussed in great detail. It is concluded that its day surface temperature may reach 10° or 20° C., while that of the moon may reach 80° or 100°.

Investigations on stellar temperatures were also made. The results range from 13,000° for $\epsilon$ Orionis, Bo, to 3000° for Antares, Map, and $\beta$ Pegasi, Mb.

A NEW THEORY OF VARIABLE STARS.—Dr. J. H. Jeans contributes a paper to the June issue of the Monthly Notices of the Royal Astronomical Society that contains some bold speculations connecting the long-period variable stars with spectroscopic binaries. He collects statistics of these binaries from Lick Observatory Bulletin 385, and deduces the mean value of the sum of masses of the two components as 18 (Sun), and the mass ratio as 0·73, the less massive star having the "earlier" spectral type. His suggestion is that the long-period variables represent the stage preceding fission in such stars. He postulates that both rotation and oscillation are present, and that the periods of these are at first different but gradually approach each other, becoming identical just before fission. The theory is shown to account for several observed types of light curve, including the Cepheid type. Since even the M type variables have frequently a single definite period of light change, it is thought that these stars may have commenced the fission process in an earlier non-luminous stage. The author concludes that the temperature of both stars rises at fission, and thus explains the prevalence of type B in spectroscopic binaries.

SPIRAL NEBULÆ.—Dr. K. Lundmark, who has for some years made a special study of these objects, has written a further paper on them in the Monthly Notices of the Royal Astronomical Society, 85, No. 8. He first discusses proper motions and radial velocities; the latter are concluded to reach a maximum of 2250 km./sec. at a distance of 110 Andromeda-nebula units, or $10^8$ light years. The sun is moving (relatively to the spirals) towards galactic longitude 75°. It is conjectured that this may arise from a rotation of our local stellar system in a period of $3 \cdot 10^9$ years. The proper motions appear to be too small and doubtful for use. From the fact that they appear to be less than 0·01″ annually, a minimum distance of 30,000 light years is found. Indirect methods give much greater distances. Assuming the novæ in spirals to be of the same character as galactic novæ, distances of the order of a million light years are found for the nearer spirals, in good agreement with Dr. Hubble's results from Cepheid variables found in them. In this case the bright Nova S. Andromedæ, found in 1885, was of absolute magnitude −16, and was comparable with Tycho's Cassiopeia Nova. Dr. Lundmark has found a star of magnitude 13·7 and spectral type Mb, which is probably Tycho's star. Its spectrum shows giant characteristics, and it is concluded to have been of absolute magnitude −16 at maximum.

The paper concludes with some interesting speculations on the Lambert-Charlier suggestion of successively higher orders of systems; galaxies of galaxies, and so on. The facts, so far as known, are concluded to accord with the suggestion.

## Research Items.

EXORCISM IN ZANZIBAR.—Mr. W. H. Ingrams describes in the September number of *Man* certain customs observed by the inhabitants of the village of Makunduchi, Zanzibar, which are not found elsewhere among the natives of the island. The inhabitants of this village and the adjacent village of Jembiyani speak a peculiar and distinctive dialect, although both belong to the Wahadimu, the aboriginal inhabitants of the island. One characteristic feature of their culture is an exorcising dance performed by the women, the orchestra only consisting of men. The women possessed of the devil sit in a small tent while the dancers move backward and forward from sunlight to shade under a palm-leaf shelter. Some of the women carry iron tridents on long handles, others knives and swords, and others model outrigger canoes and paddles. As the devil cannot speak the local dialect, a special incomprehensible jargon is used. The devil can only be contracted at sea, and a legend of the origin of this state of possession has it that the devil first appeared from the sea in a canoe and holding a trident. It is suggested that the rite and legend may enshrine a memory of a cult of Poseidon introduced by early Greek sailors who, it is known, travelled along East Africa, and to whom the first description of Pemba and Rhapta is due. It is noted that a coin of Ptolemy X Soter has been discovered at Msasani, north of Dar-es-Salaam.

MAGIC AND MEDICINE AMONG THE AMERICAN INDIANS.—Mr. Charles Whitehead, of the U.S. National Museum, in Art. 10 of vol. 67 of the Proceedings of the Museum, gives an account of the Indian exhibits in the collections which illustrate the history of medicine. The Indians attributed disease to the operations of spirits, or it might be caused by absence of the patient's soul. Consequently the remedial measures were almost entirely magical, and even in the therapeutic use of plants, more importance was attached to their magical properties, the incantations with which they were gathered and the ceremonial accompanying their use, than to experience of their healing properties. In fact, their use was usually determined by some imagined resemblance or relation to the symptoms of the disease, or its mythical cause. Disease was closely connected in their myths with animals, especially the deer. Consequently, for a disease caused by the rabbit, the antidote must be a plant called the rabbit's foot, rabbit's ear, or rabbit's tail; for snake diseases the plant used is snake's tooth ; for worms, a plant resembling a worm, and so forth. Their knowledge of surgery was based on a comparative knowledge of the anatomy of the higher animals. Splints, bandages, and the cautery were used, and bone-settings, cupping by sucking, poulticing, cutting, counter-irritation, and venesection were practised. For the last, small chips and flakes of flint were employed as lancets.

TYPES OF AVALANCHES.—In an article on "Les Catastrophes de la Neige" in *Matériaux pour l'étude des calamités*, No. 5, 1925, M. A. Allix suggests a classification of avalanches based first on the condition of the snow, and secondly on the effects of the avalanches. He recognises avalanches of dry snow, occurring below freezing point, and of wet snow, with a higher temperature. These produce respectively cold and warm avalanches, the terms being used relatively. Cold avalanches occur as streams of fine powdered snow following the snowfall. When once a crust has formed on the fallen snow it moves in slabs or flakes (*plaques*) to which different names are given. Warm avalanches of wet snow occur in larger slabs of relatively slow movement, of which several forms are recognised. All avalanches have a common origin in loss of equilibrium. If the snow is in a state of unstable equilibrium, the most insignificant cause may start the avalanche. A fall of rock, the movement of a train in the valley, even the sound of a voice may furnish the secondary cause. Other causes also operate : unequal contraction due to rise and fall of temperature ; saturation of snow with water ; and lack of initial cohesion. The paper considers protective measures and includes a short bibliography of the subject.

THE MANURING OF FRUIT TREES.—In the *Journal of Pomology and Horticultural Science*, vol. iv. Nos. 3 and 4, June 1925, Mr. T. Wallace makes perfectly clear the need for more scientific experiments upon the manuring of fruit trees, and commences the description of a series of manurial experiments he has carried out at the University of Bristol Agricultural and Horticultural Research Station, Long Ashton, in which fruit trees, bush and smaller fruit, have been grown in sand culture in pots and supplied with mineral salts in solutions of known composition. These experiments should ultimately provide data of great interest to the plant physiologist, carried on as they have to be over long periods of time. In the present paper, the results obtained with apple trees, in experiments lasting over four years, are briefly given. In order to aid diagnosis of possible causes of trouble when the expert is called in to report upon lack of progress in fruit trees grown commercially, Mr. Wallace has adopted the plan of comparing the growth made by trees receiving all necessary nutrient elements with that made by trees in which one essential element alone is lacking. In four years, cultures along this line have yielded many results of great interest. For example, the large leaf growth and relatively good root growth obtained in cultures lacking calcium or magnesium compares strikingly with the poor root formation when potash is deficient, when the leaves also show great tendency to scorch and to fall early. Nitrate or phosphate deficiency is associated with late and weak development of both leaf and flower bud. Characteristic tints also appeared in the foliage before falling in many cases; thus magnesium deficiency was associated with purple blotches in the relatively large leaves before they fell. Such distinctions suggest that Mr. Wallace's hope to obtain information of value for diagnosis, if applied cautiously to meet the problems arising in practice, is in a fair way to be fulfilled.

RAINFALL IN KOREA.—The Meteorological Observatory of Zinsen (known more familiarly to the western world as Chemulpo) has published a volume of remarkably complete statistics on the "Rainfall in Chôsen (Korea)." The text is entirely in Japanese, but the tables, which form the bulk of the work, have also English headings, and being accompanied by a series of excellent maps, ignorance of the language is no bar to extracting any information which may be desired. Althouth Korea was probably the first country in the world in which rainfall observations were taken at a network of stations (a number of rain-gauges were in use so early as A.D. 1442), modern meteorology is of very recent development, and in a country of the size of Britain there are records for only 215 stations, most of which were established less than ten years ago. Apparently no attempt has been made to correct these various short series to a common period, and the maps must be regarded as provisional only. Nevertheless they give us our first clear idea of the distribution of rainfall in Korea. The annual amounts are similar to those in Britain, ranging from 18 to 68 inches, but the falls come chiefly in the summer monsoon in very heavy showers. Ten inches in a day have been recorded at many stations, and the maximum of 19·42 inches (485·5 mm.) in a day at Kosyu greatly exceeds anything known in Britain. The tables also include heavy falls in successive days, greatest and least monthly totals, number of days with various totals, and greatest falls in eight hours and in one hour. The latter table is based on self-recording gauges at eight stations.

THE ACOUSTICS OF HALLS.—The ease and certainty of the methods worked out by Sabine for the testing and improving of the acoustic properties of lecture halls are well illustrated by an article by Mr. A. G. Coombs in the September issue of the *School Science Review*. The new school hall at Berkhamstead was notoriously bad, the audience being unable to distinguish the words in the confused sounds that reached them. On shouting in the empty hall the reverberation continued for 10 seconds, and calculation of the time from the dimensions by Sabine's method gave 13 seconds. By covering the back wall and the ceiling under the gallery with 1800 square feet of " Cabot " quilting made of fireproof eel-grass, and the floor of the gallery with 850 square feet of cocoanut matting, the time of reverberation of the empty hall was reduced to 3 seconds, and of the hall and audience to 1·5 seconds, and it is now possible to hear in it without strain. The author has found the oboe suitable for producing the sound of constant loudness necessary for the tests.

BULLET PHOTOGRAPHY.—Although there is a general impression that the study of ballistics has made great advances since the War, it is only occasionally that an article dealing with such advances is published. The Bureau of Standards at Washington has designed an apparatus for bullet photography for the Frankford Arsenal, and Scientific Paper No. 508, by Mr. Philip P. Quayle, Assistant Physicist to the Bureau, gives an account of the apparatus and some of the interesting results obtained by its means. The spark is derived from a Leyden jar charged by an electrical machine and passes on the closing of a trigger spark gap by an electromagnet operated, without interfering with the bullet, either by the firing mechanism or by the passage of the head wave of the bullet over an interrupter. By means of the apparatus it has been shown that the service projectile from a 0·30 Springfield rifle ceases to be accelerated within a foot of the muzzle. Thirty-six figures are given, most of them photographs of the bullet with the head and sound waves, and several of them relate to the effects produced by the passage of the bullet through a soap bubble containing hydrogen (*v.* also NATURE, May 16, p. 765).

ROTATION OF THE PLANE OF POLARISATION OF ELECTROMAGNETIC WAVES.—Experiments with a molecular model consisting of four metal balls fastened together by wooden rods so as to form an irregular tetrahedron, which showed that in certain positions the plane of polarisation of an electromagnetic wave was rotated by this molecular model, have previously been described by Dr. Karl F. Lindman; and in the *Annalen der Physik* for August he describes a series of observations in which a considerable number of similar models with the balls embedded in spheres of paraffin wax were prepared, and placed in veneer or cardboard boxes which were put in the path of the waves. As many as eighty-five such molecular models were packed irregularly into a single box, and it was shown that their action on the waves was that of a practically isotropic substance, the rotation of the plane of polarisation depending only on the thickness of the layer of models through which the wave passed, and not on the orientation of the box, the amount of the rotation being proportional to the thickness. The direction of the rotation depended on the form of the asymmetrical molecular models. Observations were made with waves of different frequencies, and it was found that the relation between the rotation of the plane of polarisation, the wave-length employed and the wave-length of the natural vibrations of the models agreed with the formula deduced from Drude's electrodynamical theory.

STEEL MOULDING SANDS.—The steel castings industry of Great Britain is notoriously inferior to the best continental practice, particularly German and Belgian. One reason for this is that insufficient attention is paid to moulding sands and their properties. A very comprehensive paper on " Steel Moulding Sands and their Behaviour under High Temperatures," presented at the recent meeting of the Iron and Steel Institute by Mr. A. L. Curtis, does something to remedy this defect. Mr. Curtis has shown that great variation occurs in natural argillaceous sands of Pliocene origin, of which the St. Erth variety may be taken as representative, and that similar variation occurs in steel facing mixtures in current practice. It may be concluded, therefore, that much more frequent control tests are necessary before either choosing supplies of raw sands or preparing facing mixtures in the steel foundry. Mr. Curtis has developed certain tests, *e.g.* refractory and washing tests, which are more rapid than chemical analysis, and suggests that control tests could be rapidly made by these methods. He also describes permeability and dry crushing tests which afford a sufficient indication of the physical qualities of any resultant facing mixture. The factor of mechanical " green " strength has an important bearing on steel facing mixtures. Mr. Curtis indicates that results of his tests on these lines are in progress. The paper is fully illustrated with figures and photomicrographs. It should prove very useful to the industry.

MALLEABLE AND NON-MALLEABLE NICKEL.—For more than one hundred years after its application, nickel found very little industrial application. This was partly because the metal itself was not widely known and partly because as ordinarily produced it was non-malleable. In 1879 Fleitmann discovered a process for producing malleable nickel on a commercial scale, which consisted simply in adding about 0·1 per cent. of metallic magnesium to the molten metal just before casting. This process has been very successful, and is the method used to-day in the production of malleable nickel castings, and of ingot metal to be worked into sheet, rods, wires, and tubes. It has generally been supposed that it was the presence of oxygen which rendered the nickel non-malleable, and that magnesium acted as a deoxidiser. Recent work by Merica and Waltenberg has shown that this is not the case. Reference is made to this work in the *Metallurgist* of August 28. These authors conclude that neither oxygen, carbon, silicon, arsenic, iron, copper, cobalt, nor manganese impair the malleability of nickel. The harmful element according to them is sulphur, the presence of which, in amounts exceeding 0·005 per cent., is sufficient to cause lack of malleability in furnace-refined nickel. Magnesium as a desulphuriser is remarkably efficacious in removing the sulphide $Ni_3S_2$ which is present as a eutectic, and surrounds the nickel crystals with a film which renders them brittle.

## Dr. Hrdlička on Early Man.

At a special meeting of the Royal Anthropological Institute held on September 29, when Sir Arthur Keith, ex-president, was in the chair, Dr. Aleš Hrdlička, of the Smithsonian Institution, Washington, gave an account of his recent journey to India, Java, Australia, and South Africa for the purpose of visiting the sites upon which discoveries relating to early man had been made, and exhibited bones and other relics from the cave at Broken Hill in which the skull of Rhodesian Man was discovered. These remains are to be deposited at the British Museum (Natural History) at South Kensington. Dr. Hrdlička said that on his arrival in India he was surprised to find that, in addition to the new species of fossil apes from the Siwalik Hills already known, two or three more new species had been discovered and were in the Calcutta Museum, but had never been described. Their discovery had been made by Dr. Pilgrim, superintendent of the Geological Survey, and there was a risk that these important investigations in the Siwalik Hills, where fossil remains abounded, might not be continued. In Java he had visited the site on which *Pithecanthropus erectus* had been discovered. Here again there was a great field for discovery; but priceless material which might bear upon the history of man was being lost for ever as it washed out of the deposits and was thrown away or destroyed by the natives. From Australia, perhaps, a great deal was not to be expected. The Talgai Skull was so nearly akin to those primitive specimens, the Australian skulls, that it may not be very ancient; but definite conclusions are not yet possible.

In South Africa, within the last four years, two discoveries of the greatest importance had been made—Rhodesian Man and the Taungs Skull. On the position of research in South Africa, Dr. Hrdlička had a great deal to report and a great deal that was favourable. In the matter of the finds themselves, some very important details were not yet known and had not been mentioned. Broken Hill itself, the kopje in which Rhodesian Man had been found, had now disappeared, owing to mining operations, but nearby was a similar hill, which, like Broken Hill, was honeycombed with fissures and caves in which it was hoped that further discoveries might be made. Dr. Hrdlička then described the mining operations which, in digging out the material of the hill from the top, had cut across a section of the cave. In clearing out this cave, which was full of refuse highly consolidated, it had been found that the upper and nearly level part before the steeper slope began, was nearly choked with animal bones, which have now been smelted down. Here and there were softer spots from which the material had been thrown out into dumps. In the lower part of the cave were deposits which were nearly pure lead and of the consistency and colour of brown sugar. Near the cul-de-sac in which the cave ended, a miner named Zwiegler, working with a native boy, had brought to light the Rhodesian Skull resting on its base on a shelf as if placed there. No bones of any kind were near it. Under the skull was something which was described as a bag of "petrified" skin. This had now disappeared. From 3 to 6 feet further in had been found a human tibia, and still further a skull of a lion. Dr. Hrdlička had himself worked over the dumps which still remained and had found a stone implement, possibly part of a knife, a stone ball similar to some found before in the cave, a number of animal bones, some of which had been split as if to extract the marrow, and part of a humerus. Both the humerus and the femur, of which fragments were found, had been fractured in the same way and as if for the same purpose as the animal bones. The fracture of the humerus was undoubtedly ancient, and cannibalism would be no matter for surprise.

The discovery of the Taungs Skull, like that of Rhodesian Man, was wholly unlooked for in this part of Africa. It was an anthropoid of a new type, and it came from a site that was only partly exhausted. From pockets of soft pink limestone due to the filling in of caves which had formed in a hard ferruginous limestone plateau, large numbers of skulls of baboons were to be, and had been, obtained, and also in some cases where the skulls had perished, brain casts had been obtained. Dr. Hrdlička himself had found five skulls, of which he had succeeded in extracting three unbroken. These baboons had apparently crawled into the caves and fissures to die and had then been covered up by the deposit. Among these the Taungs Skull, the skull of a young anthropoid of a new species, had been discovered. It had been cleared of the deposit in a month's careful labour by Prof. Dart, and it was a tribute to his skill that the skull had not suffered a scratch in the course of the process. Arrangements had been made for a careful watch to be kept for any further discoveries and for Prof. Dart to be summoned at once should anything be found, so that it might be seen by him *in situ*. This skull was not the "missing link," but only one of many missing links, but in view of these remarkable finds, it was impossible to say what South Africa might not produce in the future.

## Library and Information Service.

The second annual conference of the Association of Special Libraries and Information Bureaux was held at Balliol College, Oxford, on September 25–28. Nearly two hundred delegates attended, which was more than double the number present at the first meeting. The diversity of interests attracted to the conference was surprising; scientific and research institutions, industry and commerce, and public affairs all being strongly represented. The marked variety of the professions of those attending caused widespread comment as to the real source of interest which was taken in the proceedings. A heavy, almost overloaded, programme of papers, numbering more than thirty, fully occupied the conference during the whole of the session.

Undoubtedly, the common link is the collection and the distribution of fact information. Special organisations for assembling and systematically storing literature in limited fields of knowledge, and still more those for distributing information therefrom, for the service of their members or others, are found to be much more numerous than was previously recognised. The Association has done much good by demonstrating this, and is now engaged in pursuing some obvious developments which arise from the discovery. Most of these organisations are quite distinct from ordinary libraries; in fact, in some cases their own collections may be limited to indexes, or other aids to rapid contact with scattered outside library resources.

One of the first objects in view is the preparation of a "Directory of Special Libraries and Information Bureaux" in Great Britain, for which the support of the Carnegie United Kingdom Trust has been obtained. This directory is intended to place on record the existence of all these bodies, and by suitable annotation to show clearly the field covered by the individual organisations and their facilities for a thorough command of their territory, even when their services are limited to the private needs of their members.

Another almost equally important object is the encouragement of an improved supply and a better distribution of scientific and other periodical literature, the vast extent of which has only just been clearly demonstrated by the publication of the World List of Scientific Periodicals, which will be referred to later.

The support of the movement for co-operation, nationally and internationally, in improving the service of abstracts in different branches of science, was discussed at the conference ; and although there is no intention of such a youthful organisation venturing to interfere with matters which obviously belong to older and more specialised institutions, it is clear that a body of this sort provides a useful forum for diffusing knowledge of the results of experience in different branches of science.

The international outlook of the conference was demonstrated by the presence of M. Otlet, of the Institut International de Bibliographie, Brussels, and visitors from Germany, Holland, and the United States. The goodwill and friendly interest from the United States, where a Special Libraries Association has been in existence for sixteen years, was demonstrated by the reception of a presentation set of their journal and other tokens.

Sir Arthur Steel-Maitland, Minister of Labour, welcomed the delegates in an opening speech, and strongly urged the national importance of the work of the Association to enable Great Britain to maintain its position in the industrial field. He feared that both the U.S.A. and Germany were more diligent than was Great Britain in keeping track of the results of pure and applied research, and in providing the means for their record and diffusion.

Prof. Gilbert Murray dealt with the work of the Intellectual Co-operation Committee of the League of Nations, in a contribution of particular value, since so little is known in Great Britain of this branch of the League of Nations. Foremost in its activities was the support of bibliographical enterprise, and only the lack of funds limited the extension of this work, which was considered so important for reconstruction. " It is by reading one another's books that we get into one another's minds. It is by co-operation in scientific and philosophical research, it is by co-operation in building up literature and art of the countries that we can hope to get the minds of the different nations moving again in concord, and working towards something like a common end."

Dr. Chalmers Mitchell spoke of the " World List of Scientific Periodicals," which has just been published with the help of the British Museum authorities, and which discloses the existence of nearly 25,000 separate periodicals issued between 1900 and 1920. He explained fully his suggestion for a central library to contain a complete file of all periodicals publishing scientific research, the library to be kept available for abstractors and indexers, and to retain the periodicals for at least two years after publication. This library would be in no sense a rival to existing libraries, which would continue to form the permanent home of their own collections. In the past, many institutions had been proud of their possession of a few hundred or a thousand periodicals, the " World List " should encourage a wider view of the situation, and stimulate co-operation and a pooling of resources so as to render available a better aggregate provision of literature for the scientific worker.

Sir Horace Plunkett described the Co-operative Reference Library, which it is hoped to transfer from Dublin to London. The conference passed a special resolution welcoming this proposal, as it was thought likely to be of great assistance in developing the agricultural progress of the country.

Miss A. L. Lawrence, of the British Medical Association, provided an interesting review of the " Co-ordination of Medical Information," describing work in the U.S.A., France and this country ; which was usefully supplemented by Dr. O. Kentish Wright, with an account of the service of the Ministry of Health.

Mr. Langdon-Davies (Labour Publishing Co., Ltd.) explained that the relatively small editions of scientific books were not necessarily a drawback if some clearer forecast of the demand could be arrived at. In another direction, he hoped libraries and publishers would not overlook the extraordinary thirst for knowledge of the manual workers, and the resulting need of clear and simple exposition of scientific and literary subjects.

Engineering science was fully represented by papers from Brig.-General Mowat, with an account of the library of the Institution of Mechanical Engineers, and Major Simnett on engineering and transport intelligence.

The conference greatly appreciated the opportunity of hearing from Dr. A. E. Cowley, Bodley's Librarian, something of the work of that great institution, the Bodleian, which is more and more tending to departmentalise its collection to meet the growing specialisation of knowledge.

The session on Sunday morning was devoted to a series of papers by leading representatives of the library service of the three main political groups. The description of their organisation and work showed that a high standard of intelligence service is aimed at, going far beyond any narrow party need of the moment. The information sections of such government departments as the Board of Education, Ministry of Health, and Imperial Institute were described, and certainly widened the knowledge of most of those present as to sources available in this direction.

The field of general library administration is fully covered by the chartered " Library Association," and the friendly relations between this older body and the present gathering were demonstrated by the presence of several members of the Council of the Library Association, who contributed papers and took part in the discussions. An attempt is to be made to explore the possibility of closer relations between the two bodies, but it is clear that they function to a large extent in different directions, and the newer body mobilises, probably for the first time, the interests of library users.

Perhaps of even more importance than the formal discussions was the opportunity which the conference afforded for personal intercourse between specialists engaged in such diverse callings. Without the conference many of these might never have come in contact with one another for the discussions of the few, but important, matters which their professional interests have in common.

The immediate future task of the Association, the preparation of a Directory of Special Libraries, can be materially assisted by the goodwill and support of scientific bodies in response to a questionnaire which will shortly be issued by the organising secretary, Mr. G. W. Keeling, from the Association's office at 38 Bloomsbury Square, London, W.C.1. R. S. H.

## University and Educational Intelligence.

ABERDEEN.—Dr. Alexander Low, reader in embryology at the university, has been appointed to the chair of anatomy, vacant through the resignation of Prof. R. W. Reid.

NEWCASTLE.—At the meeting of the council of Armstrong College held on October 5, Dr. Frank Smith was appointed professor of education in succession to Prof. Godfrey H. Thomson, who has been appointed to Edinburgh. Since 1914, Dr. Smith has been Senior Lecturer in Education and Master of Method at University College, Aberystwyth.

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THE following lecture arrangements of the Royal College of Physicians of London have been made: The Bradshaw lecture will be given on November 5 by Dr. E. Bramwell, who will speak on "The Myopathies"; the FitzPatrick lectures, on "Medicine in Ancient Egypt, Assyria and Palestine," will be given on November 10 and 12 by Dr. A. Shadwell; the Lloyd-Roberts lecture will be given by Sir Arthur Keith on November 16 (the subject will be "Man's Structural Defects"). The Bradshaw and FitzPatrick lectures will be given at the College at 5 o'clock, and the Lloyd-Roberts lecture at the Royal Society of Medicine at 5.30.

FROM the Technological Institute, Cawnpore, we have received a prospectus which describes the arrangements made for putting into operation the scheme adopted by the Government of the United Provinces in 1921 for combining instruction in chemical technology with research in industrial chemistry. Three courses are offered, each of three years' duration, namely, in general applied chemistry, in oil extraction and refining, and in leather manufacture. The classes are limited to three students in each department in each year of the course, and only graduates in science are admitted. Arrangements have been made enabling students to receive practical training in oil mills in Cawnpore, Bombay, and Ahmedabad, and in the Government Harness and Saddlery Factory, Cawnpore.

ADULT education in some shape or form should be regarded by the whole community as a benefit in which every one of its members should participate as a matter of course. This is the ideal, proposed by the Master of Balliol at the annual conference, held at Oxford last month, of the British Institute of Adult Education—" a real students' university for adult education." Some account of the London County Council's efforts in this direction is given in "A Guide to Continued Education in London," a new edition of which has just been issued. In this particulars are given not only of classes in commercial and technical industrial subjects, art schools, and day continuation schools, but also of various kinds of "institutes," literary, women's, men's, and free, in which instruction of a more or less informal character is given. All of these are of recent origin, the latest being the junior men's institutes of which five have been opened experimentally for the season 1925–26. They are open daily from Monday to Friday from 7 to 10 P.M., and the subjects of instruction include " English in the form of topics of interest to boys, wood and metal work, ' hobbies,' gymnastics, and boxing." Every endeavour is being made to introduce the "club" atmosphere and influence so as to attract boys for whom the more formal instruction given at the ordinary commercial and technical institute has no appeal.

## Early Science at Oxford.

**October 14, 1684.** A letter from Dr. Turbervile contained severall observations relating cheifly to ye eyes; and, which is yet more oblidging, it contained also his promise to communicate to us more observations of ye same kind The Society then ordered, that their thankes be sent to ye Doctor, for what he has already imparted, and for ye hopes he gives us of a continued correspondence with him.

A discourse concerning Sands and Clays, and another discourse concerning the quicksilver in barometers, both written by Dr. Lister, were read.

Dr. Plot comunicated an abstract of a letter, sent him by Dr. Tyson, which is as follows: I have lately sent me, by Caspar Bartholin, a small tract he has put out *de ductu salivali, hactenus non descripto*.—An Acquaintance of mine has lately put forth a Chronologicall Map from ye Creation to this time, in 16 large sheets of paper; which may either be pasted together in one or two maps, or else contrived conveniently into a booke.

He also communicated a substance, called *Solda*, which came from Timoa, one of ye Moluccas; it looked like an elmbark, had an aromatic smell, is an excellent Osteocolla, when pounded to powder, and put into spirits of wine.

He shewed us also a peice of silver talc, from Norway, on which fire makes no impression; and informd us, that in Staffordshire there are mountains of gold talc, which yeild not to violent fire.

The same Person shewed us a peice of copper, from ye East Indies; it was very heavy, of an irregular figure, like ye top of a cone, but flat; in which figure that mettall naturally grows in ye mines, whence this pattern was dug.

**October 20, 1685.** The Minutes of ye Dublin Society from July 6, to August 12 1685 were read, and ye thankes of ye Society ordered for them; there being mention made in them of wanting Insects according to ye matter of their ffollicles, this method was supposed by Sr Richard Bulkly then present at ye meeting to be impracticable, forasmuch as Insects of ye same species make use of materials of severall sorts, some of which are used by Insects of other kinds.

The same Gentleman was pleased to entertain ye Society with a farther account of his Calesh, which, he saies, is not onely uneasie, but dangerous for two persons to ride in at ye same time; but one person can travaile in it with greater ease to ye horse, than if he were on ye horse's back.

He gave ye Society an account of his Anemoscope, and presented them with draughts of a monstrous Child lately seen at Dublin.

There being some discourse concerning ye effect bleeding has on ye Eye-sight, arguments were urged from experience both for its being injurious, and its being advantageous to ye sight: Bleeding in fulnesse of vessels has cleared ye sight for some time, but frequently administered, and in a weak constitution, has taken from the strength of ye sight.

A letter from Dr. Vincent of Clare-Hall, Cambridge, concerning Dr. Papin's water engine, a letter from Mr. Over, Physitian at Winchester, to Mr. Coward of Merton College containing two cases of persons in ye small-pox, and a letter from Mr. Derham to Dr. Bathurst concerning some anatomicall observations in dissecting a child, were all communicated and read.

**October 21, 1684.** A letter of Mr. Lewenhoeck's, being observations about the Chrystalline humors of ye eye &c, was read.

The Latrôn, mentioned frequently in ye Minutes of this Society, was, after a great deal of rain, observed, at this meeting, to be very hard.

## Official Publications Received.

United States Department of Agriculture. Department Bulletin No. 1346: Status of the Pronghorned Antelope, 1922–1924. By Edward W. Nelson. Pp. 64+6 plates. (Washington: Government Printing Office.) 15 cents.

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 77: The Orthoptera of South Dakota. By Morgan Hebard. Pp. 33-155. Vol. 77: North American Veronicellidæ. By H. Burrington Baker. Pp. 157-184+plates 3-6. (Philadelphia.)

University of London. University College Faculty of Medical Sciences. University Centre for Preliminary and Intermediate Medical Studies, Session 1925-1926. Pp. vi+225-258+10. (London.)

Aeronautical Research Committee. Reports and Memoranda, No. 957 (Ae. 176): Experiments on the Transmission of Air Waves through Pipes. By L. F. G. Simmons and F. C. Johansen. (A.1.a. Dynamical Similarity, etc., 57—T. 1971.) Pp. 13+6 plates. (London: H.M. Stationery Office.) 1*s.* net.

Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1921, Neue Folge, Band 58. Pp. xvi+A36+B38+C40. (Wien.)

Conseil Permanent International pour l'Exploration de la Mer. Publications de Circonstance, No. 88: On the Development and Distribution of the Norway Bullhead (*Cottus lilljeborgi* Collett). By Anton Fr. Brunn. Pp. 15. Rapports et procès-verbaux des Réunions, Vol. 37: Rapport Atlantique 1924 (Travaux du Comité du Plateau Continental Atlantique) (Atlantic Slope Committee). Publié avec l'aide de Dr. Ed. Le Danois. Pp. 89. Bulletin statistique des pêches maritimes des Pays du Nord de l'Europe. Vol. 12, pour les années 1921–1922. Rédigé par D'Arcy Wentworth Thompson. Pp. 145. (Copenhague: Andr. Fred. Høst et fils.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology). Vol. 7, No. 3: *Nilssonia* Bed of Hokkaidô and its Flora, by Seidô Endô; Nummulitic Rocks of the Islands of Amakusa (Kyûshû, Japan), by Hisakatsu Yabe and Shôshirô Hanzawa. Pp. 57-82 +plates 11-22. (Tokyo and Sendai: Maruzen Co., Ltd.)

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 32: The Continuity of the Vertebrate Nervous System; Studies on Lepidosiren paradoxa. By Frances M. Ballantyne. Pp. 663-670+6 plates. 3*s.* Vol. 53, Part 3, No. 34: Studies in the Ammonites of the Family Echioceratidae. By Dr. A. E. Trueman and Daisy M. Williams. Pp. 699-739+4 plates. 6*s.* 6*d.* (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Nigeria. Annual Report on the Agricultural Department for the Year 1924. Pp. 12. (Ibadan.)

United States Department of Agriculture Library. Bibliographical Contributions, No. 8: Author and Subject Index to the Publications on Plant Pathology issued by the U.S. Department of Agriculture up to January 1, 1925. Compiled by Jessie M. Allen. Pp. ii + 158. (Washington: Government Printing Office.)

Contributions from the Central Meteorological Observatory of Japan. Vol. 1, No. 1: On Rayleigh Wave. By Hiroshi Nakano. Pp. 94. (Tokyo.)

Publications of the Astronomical Observatory of the Warsaw Observatory. Vol. 1. Pp. iv+40. (Warsaw.)

## Diary of Societies.

*SATURDAY*, OCTOBER 10.

BIOCHEMICAL SOCIETY (in the Biochemical Department, Cambridge), at 3.—Dorothy Needham and J. Needham: The Micro-injection of *p*H and *r*H Indicators.—G. S. Lund and C. G. L. Wolf: The Fermentable Sugar in Blood.—Sir F. G. Hopkins: An Oxidation of Proteins promoted by Glutathione.—Mrs. H. J. Coombs and Marjory Stephenson: The Gravimetric Estimation of Bacterial Growth.—L. J. Harris: Extension of the Principles of Acidimetry. Application to certain Biochemical Problems: (*a*) Analysis of Amino-acid Mixtures; (*b*) Volumetric Estimation of Casein and other Proteins; (*c*) The Rationale and Prediction of Protein Behaviour; (*d*) Polypeptides; (*e*) Insulin.—H. F. Holden: The Estimation of Glucose.—C. S. Hicks: (*a*) The Effect of a Tryptophane-Free Diet on the Thyroid Gland of the Rat, with Studies in Heat Production; (*b*) The Ultra-violet Absorption Spectrum of Acetyl-thyroxin.—C. S. Hicks and M. L. Mitchell: A Preliminary Report on the Study of Induced Polyuria in Rats.—H. W. Dudley and W. V. Thorpe: A Synthesis of N-methylputrescine and of Putrescine.—J. B. S. Haldane: The Effect of Diuresis on Purin Metabolism.—H. J. Channon and Prof. J. C. Drummond: Feeding Experiments with Spinacene.

MINING INSTITUTE OF SCOTLAND (at Edinburgh).

*MONDAY*, OCTOBER 12.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Lieut.-General Sir William Leishman: Presidential Address.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates Section), at 7.—G. Lyon: An Analysis of Tests on a High-speed Petrol Engine.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—J. Stirling: Chairman's Address.

INSTITUTE OF BREWING (London Section) (at Engineers' Club, Coventry Street, W.).—Discussion on this Season's Malts.

*TUESDAY*, OCTOBER 13.

PREHISTORIC SOCIETY OF EAST ANGLIA (at 52 Upper Bedford Place, W.C.), at 2.30.—M. C. Burkitt: Some Aspects of the Azilian-Tardenoisian Industries (Presidential Address).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—E. Parsons: Notes on the Geology of Java.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—W. S. Patterson: Metallic Corrosion.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Major-General Sir Percy Z. Cox: Mesopotamia—and on the Way (Lecture).

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—R. A. Hudson: Town Planning: its Effect and Influence on Industry.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. G. H. Rodman: The Story of Cuckoo Spit.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—F. Turville-Petre and Sir Arthur Keith: Early Man in Palestine: the Galilean Skull.

*WEDNESDAY*, OCTOBER 14.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. S. L. Cummins: The Prevention and Arrest of Tuberculosis.

INSTITUTION OF CIVIL ENGINEERS (jointly with Institution of Mechanical Engineers, Institution of Electrical Engineers, Institution of Naval Architects, Institute of Marine Engineers, North-East Coast Institution of Engineers and Shipbuilders, Institution of Engineers and Shipbuilders in Scotland, Institute of Chemistry of Great Britain and Ireland, Institution of Gas Engineers, British Electrical and Allied Manufacturers' Association, British Engineers' Association, Admiralty, War Office, and the Air Ministry), at 6.—R. A. Chattock: Standard Codes for Tabulating the Results of Trials on Steam Turbines and Condensing Plant.

INSTITUTION OF ENGINEERS-IN-CHARGE (at St. Bride Institute, Bride Lane, E.C.), at 7.30.—Eng. Vice-Admiral Sir George G. Goodwin: Presidential Address.

INSTITUTION OF CHEMICAL ENGINEERS (at Science Museum, South Kensington), at 8.30 (Reception).

*THURSDAY*, OCTOBER 15.

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street), at 5.30.—Major C. K. Cochran-Patrick: Aircraft Survey in Burma.

INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Margaret Macmillan: The Future of the Nursery School.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Prof. C. V. Raman and Sushil Krishna Datta: On Brewster's Bands: Part I.—W. G. Collins: Demonstration of a New Method of Recording Rapidly Varying Phenomena.

CHEMICAL SOCIETY, at 8.—Prof. H. B. Baker and Miss M. Carlton: The Effect of Ultra-violet Light on Dried Hydrogen and Oxygen.—Miss M. Carlton: A New Peroxide of Barium.—U. R. Evans: The Production of Oxide Films on Copper at Ordinary Temperatures.—Mrs. A. H. Atack and F. W. Atack: The Structural Isomerism of the Oximes. Part III. The Benzilmonoximes.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Dr. A. Balfour: Some of Our Pioneers (Inaugural Address).

*FRIDAY*, OCTOBER 16.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating the Pathological Anatomy of Acromegaly.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. W. Bennett: Ely Cathedral (Lecture).

INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—Captain H. Vivian: Chairman's Address.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. J. Tracey: Super-Tension Cable Dielectrics.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 8.—J. L. Adam: The Engineer and his Ship.

*SATURDAY*, OCTOBER 17.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital).

### PUBLIC LECTURES.

*SATURDAY*, OCTOBER 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Earliest Egyptians and their Remains.

*MONDAY*, OCTOBER 12.

UNIVERSITY COLLEGE, at 5.—R. J. Lythgoe: The Physiology of Hearing and Vision. (Succeeding Lectures on October 14, 19, 21, 26, 28, November 2 and 4.)—Prof. G. Dawes Hicks: The Philosophy of Bradley and James Ward.

KING'S COLLEGE, at 5.30.—Rev. Dr. F. A. P. Aveling: Applications of Psychology.

MEDICAL SOCIETY OF LONDON, at 5.30.—Dr. L. S. Burrell: Tuberculosis from the Physician's Viewpoint.

*TUESDAY*, OCTOBER 13.

BEDFORD COLLEGE FOR WOMEN, at 12 noon.—Miss Tarrant: Greek Philosophy.

UNIVERSITY COLLEGE, at 3.—Prof. E. A. Gardner: Proposals for Restoration and Excavation in Athens.

GRESHAM COLLEGE, at 6.—Sir R. Armstrong-Jones: Physic. (Succeeding Lectures on October 14, 15, and 16.)

*WEDNESDAY*, OCTOBER 14.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. L. Rodwell Jones: Geography and the University.

UNIVERSITY COLLEGE, at 5.30.—Dr. E. A. Baker: The Use of Libraries.

*THURSDAY*, OCTOBER 15.

UNIVERSITY OF LEEDS, at 5.15.—A. M. Woodward: The Excavation of Sparta.

KING'S COLLEGE, at 5.30.—Prof. C. Burt: The Contributions of Psychology to Social Hygiene.

*SATURDAY*, OCTOBER 17.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: The Story of Warfare in Europe.